Evaluating the Effectiveness of Various Truck Lane Restriction Practices in Florida—Phase II

Volume 2—Safety Analysis of Florida Urban Limited Access Highways with Focus on the Influence of Truck Lane Restriction

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16. Abstract

The safety analysis of Florida urban limited access highways was performed using a negative binomial regression model to analyze crashes occurring before and after a truck lane restriction was imposed on the study corridors. The before-and-after crash analysis data were from the years 2002 to 2006 while the geometric, traffic, and crash data used in the negative binomial regression model were from the year 2005. The results of the negative binomial regression modeling of crashes showed that the coefficient of the truck lane restriction variable in the model was negative, but insignificant ($p \leq$ 0.808). The negativity of the coefficient indicates that highway sections with a truck lane restriction had insignificantly less crashes than sections without a restriction. A statistical marginal effect analysis showed that in the year 2005, there was a 4 percent decrease in crashes on sections with a truck lane restriction compared to sections that did not have a restriction. In addition, the results showed that when the percent of trucks was changed in the model from a minimum of 2 percent to a maximum of 15 percent, there was a 22 percent decrease in crashes. However, when nearly two years of before-and-after crash data were analyzed using the Comparison Group method, the results showed an effective index of 1.32. This suggests that segments with a truck lane restriction had 32 percent more crashes than the comparison segments with relatively similar geometric and traffic characteristics. These results are consistent with the results of previous studies reported in the literature that showed a negative safety influence of truck lane restrictions on some highways, but a positive safety influence on others.

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EXECUTIVE SUMMARY

Background

The State of Florida, like many other States, has implemented truck lane restrictions on major interstate freeway corridors and on the Homestead Extension of the Florida's Turnpike. These corridors have three lanes or more in one direction. The Phase II study reported herein was initiated following the results of a Phase I study which showed there were safety and operational benefits associated with the implementation of a truck lane restriction on a rural section of the Interstate 75. The question was whether these benefits extend to urban corridors of limited access highways. There were a total of 1,216 centerline miles of urban limited access highways. Of this total, 430 miles has a truck lane restriction. An urban area was defined as a metropolitan area with a population of 500,000 people or more. The urban corridors with a truck lane restriction within these urban areas were on the Interstate 75, Interstate 95, and the Homestead Extension of the Florida's Turnpike (HEFT). Trucks were restricted from using the left (non-HOV) lane in these corridors. This review of the safety experience on urban limited access highways, coupled with the analysis of the traffic operations on these highways, was designed to assist the Florida Department of Transportation (FDOT) in developing guidelines for deciding which urban highway corridors can benefit most from the implementation of a truck lane restriction.

Objectives

The objective of this study was to determine the effect of truck lane restrictions on urban limited access highways. The study was achieved by analyzing crash experience before and after a truck lane restriction was implemented on a highway segment and by conducting a detailed modeling of crashes occurring on the Florida limited access highway system. The hope was to identify the factors that contribute to crash occurrence in areas with and without a truck lane restriction. The geometric variables of interest included the length of the highway segments, the number of lanes, the number of interchanges, the number of on and off ramps, lane widths, shoulder widths, the presence of a truck lane restriction, and the presence of a high occupancy vehicle (HOV) lane. Traffic variables, likely to influence the effectiveness of a truck lane restriction, were thought to be the average annual daily traffic volume (AADT), the percent of trucks, and operating speeds.

Findings and Conclusions

The negative binomial regression model was used to determine the influence of various regression variables on the occurrence of crashes. Special emphasis was on the impact of the truck lane restriction and truck volumes, represented by the percent of AADT. The results showed that the presence of a truck lane restriction was largely statistically insignificant in influencing the overall number of crashes occurring on an urban highway section ($p \leq 0.808$). However, the coefficient for this variable in the model was negative suggesting that in the year

2005, sections with a truck lane restriction tended to have fewer crashes than sections without a restriction, although insignificantly so. This tendency was confirmed with a marginal effect analysis which showed that implementing a truck lane restriction in year 2005 would have the effect of reducing crashes by 4 percent. These results are in line with the results reported in a number of previous studies investigating the efficacy of truck lane restrictions.

The results further showed a negative relationship between an increase in the percent of trucks and crash occurrence. The marginal effect analysis revealed that if the percentage of trucks on Florida urban highways in the year 2005 was increased from a minimum of 2 percent to a maximum of 15 percent, the annual occurrence of crashes will be reduced by 22 percent. This result is both intuitive and counterintuitive, and mirrors conflicting results reported in literature. It can be argued that increased truck volumes on a highway increase the probability of a crash occurrence. This is brought about by increased lane changes among passenger car drivers. It can also be argued that the presence of a higher volume of trucks reduces the number of gaps to the point that most passenger car drivers do not attempt to change lanes.

Another result worthy noting is the significance of the regional differences in the occurrence of crashes. The modeling results showed that driving on urban limited access highways in the Orlando area was relatively safer than driving in the Jacksonville area, followed by the Tampa area, followed by tri-county area of Palm Beach, Broward, and Miami-Dade. Numerous socio-economic variables were considered in an attempt to explain these regional differences. The socio-economic factors that were considered included the percentage of people in each county who are female, who are under 18 years of age, who are above 65 years of age, who speak a language other than English at home, who have a high school education, who have a minimum of a bachelor degree, and who have income below the federal poverty line. However, further econometric analysis is warranted, if one wants to focus on these regional differences.

The before-and-after analysis involved highway segments of which the date of the implementation of a truck lane restriction was known. These segments were on Interstate 75 close to Tampa and Interstate 95 in Jacksonville. A truck lane restriction was imposed on these two segments in May 2004. Other segments were on the HEFT in the Miami-Dade area where truck lane restrictions were introduced in May 2005. The Comparison Group before-and-after study resulted in an effectiveness index of 1.32. This suggests that segments with truck lane restriction had 32 percent more crashes than comparison segments with relatively similar geometric and traffic characteristics. Although this result is slightly opposite to the results of the negative binomial regression model, it is nevertheless similar to the results of previous studies found in the literature for highways in other states that showed an increase in crashes on some highways with a truck lane restriction.

Benefits

The benefit of this study to the Florida Department of Transportation is the understanding of the influence of a truck lane restriction on the occurrence of crashes on urban limited access highways. The results showed that there were no clear cut safety benefits associated with the implementation of a truck lane restriction, and in fact, the overall number of crashes may increase in some sections. However, a companion study showed that there were operational benefits

associated with a truck lane restriction, and that a truck lane restriction is a strategy popular with the traveling public as revealed by the literature review.

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CHAPTER 1

INTRODUCTION

1.1   Overview

Urban freeways and tollways in the United States are characterized by a significant number of trucks hauling freight between various origins and destinations. These trucks vary in size and operational performance, ranging from single unit trucks to multi-unit tractor trailers. In the United States truck travel has increased by over 200 percent as measured by vehicle miles of travel (VMT) while the overall VMT has increased by only 137 percent since the year 1970 (*1, 2*). Truck data was compiled by the National Center for Statistics and Analysis (NCSA) of the National Highway Traffic Safety Administration, which is part of the United States Department of Transportation (*3*). Reports of truck data for the years 1995 through 2004 showed the total number of registered trucks and truck vehicle miles of travel. Figure 1.1 and Figure 1.2 present the distribution of these parameters and their growth.
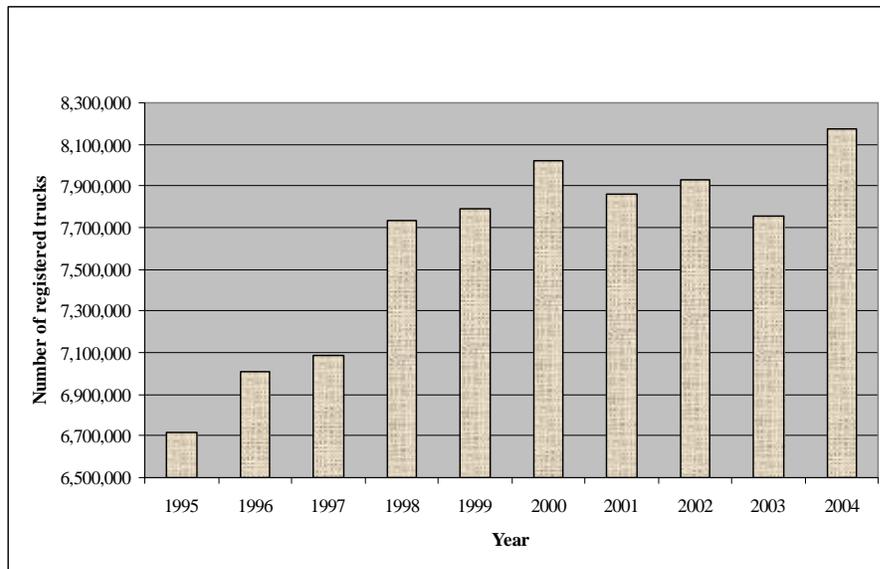
Figure 1.1: Distribution of the total number of registered trucks
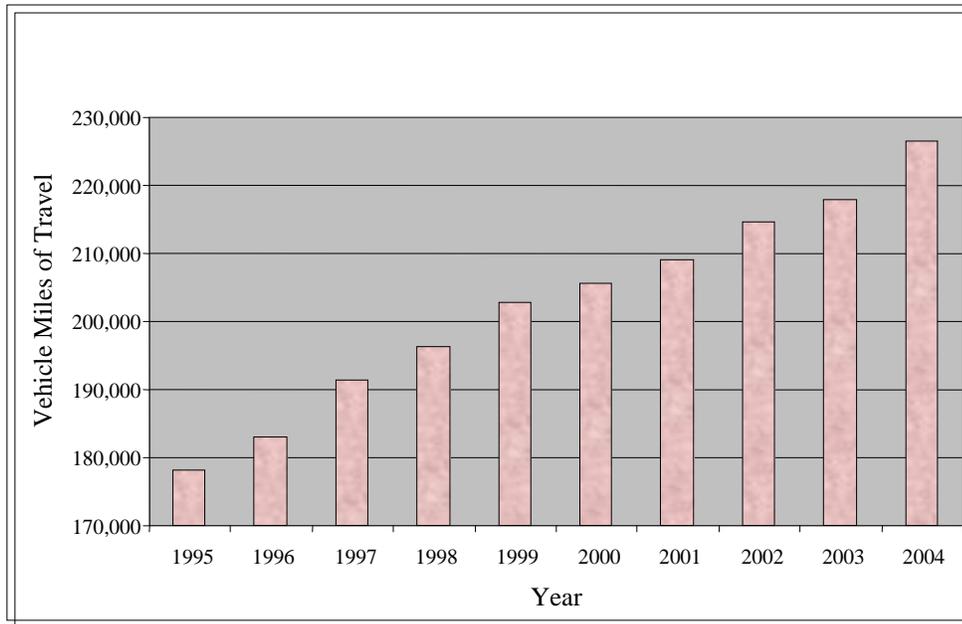
Figure 1.2: Distribution of truck vehicle miles of travel

In addition to these truck traffic data, crash data from NCSA showed that the number of overall fatalities and truck involved fatalities has been increasing over the years. Florida contributed an average of about 8% of the fatalities in the United States. Table 1.1 shows the statistics of fatalities in the United States and Florida. The continued growth of truck traffic on urban limited access roadways, coupled with the increased duration of congestion on these roadways, have raised concerns on the effect of trucks on safety and operational efficiency of these roadways. Some researchers argued that the increased truck traffic on freeways has not only degraded the quality of operations and the structural integrity of the pavements, but has also lessened the level of safety on freeways (*4*).

Table 1.1: Total fatalities in the United States and Florida

Year	2001	2002	2003	2004	2005
Total fatalities in US	42,196	43,005	42,884	42,836	43,443
Truck Involved in US	4823	4587	4721	4902	4935
Total fatalities in Florida	3,012	3,136	3,169	3,244	3,543
Truck Involved in Florida	365	376	365	377	406

Due to these concerns on truck traffic operations and safety, there have been efforts to reduce the effect of truck traffic on limited access highways. Methods that have been implemented include improvements in highway design, the introduction of operational strategies, and the use the intelligent transportation systems. The improvements in highway designs include modifications to highway geometrics, reconstructing or upgrading existing structures, and changes to design standards to accommodate the needs of trucks. Operational strategies that have been implemented include the management of truck traffic using the existing highway facilities. These strategies include weight restrictions on bridges, the introduction of express truck lanes through toll plazas, speed restrictions for trucks, truck route restrictions, and truck lane use restrictions. (*5*).

The use of intelligent transportation systems is also another method that has been used to improve traffic operations and safety on highways. Truck weigh in motion stations are one of the applications that improve the operational aspect of a highway. The proposed Advanced Vehicle Control and Safety Systems, Commercial Vehicle Information Systems and Network are other truck related strategies that are under research. These strategies are expected to improve communication and vehicle operations, and thereby, improve the transportation efficiency and safety.

One of the strategies of interest in this study is the truck lane restriction. Truck lane restrictions have been implemented on many limited access highways, and even on arterials roads, for the purpose of improving efficiency and safety. Florida is one of the States that has implemented this strategy. However, the effectiveness of this strategy has not been adequately documented, hence, the motivation of FDOT for this research. The efforts made in this study are expected to give FDOT a better understanding of the efficacy of truck lane restrictions, and provide recommendations for the development of policy for the use of this strategy.

1.2   Objectives and scope

The implementation of truck lane restrictions across the country has been predicated on a perceived principle that the restriction of trucks to certain lanes of an urban limited access highway would reduce crashes and increase the level of service. The objective of this study was therefore to conduct a study that would explain the effect of truck lane restrictions on urban limited access highways. This would be achieved by performing a before-after study of these types of highways in Florida and later conduct a detailed modeling of crashes. The hope was to identify the factors that contribute to crash occurrence in areas with or without truck lane restrictions. The geometric variables of interest include the length of highway segments, the number of lanes, the number of interchanges, the number of on and off ramps, lane widths, shoulder widths, the presence of a truck lane restriction, and the presence of a high occupancy vehicle (HOV) lane. Traffic variables likely to influence the effectiveness of a truck lane restriction include the average annual daily traffic volume (AADT), the percent of trucks, and operating speeds.

It is clear that driver behavior is generally a major causative factor in the occurrence of crashes on any highway. While all urban roadway sections that were to be considered in this study were in the State of Florida, it can be argued that driver behavior is not uniform across the state, and that there are regional differences. The challenge in this research was to determine social, economic, and ethnic factors that might explain regional differences, if any, in crash occurrence.

The safety analysis reported herein combined with an ongoing operational analysis of truck lane restricted corridors in Florida, is likely to give a comprehensive understanding of traffic dynamics in urban areas. This understanding should lead to the development of guidelines for deciding which urban highway corridors can benefit the most from the implementation of a truck lane restriction. Field review of all urban freeway sites, combined with simulation, would be used to propose recommendations for use by the Florida Department

of Transportation to develop statewide policy on truck lane restriction. The roadway characteristic inventory (RCI) field handbook categorizes urban areas ranging from small urban areas to metropolitan areas (*6*). This study was limited to limited access roadways located in metropolitan areas only.

1.3   Methodology

In order to accomplish these objectives, a research methodology was established was developed. Two of main purposes of this developing the research methodology were to ensure that the proper amount of information was obtained for this study, and appropriate procedures were established to conduct the analysis. The methodology included the following: creation of a database, field data collection and verification, selecting statistical methods, and choice of the software to be used.

1.3.1   Database creation

The creation of a database was a significant and necessary effort for this study. Within this database all the data that would be required for any analysis to be performed would be recorded. The main elements of the database were crash data, geometric data, and traffic data. The total number of crashes on all urban limited access highways was located in the crash data element of the database. These data were obtained from the CAR (Crash Analysis Reports) database which is maintained by FDOT. In addition to the total number of crashes, several categories of crashes and their causes are contained in this database.

In addition to the crash data, geometric and traffic data were also extracted from the CAR's database. However, this was not the main source of this type of data. Additional geometric and traffic data were also obtained from FDOT. The information sources included traffic CDs, online traffic data, straight line diagrams, interchange reports and video logs. The collection of all these types of data assisted in the choice of software to be used for the analysis. The type of data to be used in this study was similar to the type of data used by other researchers in past.

1.3.2   Field data collection

Geometric data collected from the different sources and recorded in the database needed to be verified for the purpose of adding any missing data element. Therefore, a field trip to all urban limited access highways in Florida was made on December 2005 in order to verify the existing database information and collect data for any missing elements. This verification and additional data collection had to be completed by the end of the year 2005 since that was the year of the crash data to be used in the crash prediction model, which is discussed in detail in chapter 5. The main data that needed to be verified in the field were the location of the truck lane restriction corridors, the location of the HOV lane corridors, speed limits, the number of lanes and the location of any construction activities that could affect the analysis of the highway segments. The data collected during the field trip were then compared to the data in the database and updated accordingly. Highway segments in which construction activities were observed during the field trip were eliminated from analysis to avoid unusual variations in traffic and

driver behavior in the analysis. Truck lane restriction corridors were observed on Interstate 95, Interstate 75 and Florida's Turnpike. These corridors are shown in Table B-2 in Appendix B.

1.3.3 Statistical analysis methods

The collection of the various types of data to be used in this study led to the choice of software and the statistical analysis to be used in this study. The first method of statistical analysis selected was before-and-after analysis. This type of analysis determines the effect of a truck lane restriction by comparing crash occurrences before the imposition of truck lane restriction to crashes occurrences after the restriction was imposed. From this type of analysis method a simple, but direct, answer on whether the truck lane restriction was successful or not can be deduced.

Another method of analysis selected is referred to as a crash prediction model. This method besides providing a simple answer to the success or failure of a truck lane restriction can also identify the effect of other variables on crash occurrence. Since crashes are rare events, the proper statistical distribution must be used in the prediction model. One of the basic statistical distributions used to model rare events is the Poisson distribution. However, this distribution has a basic assumption that requires the mean and the variance of the data to be equal. An observation of the crash data collected for the segments showed that the basic assumption for the Poisson distribution assumption was not met. Therefore, the search for another distribution to be used in a crash prediction model was performed and a negative binomial distribution was selected. The negative binomial distribution model was used to produce conclusions regarding predicted crashes and the effects of traffic, geometric and social economic characteristics. The modeling was accomplished using the STATA statistical software package which was developed by the STATA Corporation. STATA has a graphical user interface that allows for almost all commands to be accessed by pointing and clicking. Additionally, STATA allows users to enter their own commands, which makes the task of finding the right command by point and clicking easier.

These two statistical analysis methods—before-and-after method and the negative binomial model—were used to make conclusions on the effects of a truck lane restriction on urban limited access roadways in Florida. These methods will lead to the confirmation or rejection of the hypothesis that there are geometric, operational, and driver behavior factors that can lead to the success or failure of a truck lane restriction on a limited access highway in terms of operational efficiency and safety.

CHAPTER 2

LITERATURE REVIEW

2.1   Overview

Improvements to highways are not made based only on the structural condition of the pavement or geometric features of the facility. Improvements are frequently made based on how drivers react to these conditions and features. During the 1950's when freeways were first constructed (*7*), they became the primary means of transportation for people and goods across the country. Freeways were expected to be efficient and safe. These freeways were characterized by higher standards for structural, geometric and traffic operational elements. Having produced these freeways, the expected outcome was efficient roadways operating well and safely. However, these freeways did not produce what could be called "a perfect ride", i.e. there were operational and safety problems.

Over the years a lot of research has been conducted to determine the factors that cause these operational and safety problems, and to develop strategies to improve them. In general, factors that affect the operation and safety of freeways and tollways can be separated into two basic categories: (1) natural factors caused by climatic or environmental conditions, and (2) man-made factors such as traffic flow conditions and geometric features. Some of these factors, both natural and man-made, can be reduced directly by modifying operations, and others reduced indirectly by using more advanced techniques to find ways around them.

Weather, environmental and lighting conditions are factors that are fixed and can not be modified. However, there are some advanced technologies, Intelligent Transportation Systems (ITS), being developed to allow drivers to overcome or mitigate these types problems (*8, 9*). Roadway geometric features are fixed elements of a facility that are designed based on the traffic and other conditions at the time. Traffic flow conditions are based on drivers in mobile vehicles units that can be controlled by regulatory signs, signals and markings and other devices. Since geometric features also affect traffic flow conditions, it is worth discussing first, methods for improving traffic flow conditions, and thereby, operations and safety on freeways and tollways.

A detailed literature review was conducted using various sources, such as published studies, unpublished studies and other reports, to obtain information on the management of truck traffic, truck safety, and the operational aspects of truck lane use restrictions. At the end of this chapter, a summary of this literature review is presented. This summary gives an overview of the results reported from the different studies and reports on the implementation of truck lane use restrictions.

A number of these studies have addressed issues of truck traffic operations and truck safety. These studies have been motivated by the rapid growth in truck traffic on these roadway systems. During the 1950's when freeways were first constructed, they became the primary means of transportation for both people and goods. In recent years there has been dramatic

growth in truck traffic. This growth has prompted a concern by roadway users for both the operational efficiency and the safety of these facilities.

2.2   Effects of trucks on operations and safety

One of the main concerns with the growth in truck traffic is the effect on the operational efficiency of roadways. Some of the operational characteristics that are altered by the presence of trucks on freeways and tollways are travel time, speed, headways, and the Level of Service (*4, 10, 11*). A number of authors have completed studies on these aspects, either by observation of the performance on existing limited access facilities or by using computer simulations. These studies report on the effects of trucks on these roadways.

The operational effect of trucks is demonstrated in the analysis of level of service for freeways. The Highway Capacity Manual (HCM) (*10*) introduces an adjustment factor for heavy vehicles which includes trucks, buses and recreational vehicles (RV). Since there is no evidence of a distinct difference in the performance of trucks and buses, they are treated identical in the analysis. However, RVs are considered different from trucks and buses, but still part of the heavy vehicle factor. Equation 2.1 shows the adjustment factor for heavy vehicles as presented in the HCM.

$$f_{HV} = \frac{1}{1 + P_T(E_T - 1) + P_R(E_R - 1)} \qquad (2.1)$$

where E_T and E_R are passenger car equivalents for trucks/buses and recreational vehicles in the traffic stream, respectively; P_T and P_R are the proportion of trucks/buses and recreational vehicles in the traffic stream, respectively; and f_{HV} is the heavy vehicle adjustment factor.

As expressed in the above equation, the higher the percentage of trucks, the smaller the adjustment factor. This will increase the flow rate in the traffic stream and thereby, affect the level of service of the freeways which is dependent on the density.

A safety study on the New Jersey Turnpike (*12*) compared car only lanes with mixed flow truck and car lanes. The study was conducted on sections located on the northern part of the turnpike. The first section was between interchanges 10 and 11, which is about 2.5 miles.   The other section was from interchange 11 to 13, which is about 5.3 miles. This facility is a dual – dual facility where the inner lanes are dedicated for passenger cars and the outer lanes are for mixed traffic, i.e. passenger cars and trucks. For these sections the inner lanes were three lanes and the outer lanes were four lanes.

The analysis of crashes for this facility found there were more crashes in the outer lanes with mixed traffic than in the inner lanes with the passenger cars only. Another finding was that the most frequently occurring crashes were sideswipes on both the inner and outer lanes. More sideswipes occurred in the outer lanes than in the inner lanes. Crashes involving the collision with objects occurred more often in the inner lanes than the outer lanes. Another observation was that rear end collisions occurred more frequently in the outer lanes than in the inner lanes. This

higher frequency of rear end collisions in the outer lanes were thought to be the effect of the wider speed variation and the more unstable traffic conditions in these lanes.

The operational analysis for this facility was conducted using the computer simulation software VISSIM. The researcher evaluated the capacity impact of grade on entrance and exit ramps. To ensure an adequate measurement of capacity and thoroughly examine truck deceleration and acceleration, a 20 mile simulated freeway section for truck only was used. To calibrate this model, truck performance modeling and truck facility modeling was used. The analysis divided the terrain in two groups; grades from 0 to 2 for lightly rolling terrain and grades from 2 up to 4 for steeper rolling terrain. The results showed that the maximum truck capacity achieved was 1475 trucks per hour per lane and the lowest capacity was 1025 trucks per lane per hour at the highest grade (4 percent grade).

In another study in Virginia, a task force was formed to conduct a comprehensive examination of the causes of large truck crashes and potential solutions to address these causes (*13*). The goal was to identify engineering and technology measures that have the potential to improve large truck safety. Solutions to improve truck safety were divided in three categories: Intelligent Transportation Systems (ITS) solutions, traffic control solutions, and geometric design solutions.

One ITS solution was a truck speed advisory system, which detects and evaluates the speed of trucks and informs the driver if they were traveling too fast for the current conditions. Another ITS solution involved traveler information. Truck drivers are given information on congestion, weather or other conditions of the road ahead. This gives truck drivers the opportunity to make real time route decisions based on actual road conditions. In vehicle ITS systems were also found to be solutions for improving large truck safety. These involved collision avoidance technology, driver condition warning systems, fleet management systems (driving log recorders) and vehicle safety systems.

Traffic control solutions involved the use of rumble strips, lane use restrictions and proper signal phasing. Geometric design solutions were the introduction of truck escape ramps, improvements to parking facilities and road safety audits.

A survey of the Virginia Department of Transportation (VDOT) personnel was made to determine existing measures being used to improve large truck safety. Similar to the suggestions made by the task force, VDOT personnel used ITS methods, geometric design methods and traffic control methods. However, an additional measure being used was organizational/coordination improvements. This involved reports from districts that includes information on complaints about truck speeds, volumes and noise levels. This was an effort to provide the Virginia Trucking Association with information on truck operations in an area before a potential problem arose.

Results from the task force were divided into three categories: areas of consensus, areas of conflicting opinion and evidence, and areas that need more research. The measures that had consensus were those that involved enforcement, improvements to traffic phasing, improvements to the geometric design of interchanges, truck escape ramps and climbing lanes, rumble strips,

traveler information systems, and speed advisory systems. The measures that had conflicting opinions and evidence were truck lane use restrictions and the use of differential speed limits. The truck lane use restriction results on Interstate 495 showed an increase in crashes, although there were areas where safety improved with the implementation of the truck lane use restriction. In vehicle ITS systems was the area that needed more research, since these systems were still under development and the number that were deployed was not large enough to determine the actual safety benefits.

Hiselius (*14*) studied the relationship between crash frequency and homogeneous and inhomogeneous flow in Sweden. This study describes the relationship between the number of vehicles per hour and crash frequency. A homogeneous road system was studied with the assumption that only traffic flow affected the number of crashes. The first case of this study considered only homogeneous passenger car flow, and the second case considered inhomogeneous flow, which included passenger cars and trucks. The analysis used Poisson and Negative Binomial models which showed a good fit with the data that was collected. The results suggested that as the number of cars increased, the expected number of crashes increased. It was reported also that with the increase number of trucks on the roadway, there would be and increase in number of expected crashes. This was attributed to the more dangerous overtaking maneuvers. However, the results of this study indicated that as the number of trucks increased on the roadway, the number of expected crashes decreased. This result was justified by saying that as the number of trucks increased on the roadway, there was a possibility of a decrease in traffic speed. The results also pointed out that the unease situation, contributed by trucks sharing the road space, gave increased attention by all drivers. Also, the increased number of hours with a higher volume of trucks coincided with good road conditions and more hours with experienced drivers on the roadways, thereby, making the roadway safer. However, the limitation of this study was that a low sample size could have affected the conclusions. Therefore, no clear understanding could be given about how homogeneous and inhomogeneous traffic flow affected truck related crashes on freeway segments.

Another study in Utah by Miaou (*15*) reached the same conclusion as that of Hiselius. Miaou conducted a study on the relationship between truck accidents and geometric design. The results of this study reported that as the percentage of trucks increased on a rural freeway, there was a decrease in number of crashes. His hypothesis was that for constant vehicle density, the increased percentage of trucks would reduce the frequency of lane changes, hence, reducing the number of truck/car collisions on the freeway. Other studies show different results to those just described. Jovanis and Chang (*4*) developed a model with the relationship between crashes and vehicle miles of travel. They studied the effect of traffic exposure and collision types on Indiana highways. Their results found that the increased in the number of truck was usually associated with an increased in number of crashes. However, this increase in the number of crashes was at a decreased rate for all truck related crashes. With this study it was difficult to distinguish the marginal effect on cars or trucks as the number of vehicle miles of travel varied in the study.

2.3   Measures to manage truck traffic

The growth of truck traffic on freeways and tollways has led to a number of studies that deal with issues related to the overall traffic safety and operations as mentioned earlier. Since the

introduction of limited access roadways, most goods are being transported using these roads and trucks are the main means of transfer. The size and operational characteristics of these types of vehicles have prompted concerns by road users. These concerns have lead to studies that analyze their effect on the roads and the imposition of regulations to reduce the impact of these types of vehicles on operations and safety.

Several strategies have been implemented to overcome the safety and operation challenges posed by the increase of truck traffic on limited access roadways (*11, 12*). These strategies include improvements in highway design, the introduction of facilities for trucks, operational strategies, and the introduction of intelligent transportation systems. Improvements in highway design includes the upgrade of highways geometrics, new or upgraded structures, new or improved pavement, and modified design standards that specifically address trucks. Considering roadways facilities for trucks suggests that in some areas, there is a need to justify the separation of trucks from other types of vehicle. Some of the methods suggested were dedicated roads for trucks or commercial vehicles, special use lanes for trucks or commercial vehicles, truck climbing lanes and dedicated truck ramps.

Operational strategies are concerned with the management of existing facilities. Suggestions for the operational management of truck traffic were lane use restrictions, time of day restrictions, roadway restrictions, parking restrictions, incident management, and improved inter-modal operations. Other restriction strategies include weight restriction on bridges, congestion pricing, express truck lanes through toll plazas, and the restriction of truck operations during peak travel time for loads requiring permits.

The management of trucks using intelligent transportation systems makes use of the information, communication, sensors and control technologies to improve transportation system efficiency and safety. The management systems suggested in this area were Advanced Vehicle Control and Safety Systems, Commercial Vehicle Information Systems and Network. These systems would assist on the strategies for facilitating truck flow and introducing warning devices for safety purposes.

Some of these strategies are still under research, but many have already been implemented. According to the National Cooperative Highway Research Program (NCHRP), the most frequently cited types of improvements, that have already been implemented, were improved pavement, climbing lanes, lane use restrictions, and weigh in motion systems. These strategies, however, need additional evaluation in order to determine the potential benefits and costs.

For the purpose of this study, the operation and safety associated with trucks on freeways were the two major concerns. Since a truck lane restriction was one of the strategies for improving the safety and operations on a freeway, a detailed analysis was imperative in order to analyze the benefits of this strategy. A truck lane use restriction has been one of the most popular strategies on freeways. This strategy restricts trucks from certain lanes to separate them from fast moving vehicles, and thereby, improve traffic operation and safety. The next sections report on several studies undertaken to evaluate truck lane use restrictions on freeways.

2.4 Safety and operations of truck lane use restrictions

Several measures that have been taken to manage truck traffic on roadways were truck lane use restrictions, differential speed limit for trucks, and truck route restrictions. In this study the emphasis is on truck lane use restrictions on the limited access roadways. A number of studies have evaluated the effects of a truck lane use restriction on safety and operations, and used the results to develop policies on truck lane use restrictions. However, some studies have produced different results and conclusions on the effects of a truck lane use restriction, especially on safety.

2.4.1 Truck lane use restrictions in Florida

A study was conducted to evaluate a truck lane use restriction on Interstate 95 in Palm Beach County Florida (*16*). The truck lane use restriction on this section was imposed in February 1990 and trucks with 3 or more axles were restricted from using the left lane between 7 AM and 7 PM. The analysis method used for this study was a before and after analysis, and involved only the section with the truck lane use restriction. There was an attempt to make a comparison analysis using an Interstate 275 site in Tampa, which had comparable volumes with the Interstate 95 section during peak periods. However, further analysis revealed that this comparison site had different ramp configuration, truck volumes, etc. Therefore, the site could not be used in a comparison analysis. Instead, the authors used the non restriction hours as a control for the analysis. Based on the results, the truck lane use restriction appeared to have a significant impact on the reduction of total crashes and PDO crashes involving trucks and non trucks. However, the impact on injury crashes was not significant. There was a significant impact in the reduction of truck only PDO crashes. Although there was a significant decrease in crashes, the results were still questionable because traffic during non restricted hours was very low with 75% of the traffic commutes during the truck lane restriction hours. The authors concluded that since the truck lane use restriction reduced truck crashes, which are often more serious and often results in a highway closure and significant delays, it was beneficial. However, they also found that the truck lane use restriction increased the interaction between trucks and non truck traffic at freeway entrance and exit ramps. This increased truck density and damage to the outside lane. Also, the concentration of trucks in the right lanes was found to block the guide/exit signs and is also a potential problem for truck and non truck traffic.

Another study was conducted by the FDOT on Interstate 95 in Broward County (*17*). The purpose of this study was to evaluate an experimental truck lane use restriction on this section of freeway. The experiment commenced on May 3, 1982 where observations of the operational characteristics and safety of the freeways were made. The distribution of traffic on this section of the highway showed that, 3 or more axle trucks contributed to 4.2% of the total volume; other trucks, buses and recreational vehicles contributed to 4.6% of the total volume; and automobiles, pick ups, and motorcycles contributed to 91.2 % of the total traffic. Based on a 24 hour classification study, a 12 hour restriction period from 7AM to 7PM was implemented. This time period had the greatest volume of large trucks and autos. The observation of compliance showed that during the study period, no month had a compliance less than 98%. The distribution of truck traffic and automobile traffic on the three lanes before the truck lane use restriction was in the

ratio of 1:2:1 for trucks and 3:3:2 for automobiles. This ratio is for the left, center and right lanes, respectively. The introduction of truck lane use restriction managed to shift almost all 3 or more axle trucks from the left lane, but it made the proportion of automobiles decrease slightly from the left lane.

Speeds and truck travel times were also observed. The study found no significant change in speeds after the truck lane use restriction was imposed. The maximum increase in travel time was less than a minute for the off peak period. There was a slight decrease in travel time during the evening peak. The crash analysis used a 9 month period before and a 9 month period after, between January 1981 and January 1983. The results showed that the gross number of crashes decreased by 3.7% for the whole day, but increased by 4.7% during the truck lane use restriction hours. The crash rate also decreased by 2.5% when considering the whole day but increased by about 6.3% during the truck lane use restriction hours. Also, there was an increase in multi vehicle crashes of 10.8% during the restriction hours and 0.3% for the whole day. However, the proportion of crashes involving 3 or more axle trucks decreased by 3.3% during restriction hours. According to this study, there was not much gained by the truck lane use restriction, but FDOT kept the restriction on this section because of the overall reduction in injuries and fatalities.

2.4.2   Truck lane use restrictions in South Carolina

The evaluation of a truck lane use restriction in South Carolina by the South Carolina Department of Transportation (*18*) revealed that the implementation of a restriction on sections of Interstate 85 reduced the number of crashes and reduced speeds. In addition, the average property damage and fatalities were reduced significantly. Interstate 85 was one of the most dangerous highways with about 20% trucks and an average speed of 73 MPH. After the implementation of the truck lane use restriction in November of 1999, speeds decreased and estimated damages fell by 53%. No fatalities involving trucks were observed and the number of crashes with injuries fell by 72%. Compliance with the lane use restriction was very high with only 1% of trucks violating the restriction.

However, there were mixed feeling from the public. Some truckers felt they were being exposed to more dangerous conditions because of the concentration of trucks on the two right lanes of the interstate. Others felt there would be an effect on the capacity of the highway due to the concentration of the large trucks on the two right lanes, and speed discrepancies would evolve because of the free flow in the left lane. A report from the Highway Patrol Captain for the area reported there was smoother and safer traffic flow, and the number of aggressive driving complaints had significantly decreased. The number of improper lane changes was, also, significantly reduced by the introduction of truck lane use restriction. Lane changes are a major cause of crashes. The local public gave positive feedback and suggested that truck lane use restriction be placed on other sections of this roadway. However, the conclusion made by this report was that the reduction in speeds and collisions during this evaluation may have been caused by other factors such as an increased presence of law enforcement. Therefore, further analysis was deemed to be necessary to evaluate the merits of a truck lane use restriction.

2.4.3   Truck Lane Restriction in Texas

An evaluation of a truck lane use restriction demonstration project on Interstate 10 East was made on an 8 miles section between Waco and Uvalde streets in Houston,Texas (*19*). This project was implemented based on a request from a Houston City Councilman, who was seeking alternatives for improving truck safety on Houston freeways. This study was lasted 36 weeks and the evaluation and monitoring plan involved observations of compliance, enforcement, crash records, freeway operations, public perception and periodic updates. The results from this study showed the level of compliance was from 70% to 80%. A 70% level of compliance was considered acceptable, while a 85% and higher level was considered a high level compliance and desired. Enforcement was one of the driving forces in the level of compliance. The assessment of enforcement showed that the Houston Police Department strictly enforced the truck lane use restriction by issuing citations to truck drivers who violated the restriction. Most of the drivers who received citation were from outside Houston and were not aware of the truck lane use restriction. The analysis of crashes on this section of the demonstration project showed crash rates reduced from 7.5 crashes per week to 2.9 crashes per week, which is a reduction of 68%. However, since the data was only for 36 weeks, a conclusion could not be made on the effects to crashes. Conclusions for this analysis needed at least one year of crash data. In addition, there was a slight change in 18–wheeler truck involvement crashes during the demonstration period. They were involved in 20 of 87 crashes (23%) with the restriction, compared to an involvement of 89 in 391 crashes (22%) without the restriction.

The analysis of the freeways operations was conducted by observing the speed, travel time and volume on the freeway sections for the demonstration project. The analysis was made using data for two years prior to the introduction of the truck lane use restriction and two years after. There was a noticeable increase in speed in some sections of the demonstration project and some sections had a decrease in speed. There was, however, no appreciable impact on the travel time on the freeway. The decrease in speed was reported to be caused by construction activities approaching the downtown area. Analysis on the usage of the left lane showed there was an increase in traffic volume of about 12 percent during the morning peak and an increase of about 11percent during the evening peak. These increases eventually increased the throughput on the freeway. A survey was conducted to evaluate public perception of the truck lane use restriction. Two sets of questionnaires were distributed. One set was designed for truck driver and the other set was designed for passenger vehicle drivers. The results from this survey showed that truck drivers commented negatively to the truck lane use restriction, while passenger vehicle drivers were in favor of the restriction. Truck drivers were concerned with the signing for the restriction, which they indicated was not adequate. They also indicated that passenger vehicle drivers were the problem.

Another study conducted in Texas involved an operational evaluation of a truck restriction on Interstate 20 near Fort Worth (*20*). The study examined the effects on vehicle distribution, vehicle speeds and the time gap between vehicles. The analysis in this study used a before and after method for each of the three operational characteristics. Also, a statistical comparison was used in order to observe the significance of the difference between the average operational characteristics. The results reported from this study showed that compliance with the

truck lane use restriction was between 62% and 76%. The researcher observed that there was a small ratio between total trucks and total traffic before the truck lane restriction. The percent of truck using the left lane in comparison to total traffic was 1.3 percent or less. After the truck lane use restriction was implemented, only 0.4 percent of trucks used the left lane. The percent of trucks that used the left lane in comparison to the total number of trucks was 11.7 percent before the restriction and 4.4 percent after the restriction. Further, the author compared the distribution of traffic before and after the restriction. The distribution of vehicles was fairly equal. The percent of trucks on the freeway was 8.4 and 14.2 percent during peak and off – peak periods, respectively, before the restriction. After the truck lane use restriction was implemented, trucks were 6.6 and 15 percent during peak and off peak periods, respectively. However, the percentage of truck in the middle lane decreased and there was only an increase in the percentage of trucks in the right lane.

The speed characteristics for trucks decreased consequently in the westbound direction and during the non peak periods increased in the eastbound direction. The speed of the cars had the same pattern of change, although changes were generally smaller in magnitude. The average speed differential in each lane, as defined previously, was compared from before and after the restriction. The results showed there was a decrease in speed differentials in the eastbound direction during the peak period before the restriction, and no difference in speed differentials after the truck lane use restriction. The analysis of the gaps between vehicles showed there was no significant difference in gaps before and after the restriction. This result reflected the fact that the sites were in a rural area where average headways were large even during the peak period (usually greater than 5sec). Therefore, the actions of the following vehicle were not greatly affected by the actions of the leading vehicles in most of the cases.

2.4.4   Truck Lane Restriction in Virginia

A case study on truck lane use restriction on Interstate 81 at Buchanan, Wytheville and Christiansburg in Virginia (*21*) was conducted for the purpose of simulating traffic flow elements on freeway segments under conditions of restricted and non – restricted truck lane use restrictions. The traffic flow elements examined were density, lane changes and speed differentials. Each of these is an output of the FRESIM model and was used to provide insight in the performance of the freeway segments under a set of traffic and geometric conditions. The results from this study found in the Buchanan site, both directions had no impact on the three performance measures when trucks were restricted to the left lanes. This was also the case in Christiansburg southbound. However, northbound Christiansburg and eastbound Wytheville had an increased speed differential when trucks were restricted to the left. Restricting trucks from the right lane caused the number of lane change to increase for the Buchanan and Christiansburg sites. For the Wytheville site the restriction to the right lane increased the speed differentials on the eastbound site. The Wytheville westbound site was the only site that had the density affected by the restriction. When the truck lane use restriction was on the left, the density increased, and also, the number of lane changes increased. This was because this site had entrance and exit ramps which contribute to the increase in the number of lane changes.

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2.4.5   Truck Lane Restriction in Tennessee

Cate (*22*) evaluated the operational characteristics of truck lane use restrictions and reflected the results to its effects on safety. This study was conducted using data from Interstate 40/75 in Knoxville, Tennessee. To analyze the effect of a truck lane use restriction, a number of factors were taken into consideration including grade, volume, truck percentage, and the presence of ramps. These factors or a combination of these factors were used to assess the effect of a truck lane restriction by developing a number of scenarios that can identify the effect of each of the factors with the inclusion of a truck lane use restriction. The first of the two main scenarios were different combinations of these factors without a truck lane use restriction. The second was the combination of these same factors, but this time, with a truck lane use restriction. The operational characteristics that were assessed in this study were vehicle density, travel time; speed differential between cars and trucks, and lane changing frequency.

The effect of a truck lane use restriction was found to be minimal on level terrain for the above mentioned traffic operational characteristics. However, the effect was more sound when analyzing the effect on graded terrain. With the introduction of a truck lane use restriction in the simulation on the level sections, there was a slight increase in vehicle density and level of service. When a 2% grade was introduced, the truck lane use restriction showed an improvement with a reduction in the vehicle density. However, the increase in grade to 4% showed more of an impact from the truck lane use restriction, since most trucks are greatly affected by steeper grades. Therefore, the level of service without the restriction was improved by the introduction of truck lane use restriction. Travel time for passenger cars was also another operational characteristic that showed improvement with the introduction of a truck lane use restriction, especially in the scenario with steep grades. Speed differentials between cars and trucks slightly increased on level terrain by less than 1mph. However, with grades introduced, the speed differentials between cars and trucks greatly increase up to 9.9 mph. Also, the lane changing behavior was observed to be reduced with the introduction of the truck lane use restriction. This suggests that the opportunity for collision is reduced by limiting the interaction between vehicles. This indicates there are theoretical safety benefits for truck lane use restriction from reduced lane changing.

2.5   Efficiency of truck lane restriction

Truck lane use restrictions have been the most used application for managing truck traffic in the context of traffic operation and safety. However, there remains a need to evaluate the efficiency of truck lane use restrictions on the freeways and determine just how well they improve operations and safety. A study was made on an operational performance model of a freeway truck lane use restriction (*23*). The objective of the study was to develop an operational performance model that could assist in identifying the most operationally efficient truck lane use restriction alternatives for freeways under prevailing conditions. The model includes the number of lanes, interchange density, free flow speed, volume, truck percentage, and ramp volumes. The observed operational performances were average speed, throughput, speed differentials and lane changes. This model was also expected to provide information on the level of truck and non truck volumes required for the justification to implement a truck lane use restriction alternative,

and the expected travel speeds and throughputs for corridors before and after the implementation of a truck lane use restriction method.

The results from this study show that the implementation of truck lane use restriction, in general, increases the average speed under conditions of low interchange density, low truck volumes and low ramp volumes. With densely space interchanges, high truck volumes and high ramp volume, the speed was found to decrease. However, when a large number of restricted lanes are used, the speed reduction is negligible. Another finding was that a larger number of restricted lanes resulted in a higher throughput under low truck percentages and with widely spaced interchanges. Statistical analysis showed there was a significant difference between restricted and non restricted lane groups, and the magnitude increased as the number of interchanges, ramp volumes, truck percentage and free flow speed increased. Another finding was that truck lane use restrictions significantly reduced the number of lane changes by separating slower moving traffic from faster moving traffic and reducing the occurrence of vehicle overtaking one another. The reduction in lane changes suggested that there could be a reduction in crashes since lane change is a potential cause of crashes. For better performance of a truck lane use restriction, the researcher suggested that a single lane restricted from use by trucks would be suitable for three, four and five lane freeways, while two lanes restricted from use by trucks would be suitable for four, and five lane freeway sections, except when the interchange density is high and the truck percent is larger than average.

Another project, mentioned earlier on Interstate 10 (*19*), was an 8 mile demonstration project. Although this project was a success with positive opinions from the public on truck lane use restrictions, there were still challenges that were faced on the implementation of this type of truck safety improvement measure. One of the challenges was on the criteria that freeways need in order to implement a truck lane use restriction. Based on their study, a candidate freeway section for an efficient truck lane use restriction should meet the following criteria. First, the section should have six or more lanes. The second criterion was the length of the truck lane use restricted corridor should not be less than six miles in length. The total truck volume was another criterion which needed to be more than 4%. Another criterion was at least 10% of the trucks using this freeway are using the left lane, and there should not be any left side ramps within the limits of the truck lane use restricted corridor. Signing was also a major concern in the implementation of a truck lane use restriction, since truck drivers complained that the signing was a problem. The task force for this project proposed that for the restriction to be adequately posted for truck drivers, the signing should emphasize "Vehicles with 3 or more axles" to allow enforcement of all vehicle classification included in the law.

The case study in Virginia on Interstate 81 at Buchanan, Wytheville and Christiansburg sites (*21*) gave recommendations for efficient truck lane use restriction practices. There analysis of the change in density, differential speeds and lane changes, assisted in analyzing the most efficient methods for the application of truck lane use restrictions. One of the recommendations was to restrict trucks from the left lanes on highways with grades of 4 percent or higher. This type of restriction will assist in separating trucks, which have lower performance on steep grades, from faster moving vehicles, especially passenger cars. Another recommendation was to not restrict trucks from the right lane, because this type of restriction increases the number of lane changes and thereby, the potential for crashes.

## 2.6	Summary of literature review

Literature has shown how trucks have been affecting roadways operation and safety, and has made suggestions on the management of trucks on limited access roadways. Some of the literature has suggested that the increased in the number of trucks on freeways give a positive impact on safety, and some literature report otherwise. These two contradicting conclusions show that to determine the effect of trucks on safety is a great challenge to engineers and more robust studies are need. However, the effect of trucks on operations has been clear and there is a clear indication that the increased number of trucks on a freeway reduces the operational performance of the facility. Operational performance is indicated by speed, travel time, vehicle density, and the overall level of service (LOS). The recently used truck management strategies are lane use restrictions, route restrictions, the introduction of climbing lanes, and truck weigh in motion systems. These strategies have been shown to improve traffic operations and safety. The main focus in this study was the effect of truck lane use restrictions on the freeways.

A summary of the literature review results on truck lane use restrictions has demonstrated that this strategy improves the operations of the freeways by improving traffic density, increasing vehicle speed, and in turn, reducing vehicle travel time. The implementation of truck lane use restriction has also been reported to improve safety by reducing the number of lane changes on the freeways. Lane changing creates a high potential for the occurrence of crashes. However, some of the literature has also indicated that the introduction of a truck lane use restriction increases the differential speeds between lanes, which increases the potential for crashes. Without question, there has been mixed results from the studies on the safety effects of truck lane use restrictions on freeways.

CHAPTER 3

DATA COLLECTION

3.1   Overview

The evaluation of the safety implications of truck lane restrictions focuses on Florida limited access highways located in urban areas. Therefore, the data collected had to include all urban freeways and tollways that have some form of controlled access. The US Census Bureau defines an urbanized area as, an area with a population of at least 50,000 (*24*). In this study, however, the FDOT's urban roadway categorization, as defined in the Roadway Characteristic Inventory (RCI) (*6*) database, was also considered. The RCI database classifies urban areas into four groups: small urban areas, small urbanized areas, large urbanized areas, and metropolitan areas. The population distribution associated with this classification scheme is shown in Table 3.1.   The actual Florida urban geographical areas falling under each category are shown in Appendix B-1.

Table 3.1: RCI database classification of urban areas

Urban areas	Population distribution
Small urban areas	5,000 – 49,999
Small urbanized areas	50,000 – 199,999
Large Urbanized areas	200,000 – 499,999
Metropolitan areas	> 500,000

The use of Census Bureau and RCI database definitions led to selecting roadways that fall under "metropolitan areas" as seen in Table 3.1. Only four regions in Florida qualify under this definition. These are Region 1 comprised of Duval county; Region 2 comprised of Miami Dade, Broward and Palm Beach counties; Region 3 comprised of Sarasota, Hillsborough, Manatee and Pinellas counties; and Region 4 comprised of Orange and Osceola counties. These regions are shown in Figure 3.1.

As discussed in the introduction chapter, the Florida Interstate Highway System is composed of 4,035 miles of existing and planned multi-modal transportation corridors of which 3,943 miles exist. In the four highly urbanized regions shown in Figure 1, there was a total of 1216.2 centerline miles of urban limited access highways which constitute 31% of the existing highways in Florida.   Within this 31%, 430.3 centerline miles have truck lane restrictions implemented, which is 35% of the miles considered for this study and 11% of the entire Florida Interstate Highway System. Following the selection of these urban limited access highways, the next task in the analysis process was to create homogenous segments of the selected highways.

3.2   Road segmentation

One of the challenges faced in this study was to develop roadway segments that have fairly homogenous geometric characteristics. To ensure uniformity of the segments, a number of criteria for segmenting the roadways were used. The first criterion used was the consideration of traffic characteristics. A roadway segment had to start or end at a major traffic generator, such

as a freeway-to-freeway interchange or at an on-ramp or off-ramp contributing more than 10 percent change in through traffic. Using this criterion, there was the assumption that there would be a good distribution of segments with different traffic characteristics and different crash characteristics.
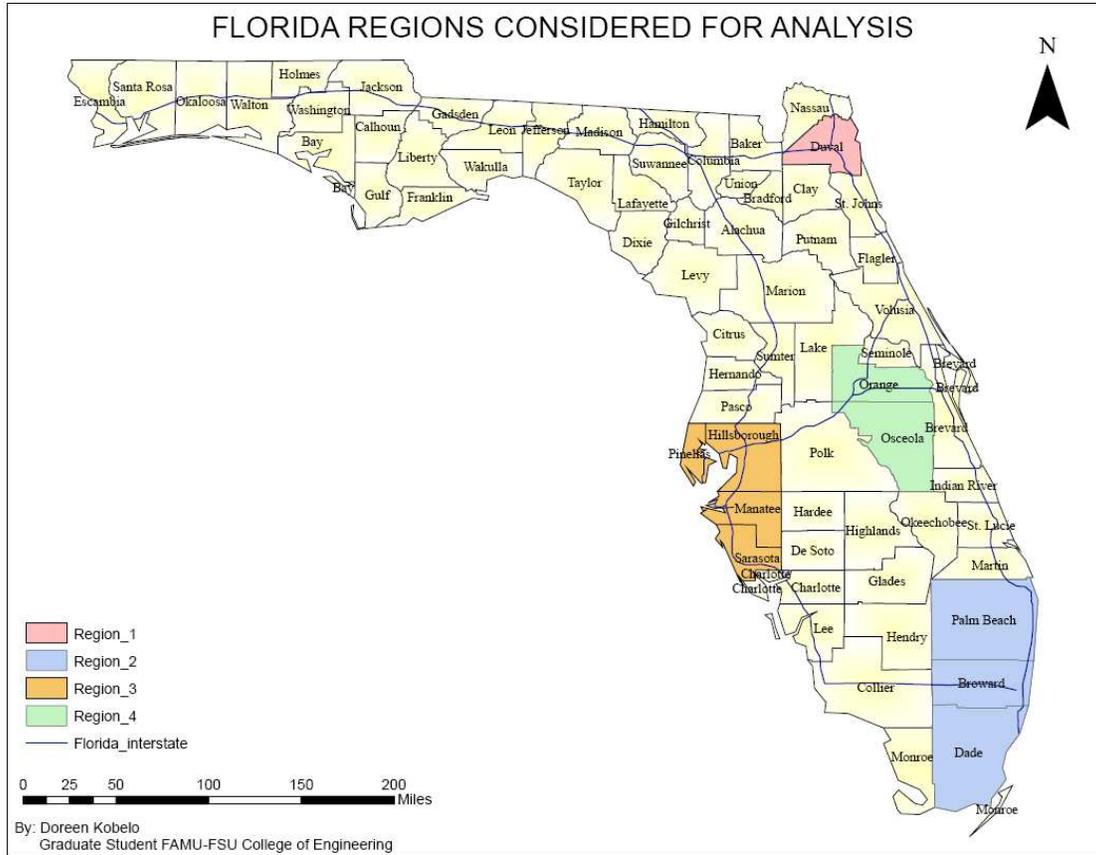
Figure 3.1: Regions considered for analysis

Another criterion for segmentation dealt with geometric characteristics of the roadways. Within these major generators, there were notable changes in geometric characteristics involving the number of lanes and other factors, particularly in highly urbanized counties of Broward and Miami-Dade. However, some of the lanes were not exactly through lanes, but rather auxiliary lanes, which started at the beginning of an entrance to a freeway and ending at the following exit or downstream two to three exits. This situation made it imperative to define lanes in order to get the correct type of segmentation with this criterion.

The segmentation by number of lanes was based on the existing through lanes. A through lane was defined as any lane from the upstream interchange that goes past a downstream interchange. All other lanes that did not fit this criterion were regarded as auxiliary lanes; that is, they enter the freeway on the upstream interchange and end in the next downstream interchange. An illustration of through lanes and auxiliary lanes is shown in Figure 3.2. To obtain reasonable homogenous segments and to avoid having too many segments, it was important to combine

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some sections that had different number of through lanes by using a weighted average formula given as:
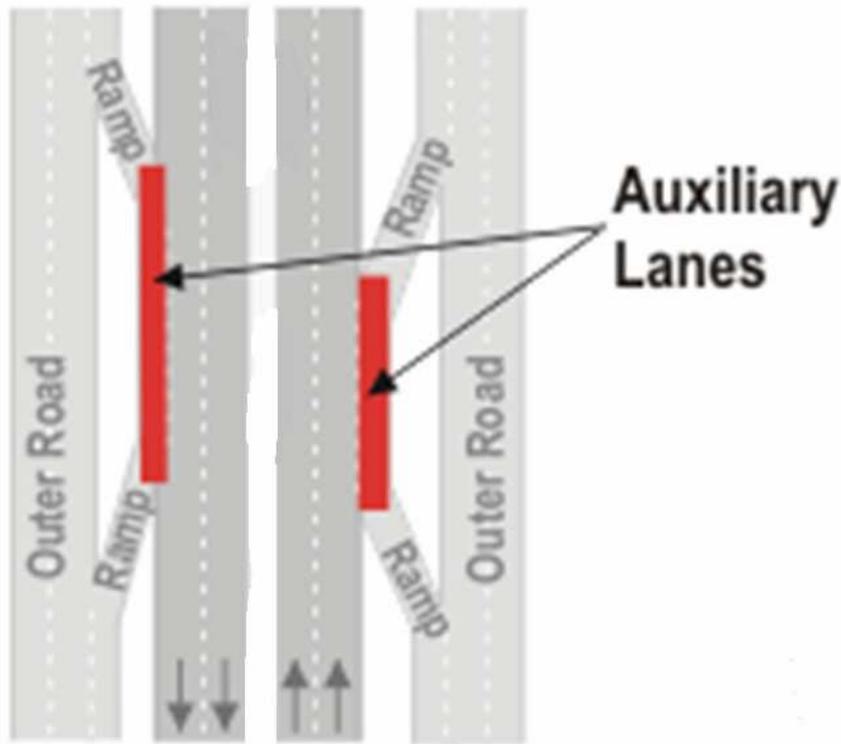
Figure 3.2: Auxiliary lanes and through lanes.

$$N = \frac{\sum\limits_{i=1}^{k} n_i l_i}{\sum\limits_{i=1}^{k} l_i} \qquad (3.1)$$

where N is the number of lanes for a particular segment, n_i is the number of lanes in the ith section of the segment, and l_i is the length of the ith section.

Furthermore, additional segmentation was done based on the presence of a truck restricted lane or a High Occupancy Vehicle (HOV) lane. The beginning or ending of a truck lane restriction or HOV lane led to the separation of sections based on the likelihood of these factors influencing crash occurrences. Finally, the speed limit was used as a segmentation criterion. This is a traffic variable that is thought to influence operating speeds and the probability of crashes. It was important that no one segment be analyzed with two different speed limits within the segment.

Following the application of all the criteria discussed above, a total of 128 segments were obtained. The attributes of each segment are shown in Appendix B-2. It is noteworthy that the geometric, traffic, and crash data associated with each segment, as shown in Appendix B-2, were

gathered from the RCI database, Straight Line Diagrams (SLD), video logs, Crash Analysis Record (CAR) database, and physical observation by driving along the highways to verify these characteristics. The data characteristics associated with each segment are discussed below.

3.3   Geometric data

The geometrical data for the segments were obtained from the Roadway Characteristics Inventory (RCI), straight line diagrams (SLD), video logs, and by field data collection. The RCI, SLD, and video log information is maintained by FDOT and is updated every year in order to obtain current conditions of the road for planning and maintenance purposes. Data collected from these sources were for the year 2005, which was the year used for crash modeling as discussed later. The geometric data assembled were the number of lanes, the number of interchanges, the number of ramps, the presence of a truck lane restriction, and the presence of a HOV lane. In order to ensure that construction zones would not cause significant difference in the lane characteristics, all segments in which construction was taking place were not considered in the analysis.

3.3.1   Lane characteristics

In the 128 segments of urban limited access highways that were analyzed, the number of through lanes ranged from two lanes in one direction of travel up to 6 lanes in one direction. As indicated earlier, the definition of through lanes used in this study excluded auxiliary lanes in each segment since the main concern was the change in the through lanes in a segment and the number of through lanes is closely associated with the intensity of traffic. The number of through lanes from the beginning of the segment to the end was not constant. Therefore, to determine the average number of through lanes for a segment a weighted average of sections within the segments with a different number of lanes was calculated. The weighted average was taken against the length of all sections within the major segment. Auxiliary lanes, acceleration lanes and deceleration lanes were excluded in this calculation. The equation for calculating the number of through lanes for a given segment was shown as Equation 3.1 above.

3.3.2   Interchange characteristics

Interchanges are systems of interconnecting roadways with one or more grade separations which provide traffic movement between two or more roadways or highways of different levels (*25*). The interchange characteristics were also one of the criteria used in picking roadway segments as discussed earlier. The interchanges that influenced segmentation were those that were generating a significant amount of traffic along the highway being considered for segmentation. The interchanges that did not have a significant impact on through traffic along a highway were not considered for segmentation. These insignificant interchanges were counted as part of the number of interchanges counted within a particular segment.

The number of interchanges within a segment was counted from the straight line diagrams (SLDs) and the interchange reports provided by FDOT. The minimum interchange spacing for urban freeways is one mile (*25*). To quantify the spacing of interchanges within segments, interchange density was calculated. Interchange density is given by equation (3.2).

$$ID = \frac{I_j}{l_j}$$

<div align="right">(3.2)</div>

Where: ID= interchange density

I_j = Number of interchanges in the I_j segment

I_j = Length of the lj segment

From the collected data, the interchange density ranged from 0 to 4 interchanges per mile with the average of 0.9, indicating that there were segments of the highways with closely spaced interchanges, i.e., interchanges less than one mile apart. Where there was a zero (0) interchange density, there was no interchange within that segment. The segments with the shortest lengths were mostly located in Dade County.

3.3.3 Ramp characteristics

A ramp provides entrance to or exit from a limited access highway. Ramps are defined by the types of arrangements and size of turning roadways, and connect two or more roadways for high speed merging and diverging. The ramp characteristics in most cases depend on the interchanges that are within each segment such that normally the number of ramps is proportional to the number of interchanges. Since the only access to the limited access highway is through the ramps, there are two types—on-ramps and off-ramps. As their names suggest, on-ramps are the points on the roadway where traffic enters the limited access highways, and off-ramps are points on the road where traffic exits the limited access highway.

The number of ramps on a highway segment was collected from the SLD and the video logs for both directions of the highway segment. The number of on-ramps for the segments ranged from 0 to 13 with an average of 4.6. The number of off-ramps ranged from 0 to 17 with an average of 4.8. The difference in the number of the on-ramps and off-ramps was caused by the presence of more than one on-ramp or off-ramps for the same interchange depending on the geometrics of the interchange.

3.3.4 Presence of truck lane restriction and HOV lanes

Truck lane restrictions and HOV lane data were collected from the FDOT records and video logs, and from physical site visits. Truck lane segments were found in all the regions that were mentioned previously in this chapter. However, the introduction of truck lane restrictions in these segments did not occur at the same time. Segments on Interstate 95 in South Florida had truck lane restriction introduced during the 1980's (*16*). Truck lane restriction on other segments such as Interstate 75 in Tampa area, Interstate 95 in Duval and HEFT were introduced between 2004 and 2005. The information on the introduction of truck lane restriction of these sections was obtained from the FDOT traffic records.

The segments that had HOV lanes were only found on Interstate 95 in South Florida from Miami Dade to Broward County. Some segments in Broward County were under construction during the time that the data were collected, so they were not included in the analysis. The information on the sections with HOV was obtained by physical site visits. Literature review

revealed that some segments had truck lane restriction since 1980's. Appendix B-2 shows the truck lane restriction segments with their length and the start date for the restriction.

3.3.5   Traffic characteristics

The traffic characteristics on the highway segments were obtained from the FDOT Traffic CD, online traffic information, RCI database, and from data collection in the field. The FDOT data are compiled annually by the Planning Office. The data collected included the AADT, truck percentage, ramp volume, and operating speeds for each segment. These data are referenced to the end of the year 2005 similar to the crash data.

3.3.6   AADT and truck percentage

There were three sources for traffic data—that is, traffic data contained in the RCI database, traffic data published by FDOT Planning Office through "Traffic CD", and online traffic data. Online traffic data are available at FDOT's secured website and published by FDOT's Statistics Office. These data were collected at Telemetered Traffic Monitoring Sites (TTMS) which are permanents sites collecting annual traffic data. Data were also collected from Portable Traffic Monitoring Sites (PTMS) which are temporary sites operating for a short period of time. The traffic parameters that are synthesized from data collected at these sites, include AADT; D-factor which is the directional distribution factor; K-factor which is the proportion of AADT occurring in the peak hour, and T-factor (truck factor). From all these sources, the AADT and the truck percentage on every highway segment were obtained. However, since there were several entrances and exits within some of the sections, there was a slight change in traffic between the interchanges. Where this phenomenon was observed, a weighted average of traffic was calculated in order to normalize the traffic volume within the segments. The directional factor was used to determine traffic for each direction of travel in each segment.

3.3.7   Speed characteristics

The speed characteristic of interest in this study was the operating speed within each segment. However, the collection of operating speed data for each segment was infeasible due to cost limitations. Thus, it was decided to substitute speed limit for operating speed using procedures promulgated in the Highway Capacity Manual (*10*). The speed limit data were obtained from the RCI database. However, as discussed earlier, there was a need to convert speed limit data to the actual operating speeds for the segments since studies show that operating speeds generally exceed the speed limit (*6, 11, 26, 27, 28*).

The HCM (*10*) procedure was used to obtain the operating speeds for these segments. The procedure uses a base free flow speed, which can either be spot speeds collected on the roadway or the prevailing speed limit in the segment. The base free flow speed is then adjusted using adjustment factors which account for the roadway conditions that are thought to affect the speed of the driver such as lane width, lateral clearance, median type and number of access points. The base free flow speed used in this analysis was the speed limit and according to the HCM procedure, the speed limit should be increased by 5 mph for posted speed limits higher than 50 mph. When the posted speed limit lies between 50 mph and 45 mph, the HCM

procedure calls for increasing the speed by 7 mph. Equation (3.3) was used to calculate the free flow speed for the segments.

$$FFS = BFFS - f_{lw} - f_{lc} - f_{n} - f_{ID} \tag{3.3}$$

where *FFS* is the free flow speed (mph), *BFFS* is the base free flow speed substitute for by the speed limit (mph), f_{lw} is the adjustment factor for lane width, f_{lc} is the adjustment factor for lateral clearance, f_{n} is the adjustment factor for the number of lanes, and f_{ID} is the adjustment factor for the interchange density. Appendix B-2 shows the speed limit and the resulting FFS for each segment to be considered for further analysis.

The highways capacity manual suggests that the base free flow speed for freeways should be 70 mph for urban area and 75 mph for rural areas (*10*). However, some segments had speed limits as low as 50 mph. Raising the base free flow speed to 70 mph would have overestimated the speed for these segments. However, the HCM also gives specifications for multilane highways where under base conditions the speed is 7 mph higher than the speed limit for speed limits of 40 mph and 50mph and it is 5 mph higher than speed limits for speed limits of 50 mph and 55 mph. Therefore, for segments with speed limits between 40 mph and 55 mph, the base free flow speed was calculated using the multilane highway procedure and for the segments with speed limits of 65 mph and greater, the freeway base free flow speed was used.

3.3.8   Crash characteristics

The attributes of crashes that occurred in the year 2005 were extracted from the Crash Analysis Report (CAR) database maintained by the FDOT. The attributes contained in the CAR database included information about drivers and vehicles involved in a crash, the roadway geometrics at the crash site, contributing causes for the crash, as well as, the type of crash. These attributes were derived from the Florida Traffic Crash form that gives detailed information of the crash. The driver information in the database includes the driver's physical condition at the time of the crash and driver's age. The vehicle information contained in the database was helpful in identifying what type of vehicle was involved in the crash. The CAR database contained 16 categories of vehicles; however, for the purpose of this study only the first seven categories were considered since the thrust of the study was knowing whether the vehicle involved was a passenger car or a truck. The first four categories represented cars categorized as automobiles, vans, light trucks (passenger units with 2 or 4 rear tires) and medium trucks (vehicles with 4 rear tires). Other vehicles not covered by this definition were regarded as trucks; that is, heavy trucks (2 or more rear axles), truck tractor-trailers, and motor homes.

Some of the geometric characteristics at the crash site are generally added by FDOT Safety Office into the CAR database. These roadway geometrics include the location of the crash, the lane where the crash occurred, roadway conditions at the time of the crash, the traffic way character at the point where the crash occurred, and the speed limits at the location where the crash occurred. Other variables that are provided in the database include the severity of the crash and the day of the week the crash occurred. Highway construction zones in 2005 were noted and the sections under construction at one time or another in 2005 were eliminated from the analysis. The majority of these sections were on Interstate 95 in Broward County.

3.3.9   Synthesis of the data

The data that were collected had to be synthesized to form a database that includes all traffic, geometric, and crash attributes for each segment. However, not all data necessary for building a robust model were collectable in the course of this study. The wish list for the data that should be contained in the synthesized database is shown in Table 3.2 with the status as to whether the particular data were acquired or not. As shown in Table 3.2, a large percentage of the data was acquired.

Table 3.2: The wish list of the data acquisition

Wish List	Acquisition Status
Geometric Data	
Number of lanes	Achieved
Interchange Density	Achieved
Number of ramps	Achieved
Length of Acceleration and Deceleration lanes	Not Achieved
Location of signs	Not Achieved
Traffic Data	
AADT for Segments	Achieved
Hourly traffic volumes	Not Achieved
Truck percentage	Achieved
Ramp volumes	Achieved
Speed limits	Achieved
Operating Speeds	Not Achieved
Crash data	Achieved

Some data, such as length of deceleration lanes and the location of traffic signs, were not collected because of the lack of sources to obtain that information and the extensiveness of research work to obtain all the data. Acquiring the information through physical measurement is not only expensive but equally dangerous if not done with caution. These roadways were high speed facilities and some of the traffic signs are placed in locations that provide no room for taking measurements without closing adjacent lane(s). Data for the hourly traffic volumes were also not available from the sources that were used. Both TTMS and PTMS provide hourly flow rates but these data are generally combined into AADT data by the Planning Office and hourly flow rates are thus irretrievable. However, hourly ramp traffic volumes were provided by FDOT District IV for ramps on Interstate 95 in Broward and Palm Beach counties. These data were obtained directly from the FDOT District IV offices where they collected hourly ramp volumes for operational purposes. Unlike geometric and traffic data, crash data are sufficiently documented in FDOT CAR database with many attributes coded. The FDOT Safety Office provided crash data occurring from 1984 to 2005. However, only crash data from 2002 to 2005 were used in this study for before-and-after analysis of truck lane restriction and for modeling variables influencing crashes using regression methods.

3.4   Database creation and description of the combined data

The data wish list was the basis for the creation of the database; however, since some data could not be acquired there was a need to restructure the contents of the database. All data were stored in a database with each row representing a segment of a particular urban limited-access highway. Subsequently, the synthesized database was the basic source of information used for descriptive statistical analysis, correlation analysis, regression modeling, and conducting before-and-after statistical studies on the influence of truck lane restriction strategy.

Appendix B-3 shows the printout of the database for all the segments that were formed. As seen in Appendix B-3, the data are too numerous and include information on the location of the section, the geometric characteristic of the sections, the traffic characteristics and the crash characteristics. The crash characteristics were expanded providing information on types of crashes that occurred, severity of the crashes, and other conditions that relate to the crash at this particular section. Again, it should be emphasized here that both traffic, geometric, and crash data are referenced for end of year 2005. Appendix B-4 shows the database information that was used for the analysis.

CHAPTER 4

BEFORE-AFTER ANALYSIS OF TRUCK LANE RESTRICTION

4.1   Overview

The before-and-after analysis method is commonly used to evaluate the effectiveness of imposed treatments in many fields of engineering. The procedure used in the before-and-after analysis is to first observe the behavior of a system before a treatment is imposed and then observe the behavior of the system after the treatment is imposed. The change that is observed between the two systems explains the effect of the treatment. The resulting change in the system behavior may be positive or negative. Depending on the measure of performance, a negative change may suggest the treatment may be causing more damage to the system while a positive change may suggest the treatment is improving the system's performance. The magnitude and direction of change can be calculated and tested for significance using various statistical analysis techniques.

In traffic engineering, the before-and-after analysis has been extensively used in safety, operation, and Intelligent Transportation Systems improvement studies. The use of the before-and-after analysis in safety studies has resulted in the development of traffic crash reduction factors (CRF) for different types of treatments such as signing, alignments, channelization, traffic signal controls, and many other transportation engineering solutions. Many highway agencies are currently using crash reduction factors developed through this method when conducting benefit-cost analysis of engineering improvement alternatives. Although there are a few shortcomings associated with the before-and-after analysis method, it is still a useful tool in deciding whether a treatment alternative is worth implementing. The before-and-after studies of truck lane restriction as a safety management strategy have been conducted prior to this study, but none of the previous studies developed crash reduction factors associated with a truck lane restriction. Lack of the development of crash reduction factors could be due to the fact that some studies did not show any benefits associated with the implementation of a truck lane restriction while some other studies showed only marginal benefits. As was discussed in the Literature Review chapter, some studies even showed negative benefits in safety following implementation of a truck lane restriction.

4.2   Before-and-After statistical methodologies

There are several before-and-after study methodologies that are being used in different areas of engineering; however, in traffic engineering there are three methods commonly used. The first method is the Naïve Before-After method which is also known as simple Before-After method. The second method is the Comparison Group before-after method. The third method is the modification of the Naïve before-after method and is known as the Empirical Bayesian before-after method. Each of these methods has its advantages and limitations depending on the nature of the data being analyzed. The following sections give a detailed explanation of these methods. Later on, the three methods will be used to analyze some of the urban freeway sections in Florida followed by discussion of the analysis results. For the purpose of this study, the following notations will be used in the analysis:

β – The expected number of target crashes in the "after" period had the system not be treated. This is known as the **predicted** number of crashes.

α – The expected number of target crashes in the "after" period with the treatment, and this is known as the **estimated** number of crashes,

δ – The reduction in crashes in the after period of the expected number of crashes $\beta - \alpha$

ϕ – The effectiveness index, the ratio of the crashes with the treatment to the number of crashes without the treatment, i.e., $\dfrac{\alpha}{\beta}$.

The cornerstone of the before and after analysis is the prediction of the number of crashes within the same period of time when the treatment was not in place. The first assumption is that the numbers of crashes before the treatment was placed are an estimate of the crashes in the after period if the treatment was not in place. Thus, β should be regarded as the number of crashes before the treatment was placed. Another assumption made is that the crashes follow Poisson distribution meaning that the average and the variance are equal. However, the expected values are never known, therefore, estimates from observed data can be used. Table 4.1 below shows the notations that are used for the estimated values that correspond to the expected values.

Table 4.1: Corresponding Annotations for the Expected Values

Expected value	Estimated Value	Equation
α	$\hat{\alpha}$	-
β	$\hat{\beta}$	-
δ	$\hat{\delta}$	$\hat{\beta} - \hat{\alpha}$
ϕ	$\hat{\phi}$	$\dfrac{\hat{\alpha}}{\hat{\beta}}$
	ϕ'	$\dfrac{\hat{\phi}}{1 + \dfrac{Var(\hat{\beta})}{\beta^2}}$
$Var(\alpha)$	$Var(\hat{\alpha})$	$\hat{\alpha}$
$Var(\beta)$	$Var(\hat{\beta})$	$\hat{\beta}$
$Var(\delta)$	$Var(\hat{\delta})$	$Var(\beta) + Var(\alpha)$
$Var(\phi)$	$Var(\hat{\phi})$	$\hat{\phi}^2 \left[\dfrac{Var(\hat{\alpha})}{\hat{\alpha}^2} + \dfrac{Var(\hat{\beta})}{\hat{\beta}^2} \right] \Big/ \left[1 + \dfrac{Var(\hat{\beta})}{\hat{\beta}^2} \right]^2$

The symbols with ^ have the same meaning as the original symbols except they are estimates of the original symbols. The original symbols represent values that can be measured in the field. In general, there are four steps in the before and after analysis.

- Step 1—Estimate α then predict β.
- Step 2—Estimate $Var(\alpha)$ and $Var(\beta)$.

- Step 3—Estimate δ and ϕ.
- Step 4—Estimate $Var(\delta)$ and $Var(\phi)$.

This is the sequence that can be followed to describe the effect of the treatment to the system. Having estimated the difference in the estimated and predicted crashes (the after crashes and before crashes, respectively) and their variances, then the treatment to the system can be described as successful or a failure.

4.2.1 Naïve Before-and-After approach

A simple result, that is calculated from the before and after analysis, is the difference between the crashes before the treatment is introduced and after the treatment is introduced. The result can be regarded as the effect of the treatment. Having positive effect shows that the treatment was a success in reducing crashes while having a negative effect signifies that the treatment failed to reduce the number of crashes, hence making the analysis section less safe. The Naïve approach is deficient in that it does not take into account other factors that could also have contributed to the occurrence of crashes within the analysis period. Hence, the name "naïve" is quite appropriate in describing this before and after method of analysis. Despite its naivety, the literature indicated that this method is one of the most used methods of predicting treatment effects (*16, 17, 29, 30, 31, 32*).

4.2.1.1 The Theory of the Naïve Before-and-After method

Suppose sections that require treatment are numbered as 1, 2, 3... n. During the before count period, the number of crashes are labeled as B_i where i is the number of sections. The crashes that occur during the after period can be labeled as A_i. If the duration of the before and after periods differ, their ratio is given by

$$r_i = \frac{t_{ai}}{t_{bi}} \tag{4.1}$$

where t_{ai} is the after duration, and t_{bi} is the before duration. For a study with different durations of before and after period, the estimation of $\hat{\beta}$ and $\hat{\alpha}$ is given by

$$\hat{\alpha} = \sum A_i \tag{4.2}$$
$$\hat{\beta} = \sum r_i B_i \tag{4.3}$$

In most cases, the ratio between the before and after period is a unit signifying that the duration for collecting the crashes before and after are equal. In that case equation (4.3) can be rewritten as follows:

$$\hat{\beta}_i = \sum B_i \tag{4.4}$$

The variance of the before crashes and after crashes is estimated next. The Poisson assumption still holds, therefore, Equations (4.5) and (4.6) give the variance equations.

$Var(\hat{\alpha}_i) = Var(A_i) = \alpha_i$. Therefore;

$$Var(\hat{\alpha}) = \sum A_i \qquad\qquad (4.5)$$

$$Var(\hat{\beta}) = \sum t_i^2 B_i \qquad\qquad (4.6)$$

Thus the results from equation (4.2) to (4.6) will give an estimate of the effect of the treatment even with different before and after durations. However, the main shortcoming of the naïve before-after analysis is that this method does not consider other roadway, traffic and several other conditions, such as driver characteristics or environmental characteristics that could also affect the increase or reduction of crashes during the study period. Also, various other treatments may have been added on the system resulting in the after effect of one treatment being masked by the effects of other treatments.

Another shortcoming of this method is that a fluctuation in the number of crashes influence the prediction of the after crashes using the before reported crashes. An example of how a fluctuation can affect the future predicted crashes is if a site had unusual crash experience in the past (which for the analysis will be used as the before crashes) the prediction of the after crashes using these data will be influenced by the unusual crash experience making the prediction of the future crashes unreasonable for the analysis.

4.2.1.2 Improving prediction of the Naïve Before-After method

Since the main problem with the Naïve before and after method is the lack of inclusion of other variables that contribute to occurrence of crashes, a method that improves prediction by introducing factors that are likely to influence occurrence of crashes needs to be considered. It is important that factors that contribute to the occurrence of crashes on highways be well understood. Factors that contribute to crash occurrence include traffic characteristics, geometric characteristics, environmental characteristics, vehicular characteristics, driver characteristics and others. Some of these characteristics can be identified, measured, and quantified for the purpose of application in a prediction model. Of course, there are some characteristics whose influence on crashes is less recognizable, quantifiable, or measurable.

With these characteristics, a method can be devised to account for them in the before-and-after prediction modeling. Traffic characteristics is the most common type of information that is invariably being collected and varies over time. When there is a change in traffic between the before and the after periods, the expected number of crashes change from a function $f(T_b)$ to $f(T_a)$. These functions could be linear or exponential and the function f of the relationship between the targeted crashes and the traffic is known as the Safety Performance Function (SPF). Various safety performance functions have been estimated for different types of roadways and intersections. These safety performance functions are estimated by the exploration of crash data

and traffic flow data assuming that all other conditions are the same during the before and after period (*30*). The safety performance functions are used to produce the factor that accounts for the change in traffic in the estimation of the predicted number of crashes. The traffic is given by the ratio of the safety performance functions for the before and after as given in equation (4.7).

$$\hat{r}_t = \frac{f(\overline{T}_a)}{f(\overline{T}_b)}$$ (4.7)

where $\hat{r}_t$ is the factor change for traffic, $\overline{T}_a$ is the mean traffic during the after period, and $\overline{T}_b$ is the mean traffic during the before period. Several methods have been used to estimate the safety performance function including generalize linear models, pattern recognition, direct diagnostics, crash diagramming in conjunction with the site. The review on the safety performance functions show that the non linear safety performance functions are mostly used; however, in order to have precise results in the prediction of crashes, the functions need to be calibrated to reflect the prevailing conditions of the area that the analysis is being performed (*33*). The most common function that is used for the safety performance function is a power function given by equation (4.8).

$$f(T) = T^{\gamma}$$ (4.8)

where γ is the estimate parameter for a type of the roadway or intersection. The factor that accounts for traffic is added to equation (4.3) to get the predicted number of crashes for the after period represented by equation (4.9).

$$\hat{\beta} = \sum r_i \hat{r}_{ti} B_i$$ (4.9)

where $\hat{r}_{ti}$ is the estimated factor change for traffic. The variance for this factor r_t is given by equation (4.10).

$$Var(r_t) = r_t^2 \beta^2 (v^2\{\overline{T}_a\} + v^2\{\overline{T}_b\})$$ (4.10)

where $v\{.\}$ is the coefficient of variation of traffic in the given period (before or after) which is the ratio of the standard deviation of the random variable and its mean. All these estimates produce a modified analysis of the Naïve before and after method giving a better estimation of the effect of a treatment by including traffic as one of the variables affecting the occurrence of crashes on the highways.

4.2.2 Comparison group method

If geometric, traffic, environmental, or other causative factors are identifiable, measureable and quantifiable, they can subsequently be used in before-after analysis. What happens, however, if we know that there are factors out there that influence crash occurrence but unfortunately we cannot identify, isolate, or measure them? A statistical method that takes into account this phenomenon needs to be investigated. The recommended method is to estimate the

factors that are measurable and understood to predict the crashes and later use the comparison group method to make the final analysis of the effect of the treatment. However, most studies account for all factors by using the Comparison Group method instead (*30, 34*).

The primary step followed when using the Comparison Group method is to identify a group of untreated sites that have similar characteristics to the treated sites, and these untreated sites are called comparison sites. There are two main assumptions when using this method. The first assumption is that the factors that contribute to the occurrence of crashes change at the same rate during the before and the after period for both the comparison and treatment sites. The second assumption is that the factors influence the comparison site and the treatment site in the same manner. That is the effect that would occur on the comparison site should be similar to the effect that would occur in the treatment site. A numerical explanation using a set of simple equations is as follows. Let

α_c = number of crashes during the after period for the comparison group

β_c = number of crashes during the before period for the comparison group

α_t = number of crashes during the after period for the treatment group

β_t = number of crashes during the before period for the treatment group

$\hat{\beta}_t$ = number of predicted crashes for the treatment group

r_c = comparison ratio

As mentioned earlier, we assume that the ratio of the number of crashes for the before and after for the comparison groups is equal to the ratio of the number of crashes for the before and after for the treatment groups. Therefore, the ratio of the comparison groups is used to predict the number of crashes for treated group at the after period if the site was not treated. Equation (4.11) and (4.12) show how to obtain the predicted number of crashes for the treatment site.

$$r_c = \frac{\alpha_c}{\beta_c} \tag{4.11}$$

$$\hat{\beta}_t = r_c \beta_t \tag{4.12}$$

4.2.2.1 Statistical analysis of the comparison group method

The most important assumption in the comparison group method is that the ratios of the crashes for the before and after periods for the comparison sites and treatment sites are equal. These ratios are obtained by using the estimated number of crashes that have been defined in the previous section. The comparison group ratio is given by equation (4.11) which is used to predict the number of crashes for the treatment site. The treatment ratio r_t is given by

$$r_t = \frac{\alpha_t}{\beta_t} \tag{4.13}$$

If the assumption is that the comparison ratio and the treatment ratios are equal then it follows that

$$\frac{r_c}{r_t} = 1 \qquad (4.14)$$

Given equation (4.14), then equation (4.12) can also be written as follows;

$$\hat{\beta}_t = r_t \beta_t \qquad (4.15)$$

To avoid bias in the estimated ratios, the variance of the ratios is introduced to get a better estimate of the ratios as

$$\hat{r}_c = \hat{r}_t = \frac{\left(\alpha_c \middle/ \beta_c \right)}{\left(1 + 1 \middle/ \beta_c \right)} \qquad (4.16)$$

To recapitulate, in the naïve method $\hat{\beta} = r\beta$ while in the comparison group method $\hat{\beta} = r_t \beta_t$ and r_c is replaced by r_t to account for other factors that cannot be controlled by the analyst. When there are many comparison groups to be considered, the goal is to make sure that the results are most precise, therefore, it is prudent to choose the comparison group that has the least value of

$$\frac{1}{\alpha_c} + \frac{1}{\beta_c} + Var\left(\frac{r_c}{r_t} \right) \qquad (4.17)$$

4.2.3 The Empirical Bayes approach

The Naïve before and after method and the comparison group method had a common assumption that the predicted number of crashes that would have occurred in the after period could be a function of the before crashes. There are two main steps in performing a before and after study. The first step involves predicting the number of crashes that are expected in the after period by using the before crashes and the second step involves observing the change of crashes from the before and after to get the effect of the treatment on the system. However, there are two problems associated with the assumptions used in the Naïve and Comparison Group methods. The first problem is that the two methods are being used in such a way that the assumption that the treatment placement does not depend on the crash history. The second problem is that β is a better estimate of $\hat{\beta}$. This is not entirely true because the before period ends as soon as the treatment is placed and there is no fixed time for the before period which makes the assumptions questionable. Therefore, as in the first two methods, the real task is not to estimate only $\hat{\beta}$ instead to find the sequence of $\hat{\beta}$s over the years that can be feasible estimators. The importance of the Empirical Bayes method tries to correct these problems by ensuring the following conditions are met:

- The first important entity that needs to be considered is the crash history during the before period that gave the drive to implementing the treatment on the given section of the roadway,

- The second important entity is the inclusion of the factors that are thought to be causes of the occurrence of crashes on these roadway sections for better estimate of the crashes.

Therefore, considerations just described are the basis of the Empirical Bayes method. Instead of using observed crashes that were described previously in the Naïve before and after method and the comparison group method, here the history of the distribution is taken into consideration and used to predict the crashes. In addition to the history of the crash distribution, factors that influenced the occurrence of crashes are also taken into consideration during the prediction process. Therefore, predicted crashes are then used in the Naïve and comparison group before and after methods.

4.2.3.1 Empirical Bayes Naïve study

The Empirical Bayes Naïve analysis follows the same procedure as the basic Naïve study. However, the difference is in the estimation of the predicted number of crashes $\hat{\beta}$ used to calculate the value of δ and ϕ. Given that a treatment was implemented on roadway sections with before number of crashes $\beta(1), \beta(2),...\beta(i)..., \beta(n)$ and produced after crash values of $\alpha(1), \alpha(2),...\alpha(i)..., \alpha(n)$, an estimate of the predicted crashes is given by $E\{\hat{\beta}(i)\}$ with variance $Var\{\hat{\beta}(i)\}$. The values of $E\{\hat{\beta}(i)\}$ and $Var\{\hat{\beta}(i)\}$ are obtained by using regression methods. The following steps are followed to obtain these values.

- Step 1—Crashes and covariates are measured and a multivariate model is fit using these data. The model will estimate $E\{\hat{\beta}(i)\}$.
- Step 2—For each roadway section residuals, which are the difference between the actual crash counts $\beta(i)$, are calculated and $E\{\hat{\beta}(i)\}$ is estimated. These residuals are used to calculate the variance $Var\{\hat{\beta}(i)\}$ which is given by $(residual)^2 - E\{\hat{\beta}(i)\}$,

After estimating these two parameters then factor weights for the predicted crashes are calculated by equation (4.18).

$$\varphi(i) = \frac{1}{1 + \dfrac{Var\{\hat{\beta}(i)\}}{E\{\hat{\beta}(i)\}}} \tag{4.18}$$

where $\varphi(i)$ is the weight for the given highways section. Therefore the estimated $\hat{\beta}$ is given by

$$\hat{\beta}(i) = \varphi(i)E\{\hat{\beta}(i)\} + [1 - \varphi(i)]\beta(i) \tag{4.19}$$

and the variance is then given by

$$Var\{\hat{\beta}(i)\} = [1 - \varphi(i)]\hat{\beta}(i) \tag{4.20}$$

From the above equations, the parameters shown in Table 4.2 are obtained.

Table 4.2: EB Naïve Before-and-After analysis

Estimates	Equations
$\hat{\alpha}$	$\sum \alpha(i)$
$\hat{\beta}$	$\sum r_i \hat{\beta}(i)$
$Var(\hat{\alpha})$	$\sum \alpha(i)$
$Var(\hat{\beta})$	$\sum r_i^2 Var\{\hat{\beta}(i)\}$

4.3   Analysis of the data

The before-and-after analysis was conducted for some sections of Interstate 75 in the Tampa Bay area, Interstate 95 in the Jacksonville area, and the Homestead Extension of the Florida's Turnpike in South Florida. Sites with a truck lane restriction were considered treatment sites with the hypothesis that a truck lane restriction is aimed at improving operations and safety of these highway sections. The review of information collected from FDOT revealed that a truck lane restriction on Interstate 75 near Tampa and Interstate 95 near Jacksonville were introduced in May 2004 whereas the truck lane restriction on the Homestead Extension of the Florida's Turnpike was implemented in May 2005. The information gathered from FDOT further showed that a truck lane restriction on Interstate 95 in South Florida was introduced in May 1983 and sections of Interstate 75 in north Florida were introduced in August 1998. Appendix Table C-1 shows the truck lane restriction corridors that existed in Florida by July 2007.

The choice of the number of years to be used in the before period and in the after period depended on the year the truck lane restriction policy was implemented and the availability of the data from the CAR database. For Interstate 75 near Tampa and Interstate 95 near Jacksonville, the before period was from May 2002 to April 2004 and the after period was from June 2004 to May 2006, given that the truck lane restriction "treatment" was introduced at these section in May of 2004. It is noteworthy that the month in which the truck lane restriction was implemented, i.e., May 2004, is not part of the before or after periods. For the Homestead Extension of the Florida's Turnpike, a one-year before and after periods were used, i.e., May 2004 to April 2005 and June 2005 to May 2006, respectively. The review of the database showed that only 18 sections with a truck lane restriction had data that can be analyzed using the before-and-after analysis method. Appendix Table C-2 shows the 18 sections.

4.3.1   Naïve Before-After analysis

The Naïve before-after analysis involved first calculating the ratio of the before and after periods. However, since the period for before and after are equal, the ratio is a unit. The assumption used in the before and after methods is that the crash occurrence follows a Poisson distribution. Therefore, the mean and variance equality condition applies. As explained in the methodology section, the main task is to predict the number of crashes that would occur in the after period if there was no treatment applied. These crashes are predicted using the before crash

data in which the before and after ratio is used as a factor for the prediction of these crashes [equation (4.4)]. The estimated number of crashes for the after period is also calculated using equation (4.2). Using these values the variances for the estimated and predicted number of crashes are obtained. Using the expressions shown in Table 4.1, the reduction of crashes δ and the effective index ϕ are estimated. Table 4.3 shows the results. The input data and the calculations used to produce the results displayed in Table 4.3 are shown in Appendix C.

Table 4.3: Naïve Before-and-After results

Estimated Parameters		Standard deviation of the Estimated Parameters	
$\hat{\alpha}$	4140	$\sigma(\hat{\alpha})$	64.34
$\hat{\beta}$	3086	$\sigma(\hat{\beta})$	55.55
δ	-1054	$\sigma(\delta)$	85.01
ϕ	1.342	$\sigma(\phi)$	0.03

4.3.2 Improved Naïve Before-and-After analysis

As indicated earlier, the Improved Naïve Before and After Analysis introduces traffic flow as a variable likely to affect the occurrence of crashes. To obtain the factor for traffic, a safety performance function needed to be developed which gives a relationship between the traffic and the crashes. However, the number of sections collected was not enough to produce a well defined safety performance function for these roadways as shown in the Appendix Figure C-1. Several researchers have conducted studies to produce safety performance functions for different types of roadway sections (*35, 36, 37, 38,*). The most commonly reported safety performance function is a power function with an estimate of $\gamma = 0.8$. This value was used in the function given in equation (4.8). Using this safety performance function, a traffic factor is calculated and used for the prediction of the crashes using equation (4.9). The results of the Improved Naïve Before and After Analysis are shown in Table 4.4. Input tables and the calculations are displayed in Appendix C.

Table 4.4: Improved Naïve Before-and-After analysis

Estimated Parameters		Standard deviation of the Estimated Parameters	
$\hat{\alpha}$	4140.00	$\sigma(\hat{\alpha})$	64.34
$\hat{\beta}$	3412.56	$\sigma(\hat{\beta})$	5850.59
δ	-727.44	$\sigma(\delta)$	5850.94
ϕ	1.21	$\sigma(\phi)$	1.05

4.3.3 Comparison group method

      The use of the Comparison Group method assists in the elimination of the effect of the factors that cannot be measured by using sections of the highway that have similar characteristics to those with the treatment sections but are not treated. These sections are named comparison sections. In this analysis, a set of 18 sections was selected as a comparison group. The main assumption involved with the Comparison Group method is that the ratio of the after crashes to the before crashes for the treatment sections and comparison sections are equal. Therefore, the analyses began by calculating the ratios for the treatment and comparison sections and predict the number of crashes for the treatment sections in order to calculate the reduction of crashes and the effectiveness index. The inputs and calculations of the Comparison Group method are shown in Appendix C. The summary of the results are shown in Table 4.5.

Table 4.5: The Comparison group results

INPUT		
	Treatment	**Comparison**
Before	2216	6904
After	3057	7213
Ratio	0.757	
OUTPUT		
Estimation of the crashes	$\hat{\alpha}$	3057
	$\hat{r}_c$	1.045
	$\hat{\beta}$	2314.8
Estimation of variances	$Var(\hat{\alpha})$	3057
	$Var(\hat{\beta})$	4062137.431
interpretation parameters	δ	-742.2
	ϕ	0.751
Standard deviations	$\sigma(\delta)$	2016.23
	$\sigma(\phi)$	0.654

4.3.4 Empirical Bayes analysis

      With the Empirical Bayes Method, the crashes are predicted using the variables that are thought to influence crashes using the distribution of the before crashes. This method then takes into consideration the crash history in the prediction of the number of after crashes and also includes measurable factors that are thought to influence the occurrence of crashes on the roadways sections.

      In this analysis, a multi-regression model was used to predict the number of crashes with the predictor variable being the before crashes and regression variables being length, number of interchanges, truck percentage, number of ramps, AADT, number of lanes, and speed. The results of the multi-regression model were then used to calculate the residual for each highway

section. The residuals were then used to calculate factor weight for the individual sections using equation (4.18) and in turn used to predict the crashes using equation (4.19) and their variances using equation (4.20). Appendix C shows the input data and the calculations associated with Empirical Bayes method.

Table 4.6: Empirical Bayes results

	Estimated Parameters		Standard deviation of the Estimated Parameters
$\hat{\alpha}$	4140		64.34
$\hat{\beta}$	3218.1		163.89
δ	-921.86		176.07
ϕ	1.29		0.07

4.4   Discussion of results

The purpose of the before and after analysis was to evaluate the effect truck lane restriction had on the sections of Interstate 75, Interstate 95 and the Homestead Extension of the Florida's Turnpike. The crashes considered were the total crashes reported from years 2002 to 2006 for these sections. The results that were obtained from these counts were the estimated number of crashes (crashes during the after period), the predicted number of crashes during the after period, if the treatment was not placed (using the before crashes), the crash reduction values and the effectiveness index. The before-and-after analysis relied on Naïve Approach, improved Naïve before and after method, Comparison Group method, and Empirical Bayes approach. The results obtained from these methods are summarized in Table 4.7.

Table 4.7: Before-and-After method summary of results

Analysis Methods	Crash Reduction (δ)	Effective Index (ϕ)
Naïve Before and After Method	-1054.00	1.34
Improved Naïve Before and After Method	-727.44	1.21
Comparison Group Method	-742.20	1.32
Empirical Bayes Before and After Method	-921.86	1.29

The results in Table 4.7 show that all methods resulted in negative crash reductions and the effective index being more than a unit. For a treatment to be effective, the crash reduction values are expected to be positive and the effective index to be less that a unit. Therefore, the conclusion that can be made about these freeway sections is that the introduction of a truck lane restriction on these freeways was not effective. To get the percent reduction/addition of the expected crash frequency equation (4.21) can be used.

Percent reduction$= (1-\phi) \times 100$ (4.21)

Since all the values that were obtained from all the methods were above a unit, the percent reduction calculated for all sections was negative, signifying that there would be a percentage increase in the frequency of crashes. These results mirror the results of other researchers who have conducted studies on truck lane restrictions. A study on Capital Beltway (*39*) around Washington DC showed an increase in crashes of 13.8 percent following implementation of truck lane restriction. Another report (*40*) reported that most of the crashes that occur in truck lane restricted areas are because of trucks changing lanes to the right, hence, increasing the number of truck-related crashes and in turn the overall number of crashes on the freeways. However, some studies have reported that truck lane restrictions have been effective in improving safety by reducing the number of crashes on the roadway. An example is the Interstate 10 analysis which showed a 68% crash reduction after truck lane restriction was implemented.

CHAPTER 5

BUILDING OF CRASH PREDICTION MODEL

5.1   Overview

The standard model for count data is the Poisson regression model, which is a nonlinear regression model. This regression model is derived from the Poisson distribution by allowing the intensity parameter μ to depend on the regressor variables. The Poisson regression model was the first model considered to formulate and express a specific hypothesis related to the distribution of crashes on urban limited access highways. Consider a cross section data where there are n independent observations the ith of which is (y_i, x_i). The scalar dependent variable, y_i, is the number of crash occurrences and the vector x_i is the linearly independent regressors that were displayed in Table 5.1. Therefore the Poisson distribution of y_i given x_i is given by the following equation:

$$f(y_i \mid x_i) = \frac{e^{-\mu_i}(\mu)^{y_i}}{y_i!} \ , \ y_i = 0,1,2,3... \tag{5.1}$$

whereby in a log-linear version of the model, the mean parameter is parameterized as $u_i = \exp(x_i'\beta)$. Since crashes are count data, negative values are not expected for the mean therefore taking the exponent of $x_i'\beta$ ensures that the parameter u_i is a non negative value. This model implies that the conditional mean is given by the following equation

$$E[y_i \mid x_i] = \exp(x_i'\beta) \tag{5.2}$$

There are several methods that can be used to solve for β', namely, ordinary least square method, moment-based method, and maximum likelihood method. Most statistical software employ the maximum likelihood method to solve Equation (5.2). The equation for the maximum likelihood estimator is given by

$$\ln L(\beta) = \sum_{i=1}^{n} \{y_i x_i'\beta - \exp(x_i'\beta) - \ln y_i!\} \tag{5.3}$$

Differentiating this equation by β yields the Poisson maximum likelihood $\hat{\beta}$ as the solution to the first order conditions

$$\sum_{i=1}^{n} (y_i - \exp(x_i'\beta))x_i = 0 \tag{5.4}$$

However, the use of Poisson regression model assumes that there is equidispersion in the data; that is, the mean and the variance of the distribution are equal. The data displayed in Table 5.1 show that mean number of crashes in a section was 166 with a variance of 35,604, indicating

that the crash data are highly over dispersed. Thus, a distribution that permits more flexible modeling of the variance is needed. A standard parametric model that accounts for over dispersion is the negative binomial regression model. The most common implementation of the negative binomial regression model is with the variance function of $\mu + \alpha\mu^2$ whose density function is given by

$$f(y \mid \mu, \alpha) = \frac{\Gamma(y + \alpha^{-1})}{\Gamma(y+1)\Gamma(\alpha^{-1})} \left(\frac{\alpha^{-1}}{\alpha^{-1} + \mu} \right)^{\alpha^{-1}} \left(\frac{\mu}{\alpha^{-1} + \mu} \right)^{y}, \quad \alpha \geq 0 , \quad y=0, 1, 2, 3 \ldots \tag{5.5}$$

where α is the over dispersion parameter and $\Gamma(.)$ is the gamma function defined by $\Gamma(y+a)/\Gamma(a) = \Pi_{j=0}^{y-1} \ln(j + \alpha^{-1})$. Therefore, the log likelihood function for the exponential mean $\mu_i = \exp(x_i'\beta)$ becomes

$$\ln L(\alpha, \beta) = \sum_{i=1}^{n} \left\{ \left(\sum_{j=0}^{y_i-1} \ln(j + \alpha^{-1}) \right) - \ln y_i! - (y_i + \alpha^{-1}) \ln(1 + \alpha \exp(x_i'\beta)) + y_i \ln \alpha + y_i \ln\{x_i'\beta\} \right\} \tag{5.6}$$

And negative binomial maximum likelihood estimators ($\hat{\beta}, \hat{\alpha}$) is the solution to the first order conditions

$$\sum_{i=1}^{n} \frac{y_i - \mu_i}{1 + \alpha\mu_i} x_i = 0 \tag{5.7}$$

and

$$\sum_{i=1}^{n} \frac{1}{\alpha 2} \left(\ln(1 + \alpha\mu_i) - \sum_{j=0}^{y_i-1} \frac{1}{(j + \alpha^{-1})} \right) + \frac{y_i - \mu_i}{\alpha(1 + \alpha\mu_i)} = 0 \tag{5.8}$$

The negative binomial model implemented in the STATA program was used in modeling the crash data.

5.2   Methodology

The procedure used in regression modeling usually begins with model specification, followed by estimation, testing, and finally evaluation. In this study, the specified model is the negative binomial model described in the preceding sections. Therefore, what is needed now is model estimation, model testing, and model evaluation. The process of model estimation was conducted in seven different phases, hereby referred to as Phase 1 through Phase 6. Later on, Phase 7 will refer to model testing and evaluation. The seven phases that were followed are short listed below.

- **Phase 1:** Descriptive statistics and correlation analysis
- **Phase 2:** Estimation of the full model that include all traffic and geometric variables

- **Phase 3:** Estimation of a model containing all traffic and geometric variables as well as additional variable called "region"
- **Phase 4:** Estimation of a model that includes region variables describing demographic and precipitation characteristics of the Florida urban regions.
- **Phase 5:** Estimation of a model that included condensed variables of the demographic and geological characteristics
- **Phase 6:** Estimation of a model containing only statistical significant variables derived from Phase 4 model
- **Phase 7:** Model testing and evaluation

The use of the above phases in the modeling process was thought to be sufficient in quantifying the influence of traffic, geometric, and regional characteristics on the occurrence of crashes on Florida urban freeways and tollways.

5.3   Modeling

The expected result from the modeling procedures is the crash prediction model. With the help of the above mentioned phases, the end product is the crash prediction model, which will include the geometric, traffic and social economic characteristics thought to influence the occurrence of crashes. Although the expected results from the modeling procedures would produce a statistical analysis of the variables, the results will also assist in explaining the practical significance of the variables in relation to the segments under analysis.

5.3.1   Phase 1: Descriptive statistics and correlation analysis

A preliminary examination of descriptive statistics for the variables and any correlation among the variables was conducted. The description statistics produced were minimum values, maximum values, mean values and the standard deviations for the independent and dependent variables. The purpose of descriptive statistical analysis was to get an overview of the behavior of the variables that are used in building the model.   The correlation analysis involved finding the interrelation between the independent variables and was done for the purpose of obtaining the correlation ratio, which gives the degree of relationship between the variables. This value assists on a preliminary choice of variables in a model, avoiding redundancy in the model by having more than one variable explaining the same result or variables that are functions of one another. The following two sections describe the results of the descriptive statistical analysis and correlation analysis.

5.3.1.1 Descriptive statistics

Descriptive statistics describes the basic features of the study data. In Chapter 3, the properties of each variable to be considered in the modeling exercise was displayed graphically. The graphical display enabled the examination of the distributive properties of each variable within a particular roadway segment.   The understanding of variable properties is further extended hereby examining minimum values, maximum values, average values, and the standard deviation of each variable. Table 5.1 shows the descriptive statistics for the number of crashes in each segment, the length of the segment, the number of interchanges, the number of on ramps,

the number of off ramps, the number of lanes, the average annual daily traffic, the truck percentage, speed limit, the presence of a truck lane restriction, and the presence of a high occupancy vehicle lane.

Table 5.1: Descriptive statistics

| Variable | Descriptive Statistics | | | |
	Min	Mean	Max	Std. Dev.
Crashes	0	156	1146	188.7
Length (miles)	0.498	9.4	44.525	8.9
Truck	2%	9%	15%	4%
Number of interchanges	0	5.7	16	4.1
Number of on-ramps	0	4.6	13	3.4
Number of off-ramps	0	4.7	17	3.4
Truck lane restriction*	0	0.23	1	0.4
Number of lanes	2	2.92	5	0.8
Total AADT	2439	54972	124964	27137.8
Free Flow Speed	58	64.1	67.5	2.4
HOV lanes*	0	0.06	1	0.2

*These are categorical variables – 0-No and 1-Yes

The values obtained from the descriptive statistics table define the distribution of the variables for the sections that have been chosen for this analysis, in this case the urban freeways and tollways. The number of crashes that have been collected range from a minimum of 0 crashes to a maximum of 1,146 crashes per section. This shows how wide spread the distribution of crashes is among the segments. However, this distribution is caused by the wide distribution of lengths in the segments. These lengths range from a minimum of 0.498 miles to a maximum of 44.523 miles. Preliminarily, it can be said that the longer the length of the segment, the higher the number of crashes since the occurrence of a crashes is dependent on exposure. Another observation of the descriptive statistics is that the free flow speeds for the segments tend to be low. The maximum speed observed was 67.5 mph. The low speeds were experienced because of the influence in the number of lanes and access points. Since the free flow speed was derived from the HCM procedure (*10*), the free flow speed was significantly reduced due to the existence of a larger number of interchanges within a section with a longer length. An overview of the variables shows a large variance between the data. This shows the independence of the variables which is important when performing any regression analysis.

5.3.1.2 Correlation analysis

Correlation analysis is a statistical technique that describes the degree of the relationship between two variables. The correlation, *r*, between two variables is given by

$$r = \frac{N\sum xy - \left(\sum x\right)\left(\sum y\right)}{\sqrt{\left[N\sum x^2 - \left(\sum x\right)^2\right]\left[N\sum y^2 - \left(\sum y\right)^2\right]}}$$

(5.9)

where N is the number of the pair of the variables whereas x and y are independent variables being analyzed.

Correlation analysis is not a cause-effect analysis among variables, in which the effect of one variable over the other is determined. However, knowing the degree of association among independent variables is important and assists in eliminating the variables that are covarying. One of the covarying variables is generally redundant in the model and does not add any useful information in the modeling process. The STATA statistical software package was used in determining the correlation values for pairs of all modeling variables of interest. The command used was CORRELATE. Another important part of the correlation analysis is the observation of the relationship between the dependent variable and the independent variable. The correlation ratio displays preliminary information on the extent the dependent variable is related to the independent variable. This relationship can be displayed by scatter plots between the dependent variable (crashes) and the independent variables (length, truck percentage, number of interchanges, number of on ramps, number of off ramps, truck lane restriction, number of lanes , total AADT, free flow speed and HOV). These scatter plots are shown in Appendix D

The correlation value given by equation 5.1 can only fall between -1 and +1. A positive correlation signifies that the two variables are directly varying with each other, i.e. as one variable's value increases the other variable's value also increases. The opposite of this is the negative correlation in which the variables are inversely varying, i.e. an increase in one variable's value is associated with a decrease in other variable's value. When the correlation coefficient, r, approaches 1.0 (regardless of the sign), it shows that the two variables are strongly correlated. This means that they have a high degree of relationship either negatively or positively depending on the sign of the correlation coefficient. Table 5.2 below shows the results of the correlation analysis produced for the variables earlier displayed in Table 5.1.

Table 5.2: Correlation matrix 1

Variables	Crashes	Length	Truck	Number of interchanges	No. of on-ramps	No. of off-ramps	Truck lane restriction*	No. of lanes	Total AADT	Free Flow Speed	HOV lanes*
Number of crashes	1										
Length (miles)	0.432	1									
Truck percentage	0.0996	0.3606	1								
Number of interchanges	0.5848	0.5683	0.2273	1							
Number of on-ramps	0.5204	0.4244	0.229	0.3608	1						
Number of off-ramps	0.4834	0.4067	0.1624	0.3531	**0.8688**	1					
Truck lane restriction*	0.3627	0.2516	0.3689	0.1574	0.3798	0.2827	1				
Number of lanes	0.397	-0.1056	-0.0811	0.1286	0.2672	0.2633	0.2809	1			
Total AADT	0.3986	-0.1869	-0.1095	0.1089	0.1844	0.1726	0.2659	**0.684**	1		
Free Flow Speed	0.2932	0.3186	0.059	0.0195	0.3166	0.3027	0.3336	0.5499	0.243	1	
HOV lanes*	0.5659	0.1226	0.196	0.2398	0.2764	0.2239	0.4427	0.4411	0.3576	0.3115	1

Closer examination of the correlation coefficients in Table 5.2 shows there is a great variability in the degree of relationship with most of the variables being lowly correlated. Given that the purpose of conducting a correlation analysis is to remove from the model a variable that is highly correlated with another variable, we need to examine correlation values that are 0.6 or

more. A close observation of the correlation values in Table 5.2 shows that the number of on-ramps variable and off-ramps variable are highly correlated ($r = 0.8688$). Also, the number of lanes variable and AADT variable are highly correlated ($r = 0.684$). Following these results, one could decide to drop one correlated variable given that two variables are correlated. However, it was thought that it would be better to combine some of variables into new variable.

The number of on-ramps and off-ramps were combined to produce a new variable termed number of ramps. Both on-ramps and off-ramps are conflict points that affect safety differently, and dropping one of these variables in the modeling process would not be prudent. The number of ramps, therefore, is given by

$$r = r_{on} + r_{off} \tag{5.10}$$

where r is the number of ramps, r_{on} is the number of on-ramps, and r_{off} is the number of off-ramps.

Furthermore, a new variable termed AADT per lane was developed by combining the number of lanes variable with AADT variable as follows

$$AADT / lane = \frac{AADT}{N} \tag{5.11}$$

where *AADT* is the Average Annual Daily Traffic and *N* is the number of through lanes in a segment. The *AADT per lane* variable is more prudent in the modeling process since it is clear that more traffic lanes are generally associated with more traffic (*25*). The two new variables replaced the four correlated variables in Table 5.2 and a new correlation matrix, for the remaining variables with these two new variables, was produced as shown in Table 5.3.

Table 5. 3: Correlation matrix 2

Variable	Number of Crashes	Length	Truck percentage	Number of interchanges	Number of ramps	Truck lane restriction	AADT per lane	Free Flow Speed	HOV lane
Number of Crashes	1								
Length	0.432	1							
Truck percentage	0.0996	0.3606	1						
Number of interchanges	0.5848	0.5683	0.2273	1					
Number of ramps	0.5192	0.4298	0.2024	0.3693	1				
Truck lane restriction	0.3627	0.2516	0.3689	0.1574	0.3425	1			
AADT per lane	0.2419	-0.1623	-0.087	0.0375	0.095	0.1785	1		
Free Flow Speed	0.2932	0.3186	0.059	0.0195	0.3203	0.3336	-0.0375	1	
HOV lane	0.5659	0.1226	0.196	0.2398	0.2587	0.4427	0.1226	0.3115	1

The resulting correlation matrix above shows that most of the variables are now less correlated with each other considering a cut off value of $r = \pm0.6$. Thus, it was decided that these variables will be included in the preliminary model where their effect on crash occurrence will be analyzed using the negative binomial regression model.

5.3.2   Phase 2: Negative binomial model of crashes against traffic and geometric variables (Model 1)

The descriptive statistics and correlation analysis revealed information that was used to judge the suitability of each variable for inclusion in the negative binomial model. In addition, the correlation between independent variables with the dependent variable, i.e. crashes, revealed that there was a positive correlation between crashes and the independent variables as mentioned in the previous section. Given that the relationships among the variables are now known, the next phase is to produce a Negative Binomial model involving all variables shown in Table 5.3. Again, the STATA statistical software package was used in specifying a Negative Binomial model. The STATA command NBREG produced the variable coefficients, standard error, the Wald's statistic (z), the probability, the confidence interval, and the likelihood – ratio test for α. These STATA outputs and their relevance in judging the suitability of the preliminary Negative Binomial regression model is discussed below.

5.3.2.1 Variable coefficient

In simple or multiple linear regression, the coefficient for each independent variable gives the size of the effect that the variable is having on the response variable. The sign of the coefficient (+ or -) gives the direction of the effect. In regression analysis of a single independent variable, the coefficient will give an indication of how much the variable will increase the value of the response, if the coefficient is positive, or how much the variable will decrease the value of the response, if the coefficient is negative. If there are, however, multiple independent variables, the coefficient will indicate how much the response will increase or decrease with a unit increase of the variable when the other variables are constant.

However, in the Negative Binomial regression modeling, the effect interpretation of the coefficients is not as straight forward as with the linear regression. The linear regression allows for negative and positive responses. However, in the case of crashes negative occurrences are not expected. Therefore, the expected values are non negative values including zero. In the negative binomial model being used for evaluation in this study, the response variable is the average number of crashes per segment. Recalling equation (5.2), β is the variable coefficient which can either be negative or positive. The effect of this coefficient to the response is an exponential effect which makes the response value non-negative. Therefore, the effect of a unit change in the variable to the response is not the value of the coefficient, rather it is given by e^{β} which will always be positive. However, a negative value of the coefficient will still give a decrease in the response value since e^{β} will be less than 1.0. When the coefficient is positive the value of e^{β} will be greater than 1.0, which will give a positive effect to the response variable.

5.3.2.2 Wald statistics

Another output produced by STAT NREG command is the Wald's Statistics. The Wald statistics tests the significance of the parameter regression coefficient, which is based on the asymptotic normality property of the maximum likelihood estimate. This is computed as

$$W = \frac{\beta^2}{Var(\beta)} \tag{5.12}$$

where β is the standard parameter estimate, β is the variable coefficient, and $Var(\beta)$ is the asymptotic variance of the parameter estimate. The Wald statistics is tested using the Chi – Square distribution.

5.3.2.3 Estimator probability

The value of the probability is calculated using the Chi–square distribution and the above Wald Statistics. This probability value is then compared to the chosen significance level to determine whether the given variable estimate is statistically significant or insignificant.

5.3.2.4 Likelihood–ratio test of α

This test, as produced by STATA, gives the estimation of the maximum likelihood of a given function. The parameters that maximize the likelihood function are known as the maximum likelihood estimators. The function of the maximum likelihood estimator was given by Equation 5.6. The test procedure considers the maximum likelihood with no parameter restrictions (that is all parameters included in the likelihood function, L_1) against the maximum likelihood when the parameters are restricted (that is the likelihood function with only the constant, L_0). Thus

$$\lambda = \frac{L_0}{L_1} \tag{5.13}$$

This ratio is used to calculate the Chi Square value for the test of α and it is always between 0 and 1. When α is 0 then the model follows Poisson distribution. The value of the Chi–square is calculated as

$$\chi^2 = -2\ln(\lambda) \tag{5.14}$$

The value is compared with the actual value of the Chi–Square on Table 5.4 with a specific significance level and k degrees of freedom depending on the number of variables. Table 5.4 shows the outputs of the STATA NREG command.

The results in Table 5.4 show that all variables have positive coefficients except for the truck percentage. This means that, for the variables with positive coefficients, increasing the values of these variables is associated with the increase in the chances of a crash. On the other hand, a truck percentage variable, which has a negative coefficient, suggests that when a segment has a high truck volume, as the percentage of AADT, the number of crashes in that segment decrease. Furthermore, the results in Table 5.4 show that all variables in the model are significant at α=0.05 value. This was mentioned earlier except for the length, truck lane restriction and presence of HOV lanes.

Table 5.4: Preliminary Negative binomial regression model

Variables	Coef.	Std. Err.	Z	P>z	[95% Conf. Interval]	
Length	0.0149	0.01	1.69	0.092	-0.002	0.032
Truck percentage	-6.2574	1.90	-3.30	0.001	-9.979	-2.536
Number of interchange	0.1732	0.02	8.23	0.000	0.132	0.214
Number of ramps	0.0420	0.01	3.50	0.000	0.019	0.066
Truck lane restriction	0.0795	0.18	0.45	0.652	-0.266	0.426
AADT/lane	0.0001	0.00	7.12	0.000	0.000	0.000
Free Flow Speed	0.1807	0.03	5.28	0.000	0.114	0.248
High occupancy vehicle lane	0.0167	0.31	0.05	0.957	-0.584	0.618
Constant	-9.2630	2.27	-4.08	0.000	-13.711	-4.815
ln (α)	-0.8504	0.13			-1.111	-0.590
A	0.4272	0.06			0.329	0.554
Likelihood-ratio test for α						
χ^2	5043.49					
$prob \geq \chi^2$	0					

5.3.3   Phase 3: Negative binomial Model with "region" as an additional variable (Model 2)

The model discussed in Section 5.2.2 had roadway and traffic as the only variables that are thought to influence the occurrence of crashes on urban limited access highways. Another element of interest in crash causation is driver behavior. To this end, the researchers wondered whether there would be regional differences in driving behavior and how would such differences be captured in the modeling process. A number of hypotheses were considered in deciding how to account for regional differences in crash occurrence.

One of the hypotheses considered in this study was that the different geographic localities could have different driver behavior contributing to the difference in crashes from one area to another. As mentioned earlier, the freeway and tollway sections modeled were from Region 1 comprised of Duval county; Region 2 comprised of Broward, Miami-Dade, and Palm Beach counties; Region 3 comprised of Hillsborough, Manatee, Pinellas, and Sarasota counties; and Region 4 comprising of Osceola and Orange counties. To differentiate among these regions, a categorical variable called "Region" was introduced. However, how these regions should be ranked proved to be a challenge given that there were four regions with 24 ways using the permutation equation (5.15) for arrangement, i.e.,

$$n\Pr = \frac{n!}{(n-r)!} \tag{5.15}$$

where n is the number of regions and r is the number of regions in one order. Thus, 24 arrangements were possible based on Equation 5.15. Twenty-four models were run with the geometric and traffic variables constant. An observation of the model that gave the most positive or most negative variable coefficients was made. The results showed that the combination with Orlando, followed by Jacksonville, Tampa Bay and South Florida gave the most positive coefficient with the reverse of this order giving the most negative coefficient. The interpretation of the significance of the "region" variable result is that there is a correlation between crashes

and regions. For the purpose of this analysis, the arrangement that gave the most positive coefficient was used, which means as the rank of the region increases, crash occurrences also increase. Therefore, driving in the Orlando area is safer than driving in the Broward-Miami-Dade-Palm Beach area. Table 5.5 shows the results of the model with the most positive coefficient of the region variable. The models produced for the other 23 ordered regions are in Appendix D.

Table 5.5: Preliminary Negative binomial regression model with "region" variable

Variables	Coeff.	Std. Err.	Z	P>z	[95% Conf. Interval]	
Length	0.0067	0.01	0.76	0.447	-0.0106	0.0241
Truck percentage	-3.9997	1.94	-2.07	0.039	-7.7939	-0.2055
Number of interchange	0.1967	0.02	9.54	0.000	0.1563	0.2372
Number of ramps	0.0438	0.01	3.93	0.000	0.0219	0.0656
Truck lane restriction	-0.1352	0.18	-0.77	0.440	-0.4784	0.2081
AADT/lane	0.0001	0.00	8.04	0.000	0.0001	0.0001
Free Flow Speed	0.1904	0.03	5.83	0.000	0.1264	0.2544
High occupancy vehicle lane	-0.2451	0.30	-0.82	0.410	-0.8285	0.3383
Region	0.3226	0.07	4.30	0.000	0.1756	0.4696
Constant	-11.2605	2.22	-5.07	0.000	-15.6126	-6.9083
ln (α)	-0.9808	0.13			-1.2445	-0.7171
A	0.3750	0.05			0.2881	0.4881
Likelihood-ratio test for α						
χ^2	4774.84					
$prob \geq \chi^2$	0					

Unlike the regression model produced in Phase 2, some variable coefficients have changed in both value and sign, while some variable coefficients have changed in value only. The variables, such as truck lane restriction and HOV, had positive coefficients in the first model, but in this model they now have negative coefficients signifying that the presence of a truck lane restriction and HOV lane reduces the occurrence of crashes in the highway section. Also, their level of significance in the model has increased from 0.652 to 0.440 for a truck lane restriction and from 0.957 to 0.410 for a HOV lane.

The coefficients for the length, truck percentage, the number of interchanges, the number of ramps, AADT/lane and free flow speed variables have not changed in sign, but have changed in their values. Most coefficient values increased, i.e. the coefficient for the number of interchanges increased from 0.1732 to 0.1967, the number of ramps increased from 0.0420 to 0.0437, the truck percentage increased from -6.2574 to -3.9997, and free flow speed increased from 0.1807 to 0.1904. The variable that had its modeling coefficient decrease was length, which reduced from 0.0149 to 0.0067. The modeling coefficient for the variable AADT/lane did not change.

The region variable is one of the variables that has a positive coefficient. As mentioned previously, the sequence of this categorical variable was that rank 1 was for Orlando, rank 2 for Jacksonville, rank 3 was for Tampa Bay and rank 4 was for South Florida, which includes Miami Dade, Broward and Palm Beach. The positive coefficient of this variable shows that the driving characteristics in South Florida signify more aggressiveness than in Orlando. The reason for this

may be because Orlando is more of a tourist area where most of the drivers are not regular commuters and unfamiliar with the roadways. Typically, these drivers are less aggressive and more careful. Therefore, the significance of this variable gives more reason to believe that there are significant differences in safety when driving within these different regions.

5.3.4 Phase 4: Negative binomial model with social economic and precipitation variables (Model 3)

The significance of the region variable as displayed in Table 5.5 posed a number of questions and challenges. For instance, what are the underlying social, cultural, economic, or other factors that the "region" variable represents, and where could these data be acquired? Before further modeling could be performed, it was important to investigate the acquisition of data and perform further analysis of the "region" variable. Efforts were made to contact various experts and databases. The data contained in the census database was found to be useful (*24*). For each Florida region, a number of variables were extracted from the database including the percentage of people in each county who are female, who are under 18 years of age, who are above 65 years of age, who speak a language other than English at home, who have a high school education, who have the minimum of a bachelor degree, and who have income below the federal poverty level. Other variables extracted from the census data were the mean travel time in the county and the ethnic distribution in the county. Since rainfall precipitation data were readily available from the Center for Ocean Atmospheric Prediction studies database (*41*), it was also included as one of the variables that could explain the significance of the "region" factor in the model. Thus, a total of 15 variables were synthesized with the idea that one or a combination of these variables could explain the regional differences in crash occurrence.

With this information, a model that included the geometric, traffic and the 15 variables (thought to explain the region differences) was run. Table 5.6 below shows the results for this model. Again, after the 15 regional characteristic variables were added to the model 2, replacing the region variable with the social economic variables, several changes occurred in comparison to the previous model 2 with the variables from the initial model. For the model displayed in Table 5.6, the variable coefficients for length increased from 0.0067 to 0.01856, for truck percentage the coefficient increased from -3.9997 to -2.94905. There was also a decrease in the variable coefficients for the number of interchanges from 0.1967 to 0.16926, and AADT/lane from 0.0001 to 0.00004, and free flow speed from 0.1904 to 0.14784. The variable coefficient for the number of ramps and truck lane restriction remained approximately the same. However, the variable coefficient for HOV changed sign from negative to positive. This variable has not been stable in the model.

Including many variables in a model could cause a problem of other variable effect being overshadowed. Since all the variables being considered for addition into the model were aimed at describing the regional difference in crash occurrence, there was a need to combine the effect of these variables in order to reduce the clustering effect of these variables to one another and to the original variables in the model.

Table 5.6: Negative binomial model with regional characteristics

Variables	Coeff.	Std. Err.	z	P>z	[95% Conf. Interval]	
Length	0.01856	0.01	1.92	0.055	-0.0004	0.0375
Truck percentage	-2.94905	1.95	-1.51	0.131	-6.7716	0.8735
Number of interchange	0.16926	0.02	9.07	0.000	0.1327	0.2059
Number of ramps	0.04368	0.01	4.34	0.000	0.0240	0.0634
Truck lane restriction	-0.13132	0.18	-0.75	0.454	-0.4749	0.2122
AADT/lane	0.00004	0.00	4.36	0.000	0.0000	0.0001
Free Flow Speed	0.14784	0.03	5.13	0.000	0.0914	0.2043
High occupancy vehicle lane	0.37770	0.27	1.38	0.167	-0.1578	0.9132
Percent female	-250.03980	96.38	-2.59	0.009	-438.9360	-61.1436
Percent under 18yrs of age	7.64404	10.81	0.71	0.479	-13.5437	28.8318
Percent above 65yrs of age	-40.39173	14.17	-2.85	0.004	-68.1611	-12.6224
Percent white	295.21230	115.08	2.57	0.010	69.6632	520.7615
Percent black	290.29970	113.26	2.56	0.010	68.3125	512.2870
Percent American Indian and Alaska Natives	-516.61260	217.85	-2.37	0.018	-943.5985	-89.6268
Percent Asian	-11.84670	15.10	-0.78	0.433	-41.4505	17.7571
Percent Native Hawaii and other Pacific Islanders	-120.89530	132.82	-0.91	0.363	-381.2079	139.4172
Percent reporting two or more races	7.14603	7.50	0.95	0.341	-7.5608	21.8529
Percent speaking language other than English	4.62748	3.32	1.39	0.163	-1.8771	11.1321
Percent with high school	106.25860	62.36	1.70	0.088	-15.9705	228.4876
Percent with bachelor or more	-1.30168	5.13	-0.25	0.800	-11.3643	8.7609
Mean travel time to work	0.00848	0.01	0.66	0.509	-0.0167	0.0336
Percent below poverty level	138.48810	92.20	1.50	0.133	-42.2194	319.1956
Annual precipitation	-0.00924	0.01	-1.13	0.260	-0.0253	0.0068
Constant	-258.00820	128.63	-2.01	0.045	-510.1151	-5.9013
ln (α)	-1.51190	0.14			-1.7828	-1.2410
A	0.22049	0.03			0.1682	0.2891
Likelihood-ratio test for α						
χ^2	3057.54					
$prob \geq \chi^2$	0					

5.3.5 Phase 5: Model including principal component variables (Model 4)

The inclusion of 15 new variables for explaining the regional differences into the model was thought to mask the effect of other traffic and geometric variables. A remedy for this was to reduce the number of regional variables and include only those that significantly influence crash occurrence. The literature review revealed that a method known as "Principal Components Analysis" can be used to condense the 15 variables to a small pool of variables to be used in the model

5.3.5.1 Principal component analysis

The analysis of principal components is concerned with explaining the variance-covariance structure of a set of variables through a few linear combinations of these variables. Although p components are required to reproduce the total system variability, often much of this

variability can be accounted for by a small number of k components. Therefore, k components are chosen such that they have as much information as there is in the p components. Suppose a sample of data $x_1, x_2, x_3, \ldots x_n$ represent n independent variables drawn from a population with p dimensions with mean vector μ and covariance matrix Σ. These data yield sample mean vector x', the sample covariance matrix S and the sample correlation matrix R. The objective is to construct uncorrelated linear combinations of the measured characteristics that account for much of the variation in the sample. The uncorrelated combination with the largest variances will be called the sample principal components. A summary of the equations that produce the principal components is as presented by equation 5.16.

$$Y_k = a_{1k}X = \sum_{k=1}^{p} a_{1k}x_{jk} \qquad (5.16)$$

where Y_k is the principal component, X is the original variables matrix, and a is the principal component coefficient. The magnitude of the coefficients of the principal components is significant in that they measure the importance of the kth variable. This information shows which variable has more influence among the collection of the p variables irrespective of the rest of the variables in the model. Two methods can be used to select k components from the principal component analysis. The first method is the Kaiser criterion in which the factors retained are those with values greater than a unit. The idea behind this method is that, unless a factor extracts at least as much as the equivalent of one original variable, that factor is dropped.

The second method is a Scree graphical method in which the individual eigenvalues are plotted against their corresponding components. The components are arranged in ascending order such that as the number of the components increases the corresponding eigenvalue decreases. At the points where there is a smooth decrease of eigenvalues and they become relatively small and about the same values towards the right, components are dropped (*42, 43*). The Scree graphical method is displayed in Appendix D.

The 15 variables associated with "region" mentioned in the previous section were programmed into the STATA statistical software. The command used to produce the results for the principal component was PCA. Table 5.7 displays the number of components produced, the eignevalues for these components, the difference between the preceding and the following eigenvalues, the proportion of the total variability, and the cumulative total explanation for the proportional explanation.

The STATA PCA command also produces principal component coefficients, which when substituted into Equation 5.16, create principal components. The full output of the principal component coefficients is shown in Appendix D. As mentioned previously, the Kaiser Criterion retains principal components, whose eigenvalues are greater than a unit. Using this method, Table 5.7 shows that five of the principal components were more than a unit. An examination of the Scree plot in Figure 5.1 shows that the eigenvalues begins to level off at the fifth principal component.

Table 5.7: Proportion of the variables described by the principal components

Component	Eigenvalues	Difference	Proportion	Cumulative
1	5.08	1.26	0.34	0.34
2	3.82	2.08	0.25	0.59
3	1.73	0.5	0.12	0.71
4	1.24	0.2	0.08	0.79
5	1.04	0.11	0.07	0.86
6	0.93	0.45	0.06	0.92
7	0.48	0.17	0.03	0.95
8	0.31	0.12	0.02	0.98
9	0.18	0.08	0.01	0.99
10	0.1	0.06	0.01	0.99
11	0.04	0.01	0	1
12	0.03	0.02	0	1
13	0.01	0.01	0	1
14	0	0	0	1
15	0	.	0	1
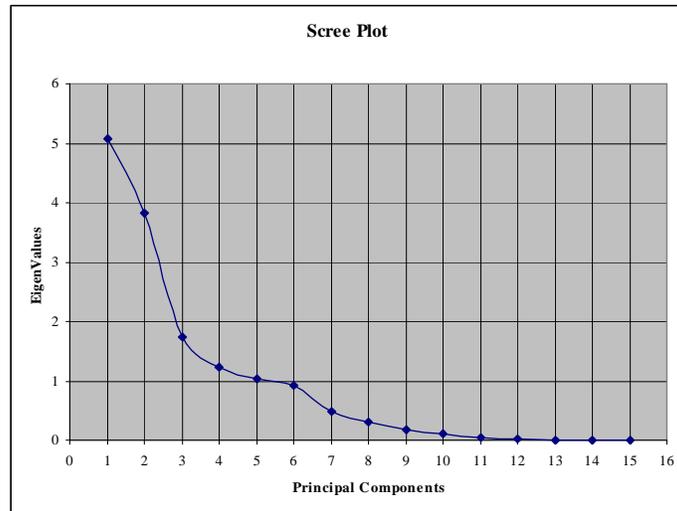
Figure 5.1: Scree plot

Using both Kaiser and Scree tests, the first five principal components were picked, accounting for 86% of the variance of the original 15 variables. Table 5.8 shows the five principal component coefficients that remained after using the two principal component tests. The above principal component coefficients were multiplied by the original regional characteristic values to produce five new variables which were named P1, P2, P3, P4 and P5. The multiplication equations are shown in Appendix D, an example of which is given below

$$P_{1,1} = \sum x_{1k} a_{1k} = x_{1,1} a_{1,1} + x_{1,2} a_{2,1} + ... + x_{1,15} a_{15,1} \tag{5.17}$$

where $P_{1,1}$ is the first principal component value for the first segment.

Equation 5.17 shows the result for the first principal component's value for the first segment. This will be done for all segments to obtain the new variables. These five new variables were added to the traffic and geometric variables in the model to account for regional differences in the crash occurrences.

Table 5.8: Principal component coefficients (Eigen vectors)

Variable	1	2	3	4	5
Female	0.18	-0.35	0.25	-0.09	-0.17
Persons under 18	0.07	0.47	-0.15	0.05	0.12
Persons above 65	-0.08	-0.47	0.12	-0.17	-0.11
Percent White	-0.16	-0.39	-0.37	0.10	-0.05
Percent Black	0.22	0.35	0.36	-0.14	0.01
Percent American Indian and Alaska Natives	-0.29	0.28	-0.31	0.15	0.05
Percent Asian	-0.24	0.17	-0.16	-0.49	-0.40
Percent Native Hawaiian and Pacific Islanders	-0.06	-0.13	-0.17	-0.32	0.81
Percent reporting two or more races	-0.10	0.02	-0.03	0.40	0.06
Percent speaking language other than English at home	0.41	-0.02	-0.23	0.04	-0.06
Percent High school graduates	-0.38	-0.01	0.34	0.07	0.17
Percent with Bachelor's or higher	0.26	-0.10	0.14	0.55	0.11
Mean travel time to work	-0.32	0.13	0.31	0.16	-0.16
Percent below poverty line	0.39	0.05	-0.29	-0.02	-0.17
Amount of precipitation	0.29	0.07	0.33	-0.26	0.17

5.3.5.2 Modeling crashes with principal components included

The five principal components were combined with the geometric and traffic variables as independent variables thought to explain the occurrence of crashes on Florida urban limited access highways. The combined dataset was a matrix of 13 variables and 125 sections. The STATA program was used to analyze the data in which a negative binomial regression model using the NBREG command. Table 5.9 below shows the output from the Negative Binomial regression performed with the five principal components.

The use of the principal components in the model has changed the value of the coefficients of other variables slightly without changing their signs. When comparing the coefficients produced in model 3 containing all 15 regional characteristics, the length variable increased from 0.01856 to 0.02456 while the truck percentage variable increased from -2.94905 to -1.88966. The number of interchange variable increased from 0.16926 to 0.17831 and the free flow speed variable increased from 0.14784 to 0.16274. On the other hand, the number of ramps variable decreased from 0.04368 to 0.04122, the truck lane restriction variable decreased from -0.13132 to -0.04236 and the HOV variable decreased from 0.3777 to 0.3391. The change of these coefficients is due to a decrease in the clustering of the values in the model. In this case, the principal component variables have a group effect, rather than and individual effect, on the rest of the variables. For example, the effect to crashes by the first principal component depends more on the increase in the percentages of principal components for speaking language other than English at home; high school graduates; mean travel time to work; and below poverty line. In model 3 these effect were being measured individually.

Table 5.9: Negative binomial model with principal components

Variables	Coeff.	Std. Err.	z	P>z	[95% Conf. Interval]	
Length	0.02456	0.008	2.91	0.004	0.008	0.041
Truck percentage	-1.88966	1.982	-0.95	0.340	-5.774	1.994
Number of interchange	0.17831	0.020	9.14	0.000	0.140	0.217
Number of ramps	0.04122	0.011	3.92	0.000	0.021	0.062
Truck lane restriction	-0.04236	0.174	-0.24	0.808	-0.383	0.299
AADT/lane	0.00004	0.000	4.80	0.000	0.000	0.000
Free Flow Speed	0.16274	0.031	5.19	0.000	0.101	0.224
High occupancy vehicle lane	0.33910	0.269	1.26	0.208	-0.189	0.867
P1	4.46417	0.714	6.25	0.000	3.064	5.864
P2	1.25777	2.724	0.46	0.644	-4.080	6.596
P3	1.57001	0.912	1.72	0.085	-0.217	3.357
P4	11.59301	1.969	5.89	0.000	7.734	15.452
P5	6.48181	2.514	2.58	0.010	1.554	11.410
Constant	-9.16761	2.553	-3.59	0.000	-14.172	-4.163
ln (α)	-1.22521	0.137			-1.494	-0.957
α	0.29370	0.040			0.225	0.384
Likelihood-ratio test for α						
χ^2	3611.79					
$prob \geq \chi^2$	0					

These changes in the significance of the variables were also not very sound. Only the length variable, which was insignificant in the previous model, became significant. The rest of the variables have the same significance characteristics as was in the previous models. However, the insignificance of the truck lane restriction variable increased from 0.454 to 0.808. Again, the change in the significance of the variables also depends on the number of variables added in the model. The addition of these principal components has made the truck lane restriction insignificant. This is due in part to the fact that most of the truck lane restriction corridors are located in the same region.

5.3.6   Phase 6: Model with statistically significant variables only (Model 5)

A stepwise elimination method was introduced to model 4 using an α of 0.05 which was the same confidence value used to just the significance of the principal component coefficients. The STATA command used for this method was SWNBREG (*VARIABLE LIST*), PR (0.05). Table 5.10 below shows the results of the stepwise elimination method with the significant variables only. The use of stepwise elimination method was necessary to identify statistical significant variables and display their effects on crashes when they are modeled alone. In a statistical context, this model gives a better interpretation of variables regardless of their practical significance.

Table 5.10: Negative binomial model with significant variables

Variable	Coeff.	Std. Err.	Z	P>z	[95% Conf. Interval]	
Length	0.02426	0.01	2.86	0.00	0.0076	0.0409
Number of interchanges	0.20016	0.02	11.02	0.00	0.1646	0.2357
Number of ramps	0.03965	0.01	3.81	0.00	0.0193	0.0600
AADT per lane	0.00005	0.00	5.29	0.00	0.0000	0.0001
Free Flow Speed	0.20444	0.03	7.35	0.00	0.1499	0.2590
P1	4.42503	0.63	6.98	0.00	3.1822	5.6678
P3	2.19722	0.31	7.16	0.00	1.5956	2.7989
P4	13.17614	1.97	6.70	0.00	9.3220	17.0303
P5	8.34091	2.21	3.78	0.00	4.0155	12.6663
Constant	-12.74046	1.80	-7.07	0.00	-16.2731	-9.2079
ln (α)	-1.07234	0.13			-1.3328	-0.8119
α	0.34221	0.05			0.2637	0.4440
Likelihood-ratio test						
χ^2	4919					
$prob \geq \chi^2$	0					

The results from Table 5.10 show that truck percentage, truck lane restriction, HOV lane and the second principal component are not in the model suggesting they were statistically insignificant. For the variables remaining in the model, there were slight changes in the results. Most of the variable coefficients increased when compared to model 4 with all principal components except the length and number of ramps variables. These variables decreased slightly from 0.02456 to 0.02426 for the length variable and from 0.04122 to 0.03965 for the number of ramps variable.

5.3.7   Phase 7: Model evaluation and testing

Following the process of specifying the type of model to be used, the estimation of the variable coefficients, and the evaluation of the performance of the individual variables in each model, there is a need to conduct an overall evaluation of the models. Since all models discussed earlier were specified to fit the Negative Binomial regression model, testing the Negative Binomial regression fit was next task. A hypothesis test can be performed to assess this fit. Negative binomial models is derived from the Poisson model as was explained previously where the over dispersion factor α is 0. Given this information, the following procedure can be used to test the model.

Hypothesis: $H_0 : \alpha = 0$ (Null hypothesis)

$H_a : \alpha > 0$ (Alternative hypothesis)

The test statistic used is the Chi –square. The STATA command used to run the Negative Binomial regression (recall NBREG) already performs this test using the likelihood ratio test at $\alpha = 0$. The results of this test are indicated by the value of $\alpha > 0$, indicating the model fits the Negative Binomial Regression Model. Other tests that were used to evaluate the fit of this model were the Pearson and Deviance tests. The Pearson statistics is given by the following equation;

$$P = \sum_{i=1}^{n} \frac{(y_i - \hat{\mu}_i)^2}{\hat{\mu}_i} \tag{5.18}$$

Evidence of over dispersion is given when the value of P exceeds one. The results from this model showed that the value of P was 143.72. Therefore, the model fits the data well. The deviance test for the Negative Binomial regression model is given by the following equation;

$$D = \sum_{i=1}^{n} y_i \ln\left(\frac{y_i}{\mu_i}\right) - (y_i + \alpha^{-1})\ln\left[\frac{y_i + \alpha^{-1}}{\mu_i + \alpha^{-1}}\right] \tag{5.19}$$

For the model to be judged as fitting the data, the value of D has to exceed zero thus showing evidence of over dispersion. From the equation the value of D was calculated as 61.97. Therefore, the model shows a good fit of the data.

Since there were several models developed, another test was performed to check which of these models was preferable. As a reminder, model 1 was the negative binomial model with crashes evaluated against geometric and traffic variables. Model 2 was the negative binomial model with crashes evaluated against geometric, traffic and regional variables. Model 3 was the negative binomial model with crashes evaluated against geometric, traffic, social economic and precipitation variables. Model 4 was the negative binomial model of crashes against geometric, traffic and principal component variables. Model 5 was the negative binomial model of crashes against only significant geometric, traffic and principal component variables. The tests that were performed to judge which of the models best describes the statistical relationship between crashes and the predictors were the Akaike Information Criteria; Bayesian Information Criteria; and the Consistent Akaike Information Criteria. These methods are used for comparison of models based on the Maximum Log Likelihood method. The expectation from this method is that as the number of parameter variables in the model increases, the likelihood also increases. This method penalizes models with a larger number of variables, k. This penalty function may also depend on the number of observations (*44*). The functions representing the above tests are:

$$AIC = -2\ln(L) + k \tag{5.20}$$
$$BIC = -2\ln(L) + k\ln(n) \tag{5.21}$$
$$CAIC = -2\ln(L) + k(1 + \ln(n)) \tag{5.22}$$

where *AIC* is the Akaike Information Criteria, *BIC* is the Bayesian Information Criteria, *CAIC* is the Consistent Akaike Information Criteria, *L* is the Likelihood of the model, and *n* is the number of observations. The value of the log likelihood is also calculated when the NBREG command is run in the model. From these equations, the model with the lowest information criteria is preferred. Table 5.11 below shows the test results involving the above equations (5.20), (5.21) and (5.22).

Table 5. 11: Model evaluation results

Models	Log likelihood	Number of variables	Number of observations	AIC	BIC	CAIC
Model 1	-669.95	8	992	1347.90	1395.10	1403.10
Model 2	-661.71	9	1116	1332.42	1386.57	1395.57
Model 3	-627.81	23	2852	1278.62	1438.61	1461.61
Model 4	-646.22	13	1612	1305.45	1388.45	1401.45
Model 5	-647.57	9	1116	1304.13	1358.29	1367.29

The model with the overall lowest value for the information criteria is the model 5, which was the model containing significant variables only.

5.4 Discussion of the results

The purpose of the modeling exercise undertaken above was mainly to examine the effect of a truck lane restriction in influencing the occurrence of crashes. The above analysis gave information on the effects of the variables and the statistical significance of these variables. However, there is also, a practical significance that can not be ignored. Therefore, variables that are not statistically significant based on their "p-values" cannot be ignored in estimating their effects on crashes.

Table 5.9 shows that both "truck percentage" variable and "truck lane restriction" variables were statistically insignificant ($\alpha = 0.05$) and had negative coefficients. The review of previous research studies also showed mixed results as well. The researchers were thus interested in determining the effect of these two variables, especially the truck lane restriction variable, on crashes regardless of its statistical insignificance in the models displayed in Table 5.9. With regard to truck percentage, the results in Table 5.9 show that an increase in truck percentage caused a reduction in the occurrence of crashes. As mentioned earlier, this result is similar to the results found by Miaou (*15*). Miaou argued that for constant vehicle density, as the percent of trucks increases, the frequency of overtaking movements by cars decreases. A case can be made that Miaou's findings and our findings are both plausible. It has been shown through simulation that lane changing on freeways generally increases with truck percentage up to 20% and 30% where lane changes stabilizes. This occurs due to the fact that there is no more room for lane changing (*11, 45*).

On the other hand, a before-and-after study of the truck lane restriction on I-95 in Palm Beach County showed there was a 13.78% reduction in all vehicle crashes during the truck lane restriction hours (*17*). Also, a study conducted on the New Jersey Turnpike showed an increase in the number of crashes on the right lane where there was mixed flow and most of crashes were attributed to trucks after the introduction of the restriction (*29*). In order to estimate the actual effect of the variables that were analyzed in the model shown in Table 5.9, a marginal effect analysis was performed as described in the following section.

5.4.1   Marginal effects analysis

The marginal effects are defined as the partial derivative of a crash probability with respect to the parameter predictor of interest. Marginal effects produce the listing of slopes computed at the sample mean of the data. The marginal effect is useful to interpret the magnitude of the effect of each variable on crash occurrence. The marginal effect for a negative binomial model is determined as

$$\frac{\partial E(y/x)}{\partial x} = \beta\mu \tag{5.17}$$

where β is the variable coefficient and μ is the rate of occurrence of crashes. The MFX COMPUTE command in STATA was used to produce the marginal effects of all variables in the full model shown in Table 5.9. To obtain the effect of a particular regression variable, the STATA command is specified as MFX COMPUTE AT (*variable = value*). This command predicts the number of crashes at a particular value of a chosen variable while the rest of the regression variables are held at their mean values. The truck lane restriction was a dichotomous variable with the value of "1", if the truck lane restriction is present in a roadway section. Otherwise, a "0" value was entered. Recall that $E[y_i \mid x_i] = \exp(x_i'\beta)$. Without a truck lane restriction (truck lane restriction = 0), then,

$$\exp(x_i'\beta) = e^{\left(\substack{9.51\times0.02456-0.092\times1.88966+5.76\times0.17831+9.4\times0.04122+18752.78\times0.00004+64.17\times0.16274+0.05\times0.33910+10.91\times4.46417+5.88\times1.25777+ \\ 23.866\times1.57-11.69\times11.593+6.62\times6.482-9.167}\right)} = 87.5$$

With a truck lane restriction (truck lane restriction = 1)

$$\exp(x_i'\beta) = e^{(9.51\times0.02456-0.092\times1.88966+5.76\times0.17831+9.4\times0.04122-0.004236\times1+18752.78\times0.00004+64.17\times0.16274+0.05\times0.33910+10.91\times4.46417+5.88\times1.25777+23.866\times1.57-11.69\times11.593+6.62\times6.482-9.167)} = 83.3$$

Thus, the predicted number of crashes changed from 87.5 to 83.8 when the truck lane restriction value changed from "0" to "1," respectively. This represents a 4 percent decrease in crashes per year. Also, holding all other variables at their mean value, the results show that the predicted number of crashes changed from 98.9 to 77.4 when the truck percentage changed from a minimum value of 2% to a maximum value of 15%, respectively. This represents a 22 percent annual decrease in crashes. The additive changes for all other variables in the full model are shown in the Table 5.12. These values are called the Incident Rate Ratios. They are the exponential effects of the coefficients, as mentioned in the previous sections. In STATA the percentage effect of the coefficient is calculated using the command LISTCOEF, PERCENT. The values calculated are for a unit change of the regression variable, such that if the regression variable is too small (like the truck percent) or too large (like the AADT/lane) the effect may be overrepresented or underrepresented. The results for the additive effect utilizing the above mentioned command are also displayed on Table 5.12.

Table 5.12: Negative binomial incidence rate ratios.

Variable	β	Z	P>z	% Change
Length	0.02456	2.913	0.004	2.5
Truck percentage	-1.88966	-0.954	0.340	-84.9
Number of interchange	0.17831	9.136	0.000	19.5
Number of ramps	0.04122	3.919	0.000	4.2
Truck lane restriction	-0.04236	-0.243	0.808	-4.1
AADT per lane	0.00004	4.800	0.000	0.0
Free Flow Speed	0.16274	5.192	0.000	17.7
HOV lane	0.33910	1.259	0.208	40.4

As with the truck lane restriction and truck percent variables, Table 5.12 also displays the effects of the other variables on the occurrence of crashes on the segments. Unlike the truck percentage and the truck lane restriction, the length, number of interchanges, number of ramps, AADT per lane, free flow speed and HOV variables produce a positive effect on the estimated crashes. Among the variable with positive effects, HOV lane tend to have the highest effect with a 40 percent change in crashes when a HOV lane is in the segment. The AADT per lane has the lowest percent of change (0 percent). However, this change is due to a unit addition of the variable whereas the AADT per lane is a variable with larger values and a unit change does not show a substantial effect. The percentage change in these values, displayed in Table 5.12, can be regarded as factor changes in crashes for these given variables for Florida's urban freeways and tollways.

CHAPTER 6

COMPARISON OF BEFORE-AND-AFTER ANALYSIS AND CRASH PREDICTION MODEL

6.1   Overview

The before-and-after method and the crash prediction models are both statistical procedures that are used to analyze factors affecting systems either in a positive or negative manner. In this study the two methods were used to asses the influence of a truck lane restriction on urban limited access highways. In assessing these effects, they resulted into factors that express the extent of the effect of truck lane restriction on these segments.

6.2   Before-and-After analysis

The before-and-after analysis was conducted using four types of analysis. The analyses were the Naïve before-after analysis, Improved Naïve before-after analysis, Comparison Group method and the Empirical Bayes method. The results produced by these analyses were the crash reduction value, the effective index, the variance of the reduction value and the variance for the effective index. The crash reduction value and the effective index were the values that gave the actual effectiveness of the truck lane restriction.

The procedures followed by these four methods were different. However, both methods produced the same results which were used to judge the effectiveness of the treatment, in this case a truck lane restriction. The results produced by the four methods were displayed on Table 4.7 in Chapter 4.

6.3   Crash prediction model

The crash prediction model was developed to assess the influence of various factors on the occurrence of crashes on an urban limited access highway with the focus on a truck lane restriction. There were several models that were examined. Since crashes are rare events, the standard distribution model that was viable for use was the Poisson. This model, as explained in previous chapters, is a non linear regression model whose main assumption is that the mean and variance of the response being modeled are equal. As mentioned in the discussion of descriptive analysis results in Chapter 5, the crash data collected did not agree with the Poisson assumption of variance being equal to the mean. Since this Poisson assumption was violated, the negative binomial model was selected given that it is a standard parametric model that can account for overdispersion. The results of the model revealed that a truck lane restriction variable was not statistically significant but had a negative coefficient leading to the conclusion that the introduction of a truck lane restriction increases safety by reducing the predicted number of crashes in a highway segment.

6.4   Comparison of the Before-and-After analysis and Crash prediction modeling

The before-and-after analysis and the crash prediction modeling are both robust statistical methods that are suitable for analyzing the effect of a treatment such as a truck lane restriction. However, there are some differences between these two statistical analysis methods that could cause the results to be interpreted differently.

One of the differences between these two methods is that the before-and-after statistical analysis assumes Poisson behavior and does not allow for over dispersion of the crashes. Unlike the before-and-after method, the crash prediction modeling begins by assuming a Poisson distribution since the crashes are rare events. However, since the Poisson assumption was in this case violated, the negative binomial model was used which allows for over dispersion of the variables.

Another difference in results of the two methods could be due to the amount of data used in each method. In the before-and-after analysis method, only 18 sections were used for the analysis given that these were the only sections with a truck lane restriction. Truck lane restriction was introduced in these sections between 2004 and 2005. In contrast, the crash prediction model contained 128 sections which had additional truck lane restriction corridors whose truck lane restriction were places as far back as the year 1983. As mention previously, the result produced by the two methods reveals the extent of the effect a truck lane restriction has on the occurrence of crashes. The before-and-after method used crash reduction and the effectiveness index to describe the effect. The crash prediction model uses the odds ratio and the marginal effects to describe the effect of a truck lane restriction on occurrence of crashes.

CHAPTER 7

CONCLUSIONS AND RECOMMENDATIONS

The purpose of this study was to determine the impact of a truck lane restriction on traffic operations and safety for urban limited access facilities in the State of Florida. The existing highways were divided into 128 sections using rigorous criteria to homogenize the sections. Data on crashes, geometrics, traffic, and socio-economic variables were collected for each highway section. Two types of statistical analyses were performed with the goal of assessing the impacts of a truck lane restriction on the occurrence of crashes on urban limited access roadways. The first statistical analysis was the before-and-after study and the second type of statistical analysis was the development of a crash prediction model. Crash prediction modeling also involved conducting principal component analysis to streamline the socio-economic variables for inclusion in the modeling process, and evaluating the marginal effect of each geometric and traffic variable on crash occurrence.

The before-and-after analysis involved highway sections for which the date of the imposition of truck lane restriction was known. Study sections were on Interstate 75 close to Tampa and Interstate 95 near Jacksonville. Restrictions on these sections were imposed in May 2004. Other study sections were on the Homestead Extension of Florida's Turnpike (HEFT) in Dade county where truck lane restrictions were introduced in May 2005. The statistical before-and-after analysis methods used in this study were the Naïve, Modified Naïve, Comparison Group, and the Empirical Bayes before-and-after analyses. The results from all four before-and-after analysis methods showed that the effective index following the imposition of truck lane restriction were 1.34, 1.21, 1.32, and 1.29 respectively. It should be noted that these results did not account for increases in traffic, which is a major limitation of the results from the before-and-after method.

The negative binomial regression model was used to determine the influence of various regression variables on the occurrence of crashes with special emphasis on the impact of a truck lane restriction and truck volume, represented by the percent of AADT. The regression variables were related to geometrics, traffic, and socio-economic factors prevailing on each of the 128 sections that were analyzed. The geometric characteristics analyzed were the length of the segment, the number of interchanges, the number of ramps, the presence of a truck lane restriction, and the presence of a HOV lane. The traffic variables that were analyzed were AADT per lane and free flow speed, derived from the speed limit prevailing on each roadway section. Although all the highway segments studied were in Florida, it was important to examine the difference in crash occurrence between the different metropolitan areas. Thus, socio-economic and precipitation factors were also added into the model.

The results showed that the presence of a truck lane restriction was largely statistically insignificant in influencing the total number of crashes occurring on an urban highway section ($p \leq 0.808$). However, the coefficient for this variable in the model was negative suggesting that in the year 2005, sections with a truck lane restriction tended to have fewer crashes than sections without a truck lane restriction, although insignificantly so. This tendency was confirmed with a marginal effect analysis which showed that implementing a truck lane restriction in year 2005

would have an effect of reducing crashes by 4 percent. These results are in line with the results reported in a number of previous studies investigating the efficacy of a truck lane restriction.

The results further showed a negative relationship between an increase in truck percentage and crash occurrence. The marginal effect analysis revealed that if the percentage of trucks on a Florida urban highway in year 2005 was to be increased from a minimum of 2 percent to a maximum of 15 percent, the annual occurrence of crashes will be reduced by 22 percent. This result is both intuitive and counterintuitive and mirrors conflicting results reported in literature. It can be argued that increased truck volumes on a highway increases the possibility of crashes brought about by increased lane changes among passenger car drivers. Then again it can also be argued that the presence of higher volumes of trucks reduce the number of gaps to the point that most passenger car drivers do not attempt to change lanes. In fact, a previous simulation study conducted by Siuhi (*11*) showed this phenomenon.

Another result worthy of noting is the significance of the regional differences in the occurrence of crashes. The results showed that driving on urban limited access highways in the Orlando area was relatively safer than driving in the Jacksonville area, followed by the Tampa area, followed by tri-county area of Palm Beach, Broward, and Miami-Dade. Numerous socio-economic variables were considered to try to explain these regional differences. The socio-economic factors that were considered include the percentage of people in each county who are female, who are under 18 years of age, who are above 65 years of age, who speak language other than English at home, who have high school education, who have a minimum of a bachelor degree, and who have income below the federal poverty level. However, further econometric analysis is warranted if one wants to focus on these regional differences.

There are a few study limitations worth mentioning that warrant further study. Actual operating speeds were not included in the model and instead the speed limit was used as a surrogate measure. A sample of operating speeds in each section needs to be collected. Additional qualifications are in order. A detailed analysis of crash occurrence by hour of the day needs to be conducted to determine the influence of traffic volume with various truck percentages on crash occurrence. Clearly, crashes involving trucks might have a different distribution depending on the extent of congestion on a highway. The results of the negative binomial regression modeling were not validated with crashes occurring in other years. Such validation requires collecting crashes for a succeeding year and conducting crash prediction modeling using geometric and traffic factors prevailing in that year.

There are a number of recommendations for further research that can be made based on the results obtained from the study reported herein. The crash analysis involved only the total number of crashes occurring in the section. Future analysis should focus on crashes stratified as fatal crashes, injury crashes, and property damage only crashes. Such analysis may help reveal the influence of a truck lane restriction on the severity of highway crashes occurring in urban areas. It is further recommended that as time goes by, before-and-after crashes can be analyzed for a longer before or after duration, say 5 years. The most significant limitation of this study was that most sections had after data for only a year or two, since the truck lane restrictions were imposed only a few years ago.

The inclusion of the "region" factor showed there were significant differences in crash occurrence among the four Florida metropolitan regions included in this study. Although efforts were made to include socio-economic differences among the regions in the model, it is clear that a better designed econometric study is required to analyze the influence of socio-economic factors on crash occurrence. Such a study can use socio-economic factors alone as independent variables or can also incorporate geometric and traffic variables in the modeling as done in this study.

Finally, a truck lane restriction is only one of the operational strategies used by highway agencies in managing truck traffic on urban limited access highways. There are other strategies that exist, as revealed by the literature search, including limiting truck speeds, providing truck routes, restricting trucks from certain routes altogether, separating trucks into dedicated truck lanes, and implementing truck lane restriction only during certain hours of the day. All these strategies have upsides and downsides that need to be studied and compared to the efficacy of implementing a truck lane restriction throughout the 24-hour period as is currently done in Florida. The issues of safety benefits accrual and the number of lanes that trucks are restricted from using need to be studied further.

APPENDIX A: Images of Truck Lane Restriction Corridors

Figure A-1: Trucks Lane restriction on a 6 Lane Corridor

Figure A-2: Truck Lane Restriction on a 3 Lane Corridor

Figure A-3: Truck Blocking the View of the Sign Board on the Side of the Road

Figure A-4: Congestion of Trucks on the Non- Restricted Lanes

APPENDIX B: Data Collected for the Analyses

Table B-1: Urban Areas Distribution from Road Condition Inventory

Urban Classification - Feature 124

URBAREA – Urban Area Number

Small Urban Areas (Population 5,000-49,999): [URBSIZE=2]

0040 Arcadia	0995 Islamorada, Village of	1630 Palatka
0085 Bartow	Islands	1658 Palm Coast (includes
0130 Belle Glade	1058 Key Biscayne	Ormond Beach)
0164 Big Pine Key	1070 Key West	1725 Perry
0380 Clermont	1065 Keystone Heights	1754 Placid Lakes
0385 Clewiston	1080 Labelle	9910 Poinciana
0440 Crestview	1110 Lake City	1825 Quincy
0450 Crystal River	1217 Lehigh Acres	9920 Ross Prairie
0620 Fernandina Beach	1230 Live Oak	1950 Sebring-Avon Park
0650 Fort Meade	1260 Macclenny	2030 Starke
0680 Frostproof	1298 Marathon	2037 Greater Sun Center
0933 Homosassa Springs	1299 Marco Island	(includes Sun City & Ruskin)
0945 Immokalee	1305 Marianna	2185 Wauchula
0975 Indiantown	9900 Marion Oaks	9930 West Jupiter
0985 Interlachen	1392 Middleburg	2250 Wildwood
0990 Inverness (includes	1565 Okeechobee	2296 Yulee
Beverly Hills)	1625 Pahokee	

Small Urbanized Areas (Population 50,000-199,999): [URBSIZE=3]

0255 Brooksville (includes Spring Hill)	1520 North Port-Punta Gorda
0512 Deltona	1545 Ocala
0670 Fort Walton Beach	1675 Panama City
0695 Gainesville	1885 Saint Augustine
1075 Kissimmee	2105 Titusville
1095 Lady Lake	2150 Vero Beach-Sebastian
1136 Lakeland	2285 Winter Haven
1215 Leesburg-Eustis	2300 Zephyrhills

Large Urbanized Areas (Population 200,000-499,999): [URBSIZE=4]

0187 Bonita Springs-Naples	1715 Pensacola
0293 Cape Coral (includes Ft Myers)	1807 Port Saint Lucie
0485 Daytona Beach-Port Orange	2070 Tallahassee
1640 Palm Bay-Melbourne	

Metropolitan Areas (Population 500,000 or more): [URBSIZE=5]

1000 Jacksonville	1600 Orlando
1370 Miami (includes Boca Raton, Delray	1930 Sarasota-Bradenton
Beach, Ft Lauderdale, Hialeah, Hollywood,	2075 Tampa-Saint Petersburg
Pompano Beach, West Palm Beach)	(includes Clearwater)

Figure B-1: Florida Counties and Interstates

Table B-2: Truck Lane Restriction Corridors in Florida

Freeway	Beginning Milepost	Ending Milepost	Beginning Coordinates		Ending Coordinates		Length (miles)	Start Date
I-75	202.46	263.46	Lat.: 28.0228		Lat.: 27.2233		61	May-04
			Long.: -82.3302		Long.: -82.4505			
I-75	Exit 328 (FL Turnpike)	Exit 467 (CR 143)	Lat.: 30.6258		Lat.: 28.8808		139	Aug-98
			Long.: -83.1708		Long.: -82.0925			
I-95	5.48	88.75	Lat.: 25.8216		Lat.: 26.9647		83.27	May 1983 in Broward County
			Long.: -80.2062		Long.: -80.1725			
I-95	298	333.4	Lat.: 29.6658		Lat.: 30.1025		35.4	Jul-05
			Long.: -81.2925		Long.: -81.5025			
I-95	363	382	Lat.: 30.4908		Lat.: 30.7442		19	May-04
			Long.: -81.6408		Long.: -81.6542			
HEFT	11	16	Lat.: 25.5841		Lat.: 25.6301		5	May-05
			Long.: -80.3672		Long.: -80.3827			
HEFT	19.5	39.5	Lat.: 26.6737		Lat.: 25.9511		20	
			Long.: -80.3888		Long.: -80.3486			

Table B-3: Database for the Urban Freeway Corridors

Area name	Direction	County name	ROAD NAME
TAMPA	NORTHBOUND	PINELLAS	I-175
TAMPA	SOUTHBOUND	PINELLAS	I-175
MIAMI	EASTBOUND	MIAMI DADE	I-195
MIAMI	EASTBOUND	MIAMI DADE	I-195
MIAMI	WESTBOUND	MIAMI DADE	I-195
MIAMI	WESTBOUND	MIAMI DADE	I-195
TAMPA	NORTHBOUND	PINELLAS	I-275
TAMPA	NORTHBOUND	PINELLAS	I-275
TAMPA	NORTHBOUND	PINELLAS/HILLS	I-275
TAMPA	NORTHBOUND	HILLSBOROUGH	I-275
TAMPA	NORTHBOUND	HILLSBOROUGH	I-275
TAMPA	SOUTHBOUND	PINELLAS	I-275
TAMPA	SOUTHBOUND	PINELLAS	I-275
TAMPA	SOUTHBOUND	PINELLAS/HILLS	I-275
TAMPA	SOUTHBOUND	HILLSBOROUGH	I-275
TAMPA	SOUTHBOUND	HILLSBOROUGH	I-275
JACKSONVILLE	NORTHBOUND	DUVAL	I-295
JACKSONVILLE	NORTHBOUND	DUVAL	I-295

Area name	Direction	County name	ROAD NAME
JACKSONVILLE	SOUTHBOUND	DUVAL	I-295
JACKSONVILLE	SOUTHBOUND	DUVAL	I-295
TAMPA	NORTHBOUND	PINELLAS	I-375
TAMPA	SOUTHBOUND	PINELLAS	I-375
MIAMI	NORTHBOUND	MIAMI DADE	I-395
MIAMI	SOUTHBOUND	MIAMI DADE	I-395
ORLANDO	NORTHBOUND	OSCEOLA	I-4
ORLANDO	NORTHBOUND	OSCEOLA/ORANGE	I-4
ORLANDO	NORTHBOUND	ORANGE	I-4
ORLANDO	NORTHBOUND	ORANGE	I-4
ORLANDO	NORTHBOUND	ORANGE	I-4
ORLANDO	SOUTHBOUND	OSCEOLA	I-4
ORLANDO	SOUTHBOUND	OSCEOLA/ORANGE	I-4
ORLANDO	SOUTHBOUND	ORANGE	I-4
ORLANDO	SOUTHBOUND	ORANGE	I-4
ORLANDO	SOUTHBOUND	ORANGE	I-4
TAMPA	NORTHBOUND	HILLSBOROUGH	I-4
TAMPA	NORTHBOUND	HILLSBOROUGH	I-4
TAMPA	SOUTHBOUND	HILLSBOROUGH	I-4
TAMPA	SOUTHBOUND	HILLSBOROUGH	I-4
MIAMI	NORTHBOUND	MIAMI DADE	I-75
MIAMI	NORTHBOUND	DADE/BROWARD	I-75
MIAMI	NORTHBOUND	BROWARD	I-75
MIAMI	SOUTHBOUND	MIAMI DADE	I-75
MIAMI	SOUTHBOUND	DADE/BROWARD	I-75
MIAMI	SOUTHBOUND	BROWARD	I-75
MIAMI	NORTHBOUND	MIAMI DADE	I-95
MIAMI	SOUTHBOUND	MIAMI DADE	I-95
JACKSONVILLE	NORTHBOUND	DUVAL	I-95
JACKSONVILLE	NORTHBOUND	DUVAL	I-95
JACKSONVILLE	NORTHBOUND	DUVAL	I-95
JACKSONVILLE	SOUTHBOUND	DUVAL	I-95
JACKSONVILLE	SOUTHBOUND	DUVAL	I-95
JACKSONVILLE	SOUTHBOUND	DUVAL	I-95
TAMPA	EASTBOUND	POLK	SR 570
TAMPA	WESTBOUND	POLK	SR 570
TAMPA	EASTBOUND	PINELLAS	SR 618
TAMPA	WESTBOUND	PINELLAS	SR 618
MIAMI	EASTBOUND	MIAMI DADE	SR 826
MIAMI	EASTBOUND	MIAMI DADE	SR 826
MIAMI	EASTBOUND	MIAMI DADE	SR 826
MIAMI	WESTBOUND	MIAMI DADE	SR 826
MIAMI	WESTBOUND	MIAMI DADE	SR 826
MIAMI	WESTBOUND	MIAMI DADE	SR 826
MIAMI	NORTHBOUND	MIAMI DADE	SR 836
MIAMI	NORTHBOUND	MIAMI DADE	SR 836

Area name	Direction	County name	ROAD NAME
MIAMI	SOUTHBOUND	MIAMI DADE	SR 836
MIAMI	SOUTHBOUND	MIAMI DADE	SR 836
MIAMI	NORTHBOUND	BROWARD	SR 869
MIAMI	SOUTHBOUND	BROWARD	SR 869
MIAMI	NORTHBOUND	MIAMI DADE	SR 874
MIAMI	SOUTHBOUND	MIAMI DADE	SR 874
MIAMI	NORTHBOUND	BROWARD	TRN PIKE
MIAMI	NORTHBOUND	BROWARD/PALM-B	TRN PIKE
MIAMI	SOUTHBOUND	BROWARD	TRN PIKE
MIAMI	SOUTHBOUND	BROWARD/PALM-B	TRN PIKE
TAMPA	NORTHBOUND	SARASOTA	I-75
TAMPA	NORTHBOUND	SARASOTA/MANATEE	I-75
TAMPA	NORTHBOUND	MANATEE/HILLS	I-75
TAMPA	NORTHBOUND	HILLSBOROUGH	I-75
TAMPA	SOUTHBOUND	SARASOTA	I-75
TAMPA	SOUTHBOUND	SARASOTA/MANATEE	I-75
TAMPA	SOUTHBOUND	MANATEE/HILLS	I-75
TAMPA	SOUTHBOUND	HILLSBOROUGH	I-75
MIAMI	NORTHBOUND	MIAMI DADE	I-95
MIAMI	NORTHBOUND	MIAMI DADE	I-95
MIAMI	NORTHBOUND	DADE/BROWARD	I-95
MIAMI	NORTHBOUND	BROWARD	I-95
MIAMI	NORTHBOUND	BROWARD/PALM-B	I-95
MIAMI	NORTHBOUND	PALM-B	i-95
MIAMI	NORTHBOUND	PALM-B	I-95
MIAMI	SOUTHBOUND	MIAMI DADE	I-95
MIAMI	SOUTHBOUND	MIAMI DADE	I-95
MIAMI	SOUTHBOUND	DADE/BROWARD	I-95
MIAMI	SOUTHBOUND	BROWARD	I-95
MIAMI	SOUTHBOUND	BROWARD/PALM-B	I-95
MIAMI	SOUTHBOUND	PALM-B	I-95
MIAMI	NORTHBOUND	MIAMI DADE	TRN PIKE
MIAMI	NORTHBOUND	MIAMI DADE	TRN PIKE
MIAMI	NORTHBOUND	MIAMI DADE	TRN PIKE
MIAMI	NORTHBOUND	DADE/BROWARD	TRN PIKE
MIAMI	SOUTHBOUND	MIAMI DADE	TRN PIKE
MIAMI	SOUTHBOUND	MIAMI DADE	TRN PIKE
MIAMI	SOUTHBOUND	MIAMI DADE	TRN PIKE
MIAMI	SOUTHBOUND	DADE/BROWARD	TRN PIKE

Table B-3 Continues

ROADWAYID	Begin exit	End exit	From mile post	To Mile post	Segment Length (miles)
15003000	-	I-275	0.000	1.439	1.439
15003000	-	I-275	0.000	1.439	1.439
87004000	1	2B	0.000	0.857	0.857
87004000	2B	5	0.857	4.268	3.411
87004000	1	2B	0.000	0.857	0.857
87004000	2B	5	0.857	4.268	3.411
15190000	-	22	0.000	21.571	21.571
15190000	22	23A	21.571	22.304	0.733
15190000/10190000	23A	39	22.304	38.847	16.543
10190000	39	45B	38.847	44.239	5.392
10190000	45B	53	44.239	52.988	8.749
15190000	-	22	0.000	21.571	21.571
15190000	22	23A	21.571	22.304	0.733
15190000/10190000	23A	39	22.304	38.847	16.543
10190000	39	45B	38.847	44.239	5.392
10190000	45B	53	44.239	52.988	8.749
72001000	I-95	21AB	0.000	20.659	20.659
72001000	21AB	I-95	20.659	35.511	14.852
72001000	I-95	21AB	0.000	20.659	20.659
72001000	21AB	I-95	20.659	35.511	14.852
15002000	-	I-275	0.000	1.220	1.220
15002000	-	I-275	0.000	1.220	1.220
87200000	US 41	I-95	0.000	1.292	1.292
87200000	US 41	I-95	0.000	1.292	1.292
92130000	60	62	59.585	61.747	2.162
92130000/75280000	62	72	61.747	71.682	9.935
75280000	72	77	71.682	76.373	4.691
75280000	77	82C	76.373	82.654	6.281
75280000	82C	90AB	82.654	89.517	6.863
92130000	60	62	59.585	61.747	2.162
92130000/75280000	62	72	61.747	71.682	9.935
75280000	72	77	71.682	76.373	4.691
75280000	77	82C	76.373	82.654	6.281
75280000	82C	90AB	82.654	89.517	6.863
10190000	1	9	1.046	8.613	7.567
10190000	9	25	8.613	25.563	16.950
10190000	1	9	1.046	8.613	7.567
10190000	9	25	8.613	25.563	16.950
87075000	1AB	5	0.056	4.961	4.905
87075000/86075000	5	19	4.961	17.379	12.418
86075000	19	49	17.379	49.428	32.049
87075000	1AB	5	0.056	4.961	4.905
87075000/86075000	5	19	4.961	17.379	12.418
86075000	19	49	17.379	49.428	32.049
87270000	1A	3A	0.469	3.240	2.771

ROADWAYID	Begin exit	End exit	From mile post	To Mile post	Segment Length (miles)
87270000	1A	3A	0.469	3.240	2.771
72280000/72020000	337	351D	337.450	351.560	14.110
72280000/72290000	351	362	351.560	361.649	10.089
72290000	362	366	361.649	365.922	4.273
72280000/72020000	337	351	337.450	351.560	14.110
72280000/72290000	351	362	351.560	361.649	10.089
72290000	362	366	361.649	365.922	4.273
16470000	0	(15.180	0.000	15.180	15.180
16470000	0	(15.180	0.000	15.180	15.180
10002000	1A	15B	0.106	14.169	14.063
10002000	1A	15B	0.106	14.169	14.063
87260000	SR 94	SR 836	0.854	7.207	6.353
87260000	SR 836	SR 948	7.207	9.171	1.964
87260000	I-75	SR 91	15.299	23.969	8.670
87260000	US 1	SR 836	0.000	7.207	7.207
87260000	SR 836	SR 948	7.207	9.171	1.964
87260000	I-75	SR 7	15.299	23.969	8.670
87200000	SR 821	SR 826	0.000	4.284	4.284
87200000	SR 826	US 1	4.284	12.841	8.557
87200000	SR 821	SR 826	0.000	4.284	4.284
87200000	SR 826	US 1	4.284	12.841	8.557
86472000	0	17	0.000	20.673	20.673
86472000	0	17	0.000	20.673	20.673
87005000	HEFT	SR 826	0.000	6.903	6.903
87005000	HEFT	SR 826	0.000	6.903	6.903
86470000	54	71	56.344	72.159	15.815
86470000/93470000	71	116	72.159	116.684	44.525
86470000	54	71	56.344	72.159	15.815
86470000/93470000	71	116	72.159	116.684	44.525
17075000	182	200	181.505	199.319	17.814
17075000/13075000	200	228	199.319	227.874	28.555
13075000/10075000	228	261	227.874	260.729	32.855
10075000	261	270	260.729	269.849	9.120
17075000	182	200	181.505	199.319	17.814
17075000/13075000	200	228	199.319	227.874	28.555
13075000/10075000	228	261	227.874	260.729	32.855
10075000	261	270	260.729	269.849	9.120
87270000	3A	4AB	3.240	4.875	1.635
87270000	4AB	12A	4.875	12.400	7.525
87270000/86070000	12A	20	12.400	19.822	7.422
86070000	25	41	25.269	40.938	15.669
86070000/93220000	41	-16.5	40.938	59.045	18.107
	-16.5	-38.21	59.045	80.755	21.710
93220000	-38.21	87	80.755	86.708	5.953
87270000	3A	4AB	3.240	4.875	1.635
87270000	4AB	12A	4.875	12.400	7.525

ROADWAYID	Begin exit	End exit	From mile post	To Mile post	Segment Length (miles)
87270000/86070000	12A	20	12.400	19.822	7.422
86070000	25	41	25.269	40.938	15.669
86070000/93220000	41	-16.5	40.938	59.045	18.107
93220000	-38.21	87	80.755	86.708	5.953
87471000	12	18	12.518	17.946	5.428
87471000	18	26B	17.946	26.440	8.494
87471000	26B	39	26.440	39.389	12.949
87471000/86471000/86470000	39	54	39.389	56.344	16.955
87471000	12	18	12.518	17.946	5.428
87471000	18	26B	17.946	26.440	8.494
87471000	26B	39	26.440	39.389	12.949
87471000/86471000/86470000	39	54	39.389	56.344	16.955

Table B-3 Continues

ROAD NAME	ROADWAYID	Number of Lanes	Interchange frequency	Interchange Density	Number of HOV lanes	Number of Truck restriction restriction lanes	Speed Limit
I-175	15003000	2	3	2.08	0	0	50
I-175	15003000	2	3	2.08	0	0	50
I-195	87004000	2	3	3.50	0	0	55
I-195	87004000	2	2	0.59	0	0	55
I-195	87004000	3	3	3.50	0	0	55
I-195	87004000	3	2	0.59	0	0	55
I-275	15190000	2	9	0.42	0	0	60
I-275	15190000	3	2	2.73	0	0	65
I-275	15190000/10190000	4	13	0.79	0	0	60
I-275	10190000	3	9	1.67	0	0	55
I-275	10190000	3	10	1.14	0	0	55
I-275	15190000	2	9	0.42	0	0	60
I-275	15190000	3	2	2.73	0	0	65
I-275	15190000/10190000	4	13	0.79	0	0	60
I-275	10190000	3	9	1.67	0	0	55
I-275	10190000	3	10	1.14	0	0	55
I-295	72001000	3	8	0.39	0	0	65
I-295	72001000	2	8	0.54	0	0	65
I-295	72001000	3	8	0.39	0	0	65
I-295	72001000	2	8	0.54	0	0	65
I-375	15002000	2	2	1.64	0	0	50
I-375	15002000	2	2	1.64	0	0	50
I-395	87200000	2	2	1.55	0	0	55
I-395	87200000	2	2	1.55	0	0	55

ROAD NAME	ROADWAYID	Number of Lanes	Interchange frequency	Interchange Density	Number of HOV lanes	Number of Truck restriction restriction lanes	Speed Limit
I-4	92130000	2	2	0.93	0	0	65
I-4	92130000/75280000	3	8	0.81	0	0	60
I-4	75280000	4	4	0.85	0	0	55
I-4	75280000	3	9	1.43	0	0	55
I-4	75280000	3	10	1.46	0	0	55
I-4	92130000	2	2	0.93	0	0	65
I-4	92130000/75280000	3	8	0.81	0	0	60
I-4	75280000	4	4	0.85	0	0	55
I-4	75280000	4	9	1.43	0	0	55
I-4	75280000	3	10	1.46	0	0	55
I-4	10190000	3	7	0.93	0	0	60
I-4	10190000	3	8	0.47	0	0	70
I-4	10190000	3	7	0.93	0	0	60
I-4	10190000	2	8	0.47	0	0	70
I-75	87075000	4	4	0.82	0	0	70
I-75	87075000/86075000	4	7	0.56	0	0	70
I-75	86075000	2	5	0.16	0	0	70
I-75	87075000	4	4	0.82	0	0	70
I-75	87075000/86075000	4	7	0.56	0	0	70
I-75	86075000	3	5	0.16	0	0	70
I-95	87270000	3	8	2.89	0	0	55
I-95	87270000	3	8	2.89	0	0	55
I-95	72280000/72020000	3	16	1.13	0	0	55
I-95	72280000/72290000	3	16	1.59	0	0	60
I-95	72290000	3	3	0.70	0	0	55
I-95	72280000/72020000	3	16	1.13	0	0	55
I-95	72280000/72290000	3	16	1.59	0	0	60
I-95	72290000	3	3	0.70	0	0	55
SR 570	16470000	2	9	0.59	0	0	60
SR 570	16470000	2	9	0.59	0	0	60
SR 618	10002000	2	16	1.14	0	0	60
SR 618	10002000	2	16	1.14	0	0	60
SR 826	87260000	3	5	0.79	0	0	55
SR 826	87260000	4	1	0.51	0	0	55
SR 826	87260000	3	3	0.35	0	0	55
SR 826	87260000	3	5	0.69	0	0	55
SR 826	87260000	4	1	0.51	0	0	55
SR 826	87260000	3	3	0.35	0	0	55
SR 836	87200000	3	4	0.93	0	0	55
SR 836	87200000	3	7	0.82	0	0	55
SR 836	87200000	3	4	0.93	0	0	55
SR 836	87200000	3	7	0.82	0	0	55
SR 869	86472000	2	12	0.58	0	0	55
SR 869	86472000	2	12	0.58	0	0	55

ROAD NAME	ROADWAYID	Number of Lanes	Interchange frequency	Interchange Density	Number of HOV lanes	Number of Truck restriction restriction lanes	Speed Limit
SR 874	87005000	3	6	0.87	0	0	60
SR 874	87005000	3	6	0.87	0	0	60
TRN PIKE	86470000	3	7	0.44	0	0	65
TRN PIKE	86470000/93470000	2	9	0.20	0	0	65
TRN PIKE	86470000	3	7	0.44	0	0	65
TRN PIKE	86470000/93470000	2	9	0.20	0	0	65
I-75	17075000	2	5	0.28	0	1	70
I-75	17075000/13075000	3	9	0.32	0	1	70
I-75	13075000/10075000	2	10	0.30	0	1	70
I-75	10075000	2	4	0.44	0	1	70
I-75	17075000	2	5	0.28	0	1	70
I-75	17075000/13075000	3	9	0.32	0	1	70
I-75	13075000/10075000	3	10	0.30	0	1	70
I-75	10075000	3	4	0.44	0	1	70
I-95	87270000	3	2	1.22	0	1	55
I-95	87270000	4	11	1.46	0	1	55
I-95	87270000/86070000	5	7	0.94	1	1	50
I-95	86070000	4	10	0.64	1	1	65
I-95	86070000/93220000	4	9	0.50	1	1	65
I-95	93220000	4	2	0.34	0	1	70
I-95	87270000	3	2	1.22	0	1	55
I-95	87270000	5	11	1.46	0	1	55
I-95	87270000/86070000	5	7	0.94	1	1	50
I-95	86070000	4	10	0.64	1	1	65
I-95	86070000/93220000	4	9	0.50	1	1	65
I-95	93220000	4	2	0.34	0	1	70
TRN PIKE	87471000	2	4	0.74	0	1	60
TRN PIKE	87471000	3	7	0.82	0	1	60
TRN PIKE	87471000	3	5	0.39	0	1	70
TRN PIKE	87471000/86471000/86470000	3	7	0.41	0	1	70
TRN PIKE	87471000	3	4	0.74	0	1	60
TRN PIKE	87471000	3	7	0.82	0	1	60
TRN PIKE	87471000	3	5	0.39	0	1	70
TRN PIKE	87471000/86471000/86470000	3	7	0.41	0	1	70

Table B-3 Continues

ROAD NAME	ROADWAYID	Number of ON ramps (right)	Number of OFF ramps (right)	Total number of ON ramp lanes (right)	Total number of OFF ramp lanes (right)	Number of ON ramps (left)	Number of OFF ramps (left)
I-175	15003000	0	0	0	0	0	0
I-175	15003000	0	0	0	0	0	0
I-195	87004000	1	4	2	6	0	0

ROAD NAME	ROADWAYID	Number of ON ramps (right)	Number of OFF ramps (right)	Total number of ON ramp lanes (right)	Total number of OFF ramp lanes (right)	Number of ON ramps (left)	Number of OFF ramps (left)
I-195	87004000	1	0	1	0	0	1
I-195	87004000	2	1	2	2	0	0
I-195	87004000	0	1	0	1	0	0
I-275	15190000	11	11	13	11	0	0
I-275	15190000	3	4	4	4	0	0
I-275	15190000/10190000	3	2	3	3	1	1
I-275	10190000	0	1		1	1	0
I-275	10190000	9	8	11	10	1	0
I-275	15190000	8	6	9	7	0	0
I-275	15190000	8	9	8	10	0	0
I-275	15190000/10190000	0	0	0	0	0	0
I-275	10190000	1	0	1	0	0	1
I-275	10190000	10	9	12	12	0	1
I-295	72001000	0	0	0	0	0	0
I-295	72001000	0	0	0	0	0	0
I-295	72001000	9	10	11	12	0	0
I-295	72001000	8	8	8	8	1	1
I-375	15002000	6	5	7	6	0	0
I-375	15002000	7	8	8	9	0	0
I-395	87200000	0	0	0	0	0	0
I-395	87200000	0	0	0	0	0	0
I-4	92130000	0	1	0	1	0	0
I-4	92130000/75280000	6	7	9	9	0	0
I-4	75280000	3	3	5	4	0	0
I-4	75280000	8	7	8	8	0	0
I-4	75280000	6	9	6	9	0	0
I-4	92130000	1		1		0	0
I-4	92130000/75280000	6	5	6	8	0	0
I-4	75280000	5	4	6	4	0	1
I-4	75280000	6	7	7	7	0	1
I-4	75280000	9	6	9	7	1	1
I-4	10190000	4	9	5	11	0	0
I-4	10190000	8	8	8	8	0	0
I-4	10190000	5	7	5	7	0	0
I-4	10190000	8	7	8	9	0	0
I-75	87075000	4	3	4	4	1	1
I-75	87075000/86075000	5	10	5	12	0	0
I-75	86075000	4	4	7	4	0	0
I-75	87075000	4	5	4	7	0	0
I-75	87075000/86075000	6	10	7	11	1	0
I-75	86075000	4	5	6	6	0	0
I-95	87270000	2	4	3	4	0	0
I-95	87270000	1	2	1	3	1	1
I-95	72280000/72020000	5	4			0	0

ROAD NAME	ROADWAYID	Number of ON ramps (right)	Number of OFF ramps (right)	Total number of ON ramp lanes (right)	Total number of OFF ramp lanes (right)	Number of ON ramps (left)	Number of OFF ramps (left)
I-95	72280000/72290000	4	4			0	0
I-95	72290000	1	1			0	0
I-95	72280000/72020000	9	7	12	9	0	0
SR 618	10002000	1	2	2	3	0	1
SR 618	10002000	3	1	4	2	1	0
SR 826	87260000	10	10	10	11	0	0
SR 826	87260000	10	9	10	11	0	0
SR 826	87260000	11	8	11	10	0	0
SR 826	87260000	10	8	10	11	0	1
SR 826	87260000	10	9	12	11	0	0
SR 826	87260000	8	9	8	10	0	0
SR 836	87200000	3	4	3	5	1	0
SR 836	87200000	9	9	10	10	0	4
SR 836	87200000	2	6	3	6	0	1
SR 836	87200000	9	10	13	12	2	3
SR 869	86472000	11	11	13	12	0	0
SR 869	86472000	8	10	8	11	0	0
SR 874	87005000	2	4	2	5	0	0
SR 874	87005000	4	4	5	4	0	0
TRN PIKE	86470000	5	7	5	8	0	0
TRN PIKE	86470000/93470000	8	8	8	8	0	0
TRN PIKE	86470000	7	6	8	7	0	0
TRN PIKE	86470000/93470000	8	8	8	8	0	0
I-75	17075000	10	9	10	10	1	1
I-75	17075000/13075000	9	10	9	10	0	0
I-75	13075000/10075000	6	4	7	4	0	0
I-75	10075000	13	17	14	19	0	0
I-75	17075000	10	10	10	12	0	0
I-75	17075000/13075000	5	3	5	5	0	0
I-75	13075000/10075000	4	4	4	4	0	0
I-75	10075000	11	8	12	9	0	0
I-95	87270000	2	2	2	4	0	0
I-95	87270000	8	8	10	8	0	0
I-95	87270000/86070000	10	12	12	14	0	0
I-95	86070000	3	2			0	0
I-95	86070000/93220000	2	2			0	0
I-95	93220000	2	1			0	0
I-95	87270000	2	2	5	4	0	1
I-95	87270000	11	9	12	12	1	0
I-95	87270000/86070000	10	8	11	8	0	0
I-95	86070000	4	4			0	0
I-95	86070000/93220000	3	2			0	0
I-95	93220000	2	1			0	0
TRN PIKE	87471000	4	3	6	4	0	1

ROAD NAME	ROADWAYID	Number of ON ramps (right)	Number of OFF ramps (right)	Total number of ON ramp lanes (right)	Total number of OFF ramp lanes (right)	Number of ON ramps (left)	Number of OFF ramps (left)
TRN PIKE	87471000	4	4	6	6	0	0
TRN PIKE	87471000	4	5	6	7	0	0
TRN PIKE	87471000/86471000/86470000	4	5	2	6	0	0
TRN PIKE	87471000	2	3	3	4		0
TRN PIKE	87471000	4	3	2	5	1	1
TRN PIKE	87471000	4	4	5	7	0	0
TRN PIKE	87471000/86471000/86470000	3	2	3	3	0	0
I-175	15003000			17518	0.0788	4	43.47322
I-175	15003000			12149	0.0788	1	15.671328
I-195	87004000			51884	0.0784	17	104.74705
I-195	87004000			46622	0.1336	48	82.694334
I-195	87004000			46047	0.0784	29	201.33671
I-195	87004000			41378	0.1336	32	62.116346
I-275	15190000			50635	0.0723	61	15.300861
I-275	15190000			66136	0.0632	12	67.818235
I-275	15190000/10190000			76876	0.0847	462	99.527722
I-275	10190000			76475	0.0923	524	348.15213
I-275	10190000			93557	0.0774	230	76.983964
I-275	15190000			35115	0.0723	88	31.829283
I-275	15190000			45864	0.0632	18	146.69109
I-275	15190000/10190000			49474	0.0847	270	90.381513
I-275	10190000			46816	0.0923	325	352.73318
I-275	10190000			43557	0.0774	314	225.74618
I-295	72001000	11933	11314	55376	0.1538	240	57.476128
I-295	72001000	5183	5500	31272	0.1538	78	46.010944
I-295	72001000	11278	10311	50162	0.1538	224	59.220356
I-295	72001000	7925	5775	27867	0.1538	69	45.675264
I-375	15002000			11495	0.0796	0	0
I-375	15002000			7972	0.0796	2	56.339114
I-395	87200000			54296	0.0239	21	82.015527
I-395	87200000			49204	0.0239	1	4.3096719
I-4	92130000	0	16500	46000	0.1375	7	19.283757
I-4	92130000/75280000	12680	4317	57032	0.08985	118	57.056177
I-4	75280000	11300	10700	82357	0.0642	75	53.186627
I-4	75280000	9838	9883	94885	0.0674	180	82.747196
I-4	75280000	10717	9063	85761	0.0674	177	82.390392
I-4	92130000			47250	0.1375	24	64.366645
I-4	92130000/75280000	3858	12650	66912	0.08985	156	64.292432
I-4	75280000	7250	6760	85444	0.0642	71	48.530915
I-4	75280000	10800	8150	102759	0.0674	183	77.680062
I-4	75280000	8643	10300	91243	0.0674	193	84.440518
I-4	10190000			63184	0.1068	192	110.02149
I-4	10190000			62737	0.1098	207	53.331529
I-4	10190000			43817	0.1068	226	186.74509

ROAD NAME	ROADWAYID	Number of ON ramps (right)	Number of OFF ramps (right)	Total number of ON ramp lanes (right)	Total number of OFF ramp lanes (right)	Number of ON ramps (left)	Number of OFF ramps (left)
I-4	10190000			44701	0.1098	215	77.742527
I-75	87075000			61525	0.1338	63	57.194867
I-75	87075000/86075000			70327	0.1068	107	33.567358
I-75	86075000			13786	0.1385	50	31.004475
I-75	87075000			52642	0.1338	64	67.907183
I-75	87075000/86075000			60174	0.1068	131	48.030587
I-75	86075000			10838	0.1385	53	41.804148
I-95	87270000	7925	15350	71258	0.1336	77	106.83848
I-95	87270000	16000	9650	63241	0.1336	57	89.114164
I-95	72280000/72020000	11268	13200	74390	0.0996	212	55.335192
I-95	72280000/72290000	4944	7236	50212	0.0996	244	131.9597
I-95	72290000	8000	3975	36598	0.0996	13	22.775097
I-95	72280000/72020000	9385	10850	67320	0.0996	187	53.935862
SR 618	10002000			20821	0.0862	60	56.140829
SR 618	10002000			16452	0.0862	109	129.07346
SR 826	87260000	9423	7817	100312	0.0204	276	118.65457
SR 826	87260000	9440	13389	86187	0.028	105	169.94688
SR 826	87260000	10080	12894	60378	0.0312	53	27.738641
SR 826	87260000	6667	11500	31938	0.0204	193	229.7218
SR 826	87260000	8720	11060	84751	0.028	123	202.4538
SR 826	87260000	12040	9867	59372	0.0312	44	23.418498
SR 836	87200000	14725	12533	78648	0.023	123	100.01729
SR 836	87200000	7945	10985	112484	0.0239	393	111.86324
SR 836	87200000	3400	11920	32602	0.023	118	231.47039
SR 836	87200000	12156	9270	40373	0.0239	537	425.86198
SR 869	86472000			33790	0.0927	65	25.493461
SR 869	86472000			29108	0.0927	65	29.594065
SR 874	87005000			58152	0.046	176	120.12054
SR 874	87005000			18515	0.046	224	480.16839
TRN PIKE	86470000			57494	0.0994	196	59.057014
TRN PIKE	86470000/93470000			40260	0.1054	545	83.296344
TRN PIKE	86470000			42356	0.0994	165	67.484952
TRN PIKE	86470000/93470000			30360	0.1054	445	90.190636
I-75	17075000	3788	3733	35388	0.1449	124	53.890393
I-75	17075000/13075000	9060	9289	53011	0.1247	147	26.605799
I-75	13075000/10075000			54678	0.1226	364	55.512965
I-75	10075000			54608	0.1334	169	92.969979
I-75	17075000	3700	4933	33487	0.1449	73	33.526816
I-75	17075000/13075000	9225	10688	42989	0.1247	141	31.469275
I-75	13075000/10075000			42320	0.1226	312	61.477274
I-75	10075000			42267	0.1334	142	100.92511
I-95	87270000	11800	11600	112847	0.1336	92	136.61148
I-95	87270000	10633	10260	121942	0.1336	679	202.72957
I-95	87270000/86070000	16483	13812	121072	0.1185	287	87.503287

ROAD NAME	ROADWAYID	Number of ON ramps (right)	Number of OFF ramps (right)	Total number of ON ramp lanes (right)	Total number of OFF ramp lanes (right)	Number of ON ramps (left)	Number of OFF ramps (left)
I-95	86070000	10376	13211	132284	0.1279	658	86.972996
I-95	86070000/93220000	8748	12180	107872	0.115	757	106.18124
I-95	93220000	9980	11728	134008	0.1231	52	17.858454
I-95	87270000	3950	17250	100153	0.1336	58	97.040586
I-95	87270000	9610	10260	108224	0.1336	579	194.78505
I-95	87270000/86070000	13800	17095	101078	0.1185	401	146.44479
I-95	86070000	11004	12156	108096	0.1279	560	90.582491
I-95	86070000/93220000	10139	8721	74628	0.115	561	113.74222
I-95	93220000	11223	9722	89109	0.1231	44	22.72492
TRN PIKE	87471000			76442	0.0763	86	56.78501
TRN PIKE	87471000			69155	0.077	167	77.891087
TRN PIKE	87471000			47526	0.0751	107	47.634698
TRN PIKE	87471000/86471000/86470000			56740	0.09	176	50.122495
TRN PIKE	87471000			52858	0.0763	65	62.068311
TRN PIKE	87471000			47886	0.077	143	96.321304
TRN PIKE	87471000			31971	0.0751	122	80.737354
TRN PIKE	87471000/86471000/86470000			43267	0.09	156	58.260896
I-175	15003000	0	2	1	0	0	0
I-175	15003000	1	2	2	1	0	0
I-195	87004000	29	2	14	11	4	1
I-195	87004000	31	21	24	16	9	2
I-195	87004000	27	8	16	13	5	2
I-195	87004000	25	18	21	13	4	2
I-275	15190000	41	17	36	8	7	5
I-275	15190000	10	2	8	1	2	1
I-275	15190000/10190000	342	64	239	83	40	38
I-275	10190000	376	118	339	103	30	21
I-275	10190000	146	59	144	37	17	5
I-275	15190000	49	17	35	11	13	4
I-275	15190000	7	4	6	1	4	0
I-275	15190000/10190000	175	67	136	46	32	20
I-275	10190000	289	60	246	67	20	15
I-275	10190000	242	49	183	64	21	19
I-295	72001000	239	80	149	68	79	19
I-295	72001000	63	15	41	14	13	9
I-295	72001000	240	71	149	64	66	23
I-295	72001000	53	16	25	18	12	13
I-375	15002000	1	1	1	0	0	1
I-375	15002000	0	0	1	0	0	0
I-395	87200000	48	17	30	18	8	3
I-395	87200000	32	35	20	24	16	3
I-4	92130000	6	1	4	3	0	0
I-4	92130000/75280000	69	31	57	17	21	3
I-4	75280000	45	30	31	18	22	3

ROAD NAME	ROADWAYID	Number of ON ramps (right)	Number of OFF ramps (right)	Total number of ON ramp lanes (right)	Total number of OFF ramp lanes (right)	Number of ON ramps (left)	Number of OFF ramps (left)
I-4	75280000	141	39	64	65	43	6
I-4	75280000	141	35	86	44	39	5
I-4	92130000	15	10	14	4	5	2
I-4	92130000/75280000	121	39	77	36	36	2
I-4	75280000	50	20	30	21	14	3
I-4	75280000	135	48	72	59	45	5
I-4	75280000	150	44	74	49	60	5
I-4	10190000	148	47	144	21	16	10
I-4	10190000	154	56	127	30	22	22
I-4	10190000	189	63	174	47	15	13
I-4	10190000	153	62	137	34	19	19
I-75	87075000	71	15	30	33	16	4
I-75	87075000/86075000	95	34	45	34	33	13
I-75	86075000	35	16	17	14	9	8
I-75	87075000	61	19	31	24	14	7
I-75	87075000/86075000	100	35	53	23	31	23
I-75	86075000	39	12	16	9	9	11
I-95	87270000	52	29	36	21	17	3
I-95	87270000	46	19	29	21	9	4
I-95	72280000/72020000	196	46	123	64	32	18
I-95	72280000/72290000	190	58	121	66	47	9
I-95	72290000	8	4	6	3	2	0
I-95	72280000/72020000	160	55	123	46	33	8
SR 618	10002000	62	15	56	11	9	1
SR 618	10002000	113	23	101	18	13	3
SR 826	87260000	211	55	121	88	43	10
SR 826	87260000	308	85	175	140	58	16
SR 826	87260000	229	62	139	91	50	7
SR 826	87260000	166	33	105	63	25	5
SR 826	87260000	381	90	220	150	62	34
SR 826	87260000	231	63	132	97	43	16
SR 836	87200000	95	28	56	37	23	5
SR 836	87200000	255	98	147	128	61	16
SR 836	87200000	85	33	56	38	19	4
SR 836	87200000	339	149	230	165	60	22
SR 869	86472000	190	50	110	64	43	23
SR 869	86472000	150	42	94	40	32	19
SR 874	87005000	156	43	99	55	33	7
SR 874	87005000	178	61	116	72	30	13
TRN PIKE	86470000	62	23	45	19	15	7
TRN PIKE	86470000/93470000	126	41	82	34	39	10
TRN PIKE	86470000	50	14	23	17	20	2
TRN PIKE	86470000/93470000	103	40	67	33	32	8
I-75	17075000	107	17	69	17	23	14

ROAD NAME	ROADWAYID	Number of ON ramps (right)	Number of OFF ramps (right)	Total number of ON ramp lanes (right)	Total number of OFF ramp lanes (right)	Number of ON ramps (left)	Number of OFF ramps (left)
I-75	17075000/13075000	101	26	69	14	24	16
I-75	13075000/10075000	311	102	280	57	33	39
I-75	10075000	125	44	106	30	13	18
I-75	17075000	55	18	27	13	22	8
I-75	17075000/13075000	104	37	69	19	30	20
I-75	13075000/10075000	276	105	234	66	33	40
I-75	10075000	111	29	90	26	11	13
I-95	87270000	74	18	42	34	9	5
I-95	87270000	502	177	279	277	86	30
I-95	87270000/86070000	496	199	324	202	117	42
I-95	86070000	493	164	302	177	110	61
I-95	86070000/93220000	633	202	417	221	141	48
I-95	93220000	942	297	655	339	189	40
I-95	87270000	44	14	20	23	9	6
I-95	87270000	440	142	249	229	68	26
I-95	87270000/86070000	560	186	330	244	118	39
I-95	86070000	446	118	266	142	96	49
I-95	86070000/93220000	522	142	360	151	102	41
I-95	93220000	783	219	557	253	138	30
TRN PIKE	87471000	75	32	55	24	19	7
TRN PIKE	87471000	182	78	121	68	41	23
TRN PIKE	87471000	153	43	77	60	35	16
TRN PIKE	87471000/86471000/86470000	517	60	400	124	71	36
TRN PIKE	87471000	98	23	54	31	29	7
TRN PIKE	87471000	202	55	110	63	53	21
TRN PIKE	87471000	139	27	66	51	29	17
TRN PIKE	87471000/86471000/86470000	415	116	314	106	60	37

Table B-3 Continues

ROAD NAME	ROADWAYID	Side of the Road			
		Fatal	Left	Median	Right
I-175	15003000	0	0	0	2
I-175	15003000	0	1	1	1
I-195	87004000	0	3	2	26
I-195	87004000	0	3	5	44
I-195	87004000	0	30	1	5
I-195	87004000	2	32	10	1
I-275	15190000	1	3	8	43
I-275	15190000	0	1	1	10
I-275	15190000/10190000	4	11	45	350

ROAD NAME	ROADWAYID	Side of the Road			
		Fatal	Left	Median	Right
I-275	10190000	0	14	30	450
I-275	10190000	1	4	22	179
I-275	15190000	2	38	24	4
I-275	15190000	0	9	2	0
I-275	15190000/10190000	3	186	38	16
I-275	10190000	1	310	24	14
I-275	10190000	4	260	20	11
I-295	72001000	2	19	47	253
I-295	72001000	1	1	12	65
I-295	72001000	6	238	38	35
I-295	72001000	1	50	7	12
I-375	15002000	0	2	0	0
I-375	15002000	0	0	0	0
I-395	87200000	2	4	11	50
I-395	87200000	2	49	12	7
I-4	92130000	0	0	0	7
I-4	92130000/75280000	1	3	11	86
I-4	75280000	1	5	6	64
I-4	75280000	0	8	19	152
I-4	75280000	1	8	16	152
I-4	92130000	0	21	3	1
I-4	92130000/75280000	4	132	13	14
I-4	75280000	2	62	7	1
I-4	75280000	1	158	15	10
I-4	75280000	1	150	34	10
I-4	10190000	2	19	14	162
I-4	10190000	5	15	15	180
I-4	10190000	3	226	12	14
I-4	10190000	4	171	27	16
I-75	87075000	2	11	7	68
I-75	87075000/86075000	4	10	16	103
I-75	86075000	1	7	16	28
I-75	87075000	4	66	13	1
I-75	87075000/86075000	4	104	22	9
I-75	86075000	5	31	17	3
I-95	87270000	3	5	12	64
I-95	87270000	1	53	6	4
I-95	72280000/72020000	4	16	26	200
I-95	72280000/72290000	2	9	17	222
I-95	72290000	1	1	3	8
I-95	72280000/72020000	0	168	30	17
SR 618	10002000	0	9	6	58
SR 618	10002000	0	105	10	14

ROAD NAME	ROADWAYID	Side of the Road			
		Fatal	Left	Median	Right
SR 826	87260000	2	12	20	234
SR 826	87260000	2	11	24	357
SR 826	87260000	1	17	36	238
SR 826	87260000	0	175	9	15
SR 826	87260000	4	422	34	13
SR 826	87260000	2	263	20	11
SR 836	87200000	1	6	11	106
SR 836	87200000	1	14	31	308
SR 836	87200000	0	102	6	10
SR 836	87200000	5	441	34	13
SR 869	86472000	0	11	15	203
SR 869	86472000	5	138	18	24
SR 874	87005000	0	8	17	173
SR 874	87005000	1	215	15	9
TRN PIKE	86470000	0	7	17	62
TRN PIKE	86470000/93470000	0	3	19	143
TRN PIKE	86470000	0	49	6	7
TRN PIKE	86470000/93470000	1	119	14	10
I-75	17075000	1	3	24	97
I-75	17075000/13075000	4	6	19	99
I-75	13075000/10075000	4	24	63	326
I-75	10075000	1	4	26	139
I-75	17075000	1	47	16	10
I-75	17075000/13075000	2	97	22	22
I-75	13075000/10075000	7	311	39	31
I-75	10075000	0	115	17	8
I-95	87270000	0	5	7	79
I-95	87270000	4	25	35	619
I-95	87270000/86070000	5	19	78	595
I-95	86070000	5	17	63	577
I-95	86070000/93220000	3	33	75	727
I-95	93220000	6	23	127	1086
I-95	87270000	0	52	4	1
I-95	87270000	6	538	26	18
I-95	87270000/86070000	7	638	62	43
I-95	86070000	6	459	57	48
I-95	86070000/93220000	5	552	68	41
I-95	93220000	9	856	84	60
TRN PIKE	87471000	0	2	19	86
TRN PIKE	87471000	3	22	28	210
TRN PIKE	87471000	3	8	39	149
TRN PIKE	87471000/86471000/86470000	4	27	106	506
TRN PIKE	87471000	0	87	25	9

ROAD NAME	ROADWAYID	Side of the Road			
		Fatal	Left	Median	Right
TRN PIKE	87471000	2	189	40	28
TRN PIKE	87471000	2	132	25	9
TRN PIKE	87471000/86471000/86470000	3	401	92	38

Table B-3 Continues

ROAD NAME	ROADWAYID	Lane of Crash					
		1	2	3	4	5	6
I-175	15003000	1	0	0	0	0	0
I-175	15003000	2	0	0	0	0	0
I-195	87004000	6	3	3	2	0	0
I-195	87004000	14	11	12	1	0	0
I-195	87004000	3	7	5	2	0	0
I-195	87004000	4	14	5	0	0	0
I-275	15190000	17	12	4	0	0	0
I-275	15190000	1	5	5	0	0	0
I-275	15190000/10190000	73	71	131	30	0	0
I-275	10190000	161	71	157	38	11	1
I-275	10190000	54	50	54	1	1	0
I-275	15190000	7	8	7	0	0	0
I-275	15190000	3	1	2	0	0	0
I-275	15190000/10190000	37	57	51	10	0	0
I-275	10190000	115	69	111	11	0	0
I-275	10190000	67	64	99	11	0	0
I-295	72001000	27	48	66	12	0	0
I-295	72001000	23	23	5	0	0	0
I-295	72001000	31	45	59	9	0	0
I-295	72001000	15	21	1	0	0	0
I-375	15002000	0	0	0	0	0	0
I-375	15002000	1	0	0	0	0	0
I-395	87200000	9	12	3	0	0	0
I-395	87200000	7	12	7	4	0	0
I-4	92130000	2	1	0	0	0	0
I-4	92130000/75280000	19	22	17	6	0	0
I-4	75280000	22	12	14	8	0	0
I-4	75280000	39	31	48	18	1	0
I-4	75280000	32	36	51	16	0	0
I-4	92130000	11	5	1	0	0	0
I-4	92130000/75280000	50	31	28	9	0	0

ROAD NAME	ROADWAYID	Lane of Crash					
		1	2	3	4	5	6
I-4	75280000	9	17	14	11	0	0
I-4	75280000	39	41	35	29	0	0
I-4	75280000	49	29	42	19	0	0
I-4	10190000	60	62	22	11	0	0
I-4	10190000	46	47	54	5	0	0
I-4	10190000	124	61	28	5	0	0
I-4	10190000	50	41	46	11	1	0
I-75	87075000	8	7	7	20	4	0
I-75	87075000/86075000	13	11	28	16	6	0
I-75	86075000	5	13	1	0	0	0
I-75	87075000	7	9	7	16	6	0
I-75	87075000/86075000	14	19	24	16	6	0
I-75	86075000	9	7	2	1	0	0
I-95	87270000	13	16	9	8	4	0
I-95	87270000	11	11	9	4	4	0
I-95	72280000/72020000	52	45	41	7	2	0
I-95	72280000/72290000	55	75	41	16	0	1
I-95	72290000	1	3	0	0	0	0
I-95	72280000/72020000	28	45	38	7	3	0
SR 618	10002000	14	24	1	1	0	0
SR 618	10002000	41	29	2	1	4	0
SR 826	87260000	60	51	53	50	4	1
SR 826	87260000	107	61	69	79	7	0
SR 826	87260000	61	70	62	20	2	0
SR 826	87260000	55	42	29	32	1	0
SR 826	87260000	145	73	80	105	10	0
SR 826	87260000	61	66	79	12	1	0
SR 836	87200000	30	22	33	7	1	0
SR 836	87200000	102	68	70	27	3	0
SR 836	87200000	34	26	22	12	1	0
SR 836	87200000	108	113	129	42	3	0
SR 869	86472000	61	45	28	5	1	0
SR 869	86472000	48	35	11	0	0	0
SR 874	87005000	52	41	22	7	0	0
SR 874	87005000	44	39	57	23	1	0
TRN PIKE	86470000	13	24	18	5	1	0
TRN PIKE	86470000/93470000	37	25	24	9	0	0
TRN PIKE	86470000	8	18	7	9	0	0
TRN PIKE	86470000/93470000	28	22	27	9	0	0
I-75	17075000	49	35	0	0	0	0
I-75	17075000/13075000	24	24	22	1	0	0
I-75	13075000/10075000	60	61	64	19	0	0
I-75	10075000	65	30	17	0	0	0

		Lane of Crash					
ROAD NAME	ROADWAYID	1	2	3	4	5	6
I-75	17075000	12	25	0	0	0	0
I-75	17075000/13075000	29	28	29	2	0	0
I-75	13075000/10075000	53	61	84	11	1	0
I-75	10075000	47	34	21	0	0	0
I-95	87270000	18	15	14	16	7	1
I-95	87270000	106	135	133	98	105	5
I-95	87270000/86070000	64	109	93	76	77	8
I-95	86070000	85	165	95	102	63	4
I-95	86070000/93220000	106	197	117	110	25	1
I-95	93220000	389	257	290	31	2	0
I-95	87270000	12	10	13	7	3	0
I-95	87270000	107	102	93	96	103	2
I-95	87270000/86070000	79	105	99	90	118	21
I-95	86070000	75	146	87	69	70	2
I-95	86070000/93220000	67	129	96	92	23	1
I-95	93220000	332	216	199	30	2	0
TRN PIKE	87471000	14	19	14	4	0	0
TRN PIKE	87471000	34	36	25	1	0	0
TRN PIKE	87471000	42	35	30	0	0	1
TRN PIKE	87471000/86471000/86470000	175	108	23	0	0	0
TRN PIKE	87471000	29	24	9	5	1	0
TRN PIKE	87471000	28	19	26	4	0	0
TRN PIKE	87471000	22	40	34	1	1	0
TRN PIKE	87471000/86471000/86470000	140	101	14	1	0	0

Table B-3 Continues

		Road Condition			
ROAD NAME	ROADWAYID	Dry	Wet	Slippery	77
I-175	15003000	2	0	0	0
I-175	15003000	3	0	0	0
I-195	87004000	25	6	0	1
I-195	87004000	41	41	11	0
I-195	87004000	28	7	0	1
I-195	87004000	28	14	1	0
I-275	15190000	48	9	1	0
I-275	15190000	9	3	0	0
I-275	15190000/10190000	351	52	2	1
I-275	10190000	441	51	0	2
I-275	10190000	174	29	1	1
I-275	15190000	42	22	2	0
I-275	15190000	9	1	1	0
I-275	15190000/10190000	200	38	3	1

ROAD NAME	ROADWAYID	Road Condition			
		Dry	Wet	Slippery	77
I-275	10190000	300	48	0	1
I-275	10190000	256	33	1	1
I-295	72001000	203	113	2	1
I-295	72001000	59	17	2	0
I-295	72001000	231	77	2	1
I-295	72001000	47	22	0	0
I-375	15002000	2	0	0	0
I-375	15002000	0	0	0	0
I-395	87200000	43	19	2	1
I-395	87200000	52	16	0	0
I-4	92130000	4	3	0	0
I-4	92130000/75280000	76	24	0	0
I-4	75280000	46	24	2	77
I-4	75280000	149	29	2	0
I-4	75280000	138	34	4	0
I-4	92130000	22	3	0	0
I-4	92130000/75280000	121	39	0	0
I-4	75280000	48	22	1	2
I-4	75280000	135	47	0	1
I-4	75280000	112	75	5	2
I-4	10190000	152	37	5	1
I-4	10190000	158	49	2	1
I-4	10190000	193	53	4	2
I-4	10190000	146	64	2	3
I-75	87075000	70	15	0	1
I-75	87075000/86075000	103	23	1	2
I-75	86075000	39	12	0	0
I-75	87075000	58	19	2	1
I-75	87075000/86075000	104	30	0	1
I-75	86075000	40	9	1	1
I-95	87270000	64	17	0	0
I-95	87270000	55	10	0	0
I-95	72280000/72020000	140	96	6	0
I-95	72280000/72290000	158	89	1	0
I-95	72290000	9	3	0	0
I-95	72280000/72020000	188	96	7	3
SR 618	10002000	60	17	0	0
SR 618	10002000	111	24	1	0
SR 826	87260000	212	52	1	1
SR 826	87260000	314	75	1	3
SR 826	87260000	238	50	1	2
SR 826	87260000	161	37	0	1
SR 826	87260000	385	81	2	3
SR 826	87260000	228	64	0	2
SR 836	87200000	91	31	0	1
SR 836	87200000	279	66	4	4

ROAD NAME	ROADWAYID	Road Condition			
		Dry	Wet	Slippery	77
SR 836	87200000	97	20	0	1
SR 836	87200000	384	96	3	5
SR 869	86472000	168	70	0	2
SR 869	86472000	139	50	2	1
SR 874	87005000	139	56	2	2
SR 874	87005000	184	52	0	3
TRN PIKE	86470000	68	16	2	0
TRN PIKE	86470000/93470000	120	47	0	0
TRN PIKE	86470000	46	17	0	1
TRN PIKE	86470000/93470000	108	32	0	3
I-75	17075000	99	25	0	0
I-75	17075000/13075000	97	27	2	1
I-75	13075000/10075000	302	108	2	1
I-75	10075000	141	25	2	1
I-75	17075000	60	12	1	0
I-75	17075000/13075000	119	19	2	1
I-75	13075000/10075000	297	75	8	1
I-75	10075000	114	26	0	0
I-95	87270000	75	15	1	1
I-95	87270000	570	97	5	7
I-95	87270000/86070000	575	115	3	2
I-95	86070000	556	93	1	7
I-95	86070000/93220000	673	154	3	5
I-95	93220000	985	238	9	7
I-95	87270000	48	9	0	1
I-95	87270000	509	67	2	4
I-95	87270000/86070000	628	112	4	2
I-95	86070000	458	99	2	5
I-95	86070000/93220000	535	119	4	6
I-95	93220000	767	222	8	5
TRN PIKE	87471000	75	29	0	3
TRN PIKE	87471000	181	77	2	0
TRN PIKE	87471000	149	44	2	1
TRN PIKE	87471000/86471000/86470000	464	464	10	3
TRN PIKE	87471000	85	35	0	1
TRN PIKE	87471000	153	99	4	1
TRN PIKE	87471000	125	40	1	0
TRN PIKE	87471000/86471000/86470000	372	141	15	3

Table B-3 Continues

ROAD NAME	ROADWAYID	Lightning Conditions					
		Daylight	Dusk	Dawn	Dark (street light)	Dark (no street light)	88
I-175	15003000	1	0	0	1	0	0
I-175	15003000	2	0	0	1	0	0
I-195	87004000	20	0	0	11	0	0
I-195	87004000	36	1	2	14	2	0
I-195	87004000	25	0	2	8	0	1
I-195	87004000	27	1	2	12	1	0
I-275	15190000	43	0	1	13	0	1
I-275	15190000	10	0	0	1	1	0
I-275	15190000/10190000	272	9	4	115	5	1
I-275	10190000	349	9	5	127	3	1
I-275	10190000	126	2	3	71	2	1
I-275	15190000	45	0	0	19	2	0
I-275	15190000	7	1	1	2	0	0
I-275	15190000/10190000	144	3	5	82	7	1
I-275	10190000	267	8	2	70	2	1
I-275	10190000	192	5	11	80	2	1
I-295	72001000	215	7	5	83	7	2
I-295	72001000	52	2	0	18	6	0
I-295	72001000	213	1	6	87	3	1
I-295	72001000	47	4	3	10	5	0
I-375	15002000	1	0	0	0	1	0
I-375	15002000	0	0	0	0	0	0
I-395	87200000	34	2	1	25	2	1
I-395	87200000	32	1	1	33	1	0
I-4	92130000	6	0	0	1	0	0
I-4	92130000/75280000	51	2	3	34	9	1
I-4	75280000	40	3	1	27	4	0
I-4	75280000	129	5	3	34	8	1
I-4	75280000	105	7	1	58	4	1
I-4	92130000	14	0	2	3	6	0
I-4	92130000/75280000	86	6	2	57	9	0
I-4	75280000	45	2	0	19	4	0
I-4	75280000	135	6	3	34	5	0
I-4	75280000	125	7	1	53	5	88
I-4	10190000	125	2	5	59	4	0
I-4	10190000	136	3	6	39	25	1
I-4	10190000	197	5	7	36	5	2
I-4	10190000	147	3	6	34	23	2
I-75	87075000	47	2	2	25	10	0
I-75	87075000/86075000	85	3	5	25	10	1
I-75	86075000	27	2	0	4	18	0

ROAD NAME	ROADWAYID	Lightning Conditions					
		Daylight	Dusk	Dawn	Dark (street light)	Dark (no street light)	88
I-75	87075000	48	1	1	22	6	2
I-75	87075000/86075000	88	2	1	31	13	0
I-75	86075000	36	0	0	4	5	2
I-95	87270000	40	0	1	39	1	0
I-95	87270000	45	0	0	20	0	0
I-95	72280000/72020000	179	7	1	51	3	1
I-95	72280000/72290000	174	6	3	53	11	1
I-95	72290000	7	0	1	2	1	0
I-95	72280000/72020000	147	4	0	56	8	0
SR 618	10002000	53	0	1	18	4	1
SR 618	10002000	107	5	3	19	2	0
SR 826	87260000	186	5	4	66	4	1
SR 826	87260000	221	5	9	152	2	4
SR 826	87260000	214	2	4	66	3	2
SR 826	87260000	116	6	5	68	3	1
SR 826	87260000	328	11	9	120	1	2
SR 826	87260000	185	1	7	96	3	2
SR 836	87200000	72	1	4	42	4	0
SR 836	87200000	238	4	5	99	4	3
SR 836	87200000	62	1	0	45	9	1
SR 836	87200000	280	5	9	170	18	6
SR 869	86472000	166	5	2	58	7	2
SR 869	86472000	124	6	2	52	8	0
SR 874	87005000	137	3	11	46	1	1
SR 874	87005000	146	2	0	84	2	2
TRN PIKE	86470000	60	5	1	19	1	0
TRN PIKE	86470000/93470000	127	2	2	36	0	0
TRN PIKE	86470000	32	2	0	27	2	1
TRN PIKE	86470000/93470000	81	10	1	46	2	3
I-75	17075000	102	2	1	4	15	0
I-75	17075000/13075000	92	3	2	8	22	0
I-75	13075000/10075000	294	9	7	48	54	1
I-75	10075000	115	11	1	26	15	1
I-75	17075000	55	3	2	2	11	0
I-75	17075000/13075000	96	3	4	5	31	2
I-75	13075000/10075000	247	9	9	43	73	0
I-75	10075000	97	1	1	14	27	0
I-95	87270000	60	1	1	30	0	0
I-95	87270000	442	8	11	209	3	6
I-95	87270000/86070000	427	9	18	214	23	4
I-95	86070000	442	8	11	178	15	3
I-95	86070000/93220000	546	21	10	237	18	3
I-95	93220000	821	31	26	256	100	5

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ROAD NAME	ROADWAYID	Lightning Conditions					
		Daylight	Dusk	Dawn	Dark (street light)	Dark (no street light)	88
I-95	87270000	37	0	1	19	0	1
I-95	87270000	425	2	11	140	1	3
I-95	87270000/86070000	507	4	7	216	9	3
I-95	86070000	387	6	1	151	16	3
I-95	86070000/93220000	424	28	10	186	12	4
I-95	93220000	656	33	23	202	85	3
TRN PIKE	87471000	76	2	0	21	5	3
TRN PIKE	87471000	184	4	3	57	11	1
TRN PIKE	87471000	136	3	0	50	6	1
TRN PIKE	87471000/86471000/86470000	491	9	13	34	93	1
TRN PIKE	87471000	84	3	0	25	7	2
TRN PIKE	87471000	174	4	4	65	10	0
TRN PIKE	87471000	116	4	4	34	8	0
TRN PIKE	87471000/86471000/86470000	385	15	8	32	88	3

Table B-3 Continues

ROAD NAME	ROADWAYID	Weather Condition				
		Clear	Cloudy	Rain	Fog	77
I-175	15003000	1	1	0	0	0
I-175	15003000	2	1	0	0	0
I-195	87004000	22	5	4	0	0
I-195	87004000	35	9	8	0	0
I-195	87004000	21	10	4	0	1
I-195	87004000	23	11	9	0	0
I-275	15190000	37	12	8	0	1
I-275	15190000	7	2	3	0	0
I-275	15190000/10190000	291	68	45	1	1
I-275	10190000	391	67	32	2	2
I-275	10190000	150	27	25	2	1
I-275	15190000	28	20	17	1	0
I-275	15190000	8	1	2	0	0
I-275	15190000/10190000	158	50	32	1	1
I-275	10190000	251	61	36	0	1
I-275	10190000	221	43	25	1	1
I-295	72001000	176	51	90	1	0
I-295	72001000	42	22	14	0	0
I-295	72001000	181	72	55	3	0
I-295	72001000	36	13	19	1	0

ROAD NAME	ROADWAYID	Weather Condition				
		Clear	Cloudy	Rain	Fog	77
I-375	15002000	2	0	0	0	0
I-375	15002000	0	0	0	0	0
I-395	87200000	38	12	14	0	1
I-395	87200000	44	13	11	0	0
I-4	92130000	1	4	2	0	0
I-4	92130000/75280000	55	34	11	0	0
I-4	75280000	33	23	19	0	0
I-4	75280000	117	34	29	0	0
I-4	75280000	109	39	28	0	0
I-4	92130000	10	10	3	2	0
I-4	92130000/75280000	78	57	25	0	0
I-4	75280000	39	17	14	0	0
I-4	75280000	110	33	36	2	2
I-4	75280000	92	42	58	0	2
I-4	10190000	132	37	25	0	1
I-4	10190000	131	43	33	2	1
I-4	10190000	161	48	40	1	2
I-4	10190000	129	40	42	2	2
I-75	87075000	60	15	11	0	0
I-75	87075000/86075000	85	33	9	0	0
I-75	86075000	32	11	8	0	0
I-75	87075000	47	17	15	0	1
I-75	87075000/86075000	85	25	22	1	2
I-75	86075000	34	8	8	0	1
I-95	87270000	46	22	13	0	0
I-95	87270000	48	9	8	0	0
I-95	72280000/72020000	119	45	78	0	0
I-95	72280000/72290000	118	58	67	2	3
I-95	72290000	7	3	2	0	0
I-95	72280000/72020000	120	35	56	1	3
SR 618	10002000	51	14	10	2	0
SR 618	10002000	93	24	19	0	0
SR 826	87260000	152	80	33	0	1
SR 826	87260000	238	102	45	3	5
SR 826	87260000	198	56	35	0	2
SR 826	87260000	108	71	18	1	1
SR 826	87260000	281	145	42	0	3
SR 826	87260000	184	71	37	0	2
SR 836	87200000	65	41	17	0	0
SR 836	87200000	206	104	39	0	4
SR 836	87200000	67	39	11	0	1
SR 836	87200000	264	154	63	2	5

ROAD NAME	ROADWAYID	Weather Condition				
		Clear	Cloudy	Rain	Fog	77
SR 869	86472000	145	57	36	0	0
SR 869	86472000	116	43	32	0	1
SR 874	87005000	93	71	33	1	1
SR 874	87005000	126	88	23	0	2
TRN PIKE	86470000	51	24	11	0	0
TRN PIKE	86470000/93470000	97	43	27	0	0
TRN PIKE	86470000	33	16	14	0	1
TRN PIKE	86470000/93470000	84	36	19	0	4
I-75	17075000	78	30	16	0	0
I-75	17075000/13075000	72	29	25	1	0
I-75	13075000/10075000	250	78	81	3	1
I-75	10075000	119	30	17	1	2
I-75	17075000	49	20	3	1	0
I-75	17075000/13075000	99	25	13	3	1
I-75	13075000/10075000	249	70	61	0	1
I-75	10075000	89	29	18	4	0
I-95	87270000	62	19	10	0	1
I-95	87270000	431	161	81	0	6
I-95	87270000/86070000	472	157	64	0	2
I-95	86070000	475	127	50	0	5
I-95	86070000/93220000	430	313	85	3	4
I-95	93220000	691	374	162	3	9
I-95	87270000	41	10	6	0	1
I-95	87270000	392	136	48	1	5
I-95	87270000/86070000	512	176	56	0	2
I-95	86070000	384	115	61	0	4
I-95	86070000/93220000	378	218	62	1	5
I-95	93220000	492	350	155	1	4
TRN PIKE	87471000	54	32	18	0	3
TRN PIKE	87471000	143	66	50	1	0
TRN PIKE	87471000	105	70	20	0	1
TRN PIKE	87471000/86471000/86470000	367	160	112	1	1
TRN PIKE	87471000	66	29	25	0	1
TRN PIKE	87471000	120	67	70	0	0
TRN PIKE	87471000	90	49	26	0	1
TRN PIKE	87471000/86471000/86470000	286	135	107	0	3

Table B-3 Continues

ROAD NAME	ROADWAYID	Traffic way Character			
		Straight - level	Straight-upgrade/down grade	curve-level	curve-upgrade/down grade
I-175	15003000	1	0	0	1
I-175	15003000	1	0	1	1
I-195	87004000	21	2	3	5
I-195	87004000	34	17	0	1
I-195	87004000	19	6	6	5
I-195	87004000	29	9	4	1
I-275	15190000	29	9	8	12
I-275	15190000	7	2	2	1
I-275	15190000/10190000	350	35	8	13
I-275	10190000	349	120	10	15
I-275	10190000	154	47	0	4
I-275	15190000	36	13	10	7
I-275	15190000	7	1	3	0
I-275	15190000/10190000	195	32	8	7
I-275	10190000	254	64	13	18
I-275	10190000	205	75	4	7
I-295	72001000	216	60	23	20
I-295	72001000	45	18	11	4
I-295	72001000	212	56	25	18
I-295	72001000	43	20	4	2
I-375	15002000	0	0	2	0
I-375	15002000	0	0	0	0
I-395	87200000	21	24	6	14
I-395	87200000	36	19	2	11
I-4	92130000	6	0	0	1
I-4	92130000/75280000	87	10	3	0
I-4	75280000	66	6	1	2
I-4	75280000	143	24	4	9
I-4	75280000	124	37	5	10
I-4	92130000	23	2	0	0
I-4	92130000/75280000	147	5	3	5
I-4	75280000	58	7	2	3
I-4	75280000	132	27	6	18
I-4	75280000	129	29	12	24
I-4	10190000	153	36	4	2
I-4	10190000	179	28	2	1
I-4	10190000	185	60	4	3
I-4	10190000	184	30	1	0
I-75	87075000	69	5	6	6
I-75	87075000/86075000	111	4	7	7
I-75	86075000	48	2	1	0

ROAD NAME	ROADWAYID	Traffic way Character			
		Straight - level	Straight-upgrade/down grade	curve-level	curve-upgrade/down grade
I-75	87075000	60	2	13	5
I-75	87075000/86075000	110	5	17	3
I-75	86075000	43	4	4	0
I-95	87270000	47	13	10	11
I-95	87270000	36	17	3	9
I-95	72280000/72020000	163	36	24	19
I-95	72280000/72290000	124	80	13	31
I-95	72290000	8	1	1	2
I-95	72280000/72020000	114	42	18	41
SR 618	10002000	56	13	3	5
SR 618	10002000	89	20	7	20
SR 826	87260000	204	45	7	10
SR 826	87260000	312	71	6	4
SR 826	87260000	210	68	10	3
SR 826	87260000	151	41	2	5
SR 826	87260000	357	101	6	7
SR 826	87260000	217	64	10	3
SR 836	87200000	89	21	7	6
SR 836	87200000	252	72	11	18
SR 836	87200000	88	21	2	7
SR 836	87200000	341	99	14	34
SR 869	86472000	175	43	10	12
SR 869	86472000	144	24	10	14
SR 874	87005000	158	21	8	12
SR 874	87005000	214	16	5	4
TRN PIKE	86470000	68	11	3	4
TRN PIKE	86470000/93470000	137	20	7	3
TRN PIKE	86470000	54	6	4	0
TRN PIKE	86470000/93470000	122	18	1	2
I-75	17075000	95	24	2	3
I-75	17075000/13075000	100	14	5	8
I-75	13075000/10075000	312	47	29	25
I-75	10075000	145	16	6	2
I-75	17075000	66	5	1	1
I-75	17075000/13075000	113	14	8	6
I-75	13075000/10075000	289	41	24	27
I-75	10075000	126	12	2	0
I-95	87270000	74	16	1	1
I-95	87270000	515	151	2	11
I-95	87270000/86070000	530	110	39	16
I-95	86070000	571	74	10	2
I-95	86070000/93220000	736	48	28	23

ROAD NAME	ROADWAYID	Traffic way Character			
		Straight - level	Straight-upgrade/downgrade	curve-level	curve-upgrade/downgrade
I-95	93220000	1010	163	36	30
I-95	87270000	43	11	2	2
I-95	87270000	466	108	3	5
I-95	87270000/86070000	559	135	31	21
I-95	86070000	478	66	11	9
I-95	86070000/93220000	552	63	22	27
I-95	93220000	806	147	10	39
TRN PIKE	87471000	92	14	0	1
TRN PIKE	87471000	167	42	17	34
TRN PIKE	87471000	172	12	6	6
TRN PIKE	87471000/86471000/86470000	509	75	34	23
TRN PIKE	87471000	101	19	1	0
TRN PIKE	87471000	151	46	13	47
TRN PIKE	87471000	136	17	8	5
TRN PIKE	87471000/86471000/86470000	454	41	23	13

Table B-3 Continues

ROAD NAME	ROADWAYID	Work Area code		
		1	2	3
I-175	15003000	2	0	0
I-175	15003000	3	0	0
I-195	87004000	30	1	0
I-195	87004000	52	0	0
I-195	87004000	33	3	0
I-195	87004000	43	0	0
I-275	15190000	55	2	1
I-275	15190000	10	1	1
I-275	15190000/10190000	361	10	35
I-275	10190000	325	76	93
I-275	10190000	126	21	58
I-275	15190000	63	0	3
I-275	15190000	10	0	1
I-275	15190000/10190000	204	15	23
I-275	10190000	247	42	60
I-275	10190000	172	43	76
I-295	72001000	256	24	39
I-295	72001000	70	2	6

ROAD NAME	ROADWAYID	Work Area code		
		1	2	3
I-295	72001000	256	23	32
I-295	72001000	62	1	6
I-375	15002000	0	0	0
I-375	15002000	2	0	0
I-395	87200000	64	1	0
I-395	87200000	68	0	0
I-4	92130000	0	1	6
I-4	92130000/75280000	57	11	32
I-4	75280000	73	1	1
I-4	75280000	119	25	36
I-4	75280000	166	5	5
I-4	92130000	3	1	21
I-4	92130000/75280000	73	18	69
I-4	75280000	68	2	0
I-4	75280000	139	24	20
I-4	75280000	189	3	2
I-4	10190000	102	36	54
I-4	10190000	206	1	0
I-4	10190000	113	47	92
I-4	10190000	206	8	1
I-75	87075000	83	3	0
I-75	87075000/86075000	115	7	7
I-75	86075000	48	1	2
I-75	87075000	76	2	2
I-75	87075000/86075000	129	6	0
I-75	86075000	48	2	1
I-95	87270000	78	3	0
I-95	87270000	65	0	0
I-95	72280000/72020000	215	10	16
I-95	72280000/72290000	184	28	36
I-95	72290000	11	1	0
I-95	72280000/72020000	179	13	23
SR 618	10002000	32	16	29
SR 618	10002000	44	14	78
SR 826	87260000	206	17	43
SR 826	87260000	185	57	151
SR 826	87260000	287	4	0
SR 826	87260000	143	14	42
SR 826	87260000	212	69	190
SR 826	87260000	293	1	0
SR 836	87200000	79	22	22
SR 836	87200000	313	27	13

ROAD NAME	ROADWAYID	Work Area code		
		1	2	3
SR 836	87200000	47	26	45
SR 836	87200000	411	25	52
SR 869	86472000	227	6	6
SR 869	86472000	184	4	4
SR 874	87005000	196	2	0
SR 874	87005000	235	2	2
TRN PIKE	86470000	85	0	1
TRN PIKE	86470000/93470000	162	4	1
TRN PIKE	86470000	64	0	0
TRN PIKE	86470000/93470000	137	3	3
I-75	17075000	91	15	18
I-75	17075000/13075000	123	4	0
I-75	13075000/10075000	363	25	25
I-75	10075000	141	12	16
I-75	17075000	63	5	5
I-75	17075000/13075000	136	3	2
I-75	13075000/10075000	339	17	25
I-75	10075000	116	7	17
I-95	87270000	90	1	1
I-95	87270000	668	7	4
I-95	87270000/86070000	672	11	12
I-95	86070000	649	6	2
I-95	86070000/93220000	694	76	65
I-95	93220000	433	150	656
I-95	87270000	58	0	0
I-95	87270000	580	2	0
I-95	87270000/86070000	724	13	9
I-95	86070000	554	9	1
I-95	86070000/93220000	588	26	50
I-95	93220000	373	130	499
TRN PIKE	87471000	106	1	0
TRN PIKE	87471000	254	3	3
TRN PIKE	87471000	184	6	6
TRN PIKE	87471000/86471000/86470000	382	78	181
TRN PIKE	87471000	120	1	0
TRN PIKE	87471000	251	5	1
TRN PIKE	87471000	162	2	2
TRN PIKE	87471000/86471000/86470000	360	52	119

Table B-3 Continues

ROAD NAME	ROADWAYID	Road Condition at time of crash								
		1	2	3	4	5	6	7	8	9
I-175	15003000	2	0	0	0	0	0	0	0	0
I-175	15003000	3	0	0	0	0	0	0	0	0
I-195	87004000	28	1	0	0	0	0	0	0	0
I-195	87004000	51	1	0	0	0	0	0	0	0
I-195	87004000	33	0	0	0	1	0	1	0	0
I-195	87004000	37	0	0	0	0	0	1	6	0
I-275	15190000	55	0	0	0	0	0	0	3	0
I-275	15190000	9	0	1	0	0	0	0	1	0
I-275	15190000/10190000	376	2	5	12	0	1	0	7	0
I-275	10190000	450	1	0	37	0	0	0	3	0
I-275	10190000	175	1	2	23	0	0	1	1	0
I-275	15190000	58	0	0	1	0	0	0	6	1
I-275	15190000	10	0	0	1	0	0	0	0	0
I-275	15190000/10190000	216	3	6	10	0	1	0	3	0
I-275	10190000	323	1	2	19	1	0	0	2	0
I-275	10190000	255	4	1	26	1	0	0	2	0
I-295	72001000	275	3	5	16	0	0	0	17	0
I-295	72001000	70	1	1	4	0	1	2	0	0
I-295	72001000	282	1	3	15	0	0	0	8	1
I-295	72001000	62	0	0	3	0	1	0	2	0
I-375	15002000	2	0	0	0	0	0	0	0	0
I-375	15002000	0	0	0	0	0	0	0	0	0
I-395	87200000	64	1	0	0	0	0	1	0	0
I-395	87200000	66	0	0	0	0	0	0	2	0
I-4	92130000	5	0	0	2	0	0	0	0	0
I-4	92130000/75280000	90	0	1	9	0	0	0	0	0
I-4	75280000	67	0	3	0	0	0	0	1	0
I-4	75280000	147	1	1	28	0	0	0	3	0
I-4	75280000	164	3	1	4	0	0	0	3	0
I-4	92130000	17	0	0	8	0	0	0	0	0
I-4	92130000/75280000	134	0	3	23	0	0	0	0	0
I-4	75280000	68	0	0	0	0	0	0	2	0
I-4	75280000	163	1	0	11	0	0	0	4	0
I-4	75280000	186	0	1	1	0	0	0	0	0
I-4	10190000	173	0	1	19	0	0	3	1	0
I-4	10190000	204	0	4	0	1	0	0	0	0
I-4	10190000	224	1	1	22	0	0	0	2	0
I-4	10190000	205	1	2	1	0	0	0	4	0
I-75	87075000	85	0	1	0	0	0	0	0	0
I-75	87075000/86075000	120	1	1	5	1	0	0	0	0
I-75	86075000	51	0	0	0	0	0	0	0	0
I-75	87075000	74	1	1	0	0	0	0	1	3
I-75	87075000/86075000	129	1	1	1	0	0	0	3	0
I-75	86075000	51	0	0	0	0	0	0	0	0

ROAD NAME	ROADWAYID	Road Condition at time of crash								
		1	2	3	4	5	6	7	8	9
I-95	87270000	77	0	0	0	0	0	0	4	0
I-95	87270000	65	0	0	0	0	0	0	0	0
I-95	72280000/72020000	222	1	1	10	0	0	6	6	0
I-95	72280000/72290000	231	1	0	12	0	1	0	1	0
I-95	72290000	12	0	0	0	0	0	0	0	0
I-95	72280000/72020000	195	1	0	11	0	0	0	5	0
SR 618	10002000	51	1	0	23	0	0	0	0	0
SR 618	10002000	97	0	1	34	0	0	0	4	0
SR 826	87260000	248	1	1	15	0	0	0	0	0
SR 826	87260000	335	4	2	45	0	0	0	2	0
SR 826	87260000	284	2	1	0	0	0	6	0	0
SR 826	87260000	178	1	2	16	0	0	3	1	0
SR 826	87260000	406	6	1	52	0	0	0	2	0
SR 826	87260000	287	2	0	0	0	0	0	3	0
SR 836	87200000	115	2	1	5	0	0	1	0	0
SR 836	87200000	340	1	2	1	0	0	0	4	0
SR 836	87200000	103	2	0	8	2	0	0	1	0
SR 836	87200000	448	5	1	23	0	0	0	0	0
SR 869	86472000	230	1	1	5	0	0	1	1	0
SR 869	86472000	182	0	0	3	0	0	0	6	0
SR 874	87005000	187	0	0	4	0	0	0	6	0
SR 874	87005000	233	1	1	0	0	0	0	1	3
TRN PIKE	86470000	83	1	0	0	0	0	2	1	0
TRN PIKE	86470000/93470000	161	0	0	0	0	0	1	5	0
TRN PIKE	86470000	63	0	0	0	0	0	0	1	0
TRN PIKE	86470000/93470000	136	0	0	1	0	0	0	2	4
I-75	17075000	115	8	1	0	0	0	0	0	0
I-75	17075000/13075000	122	0	2	1	0	0	5	8	0
I-75	13075000/10075000	378	2	6	17	1	1	7	2	0
I-75	10075000	157	1	2	7	2	0	0	0	0
I-75	17075000	67	0	1	5	0	0	0	0	0
I-75	17075000/13075000	130	1	4	2	0	0	0	1	0
I-75	13075000/10075000	352	1	5	15	0	0	0	1	0
I-75	10075000	130	1	2	7	0	0	0	0	0
I-95	87270000	86	0	0	1	0	0	0	4	0
I-95	87270000	661	0	2	1	0	0	0	5	0
I-95	87270000/86070000	676	0	2	8	0	0	0	6	0
I-95	86070000	640	5	3	1	0	0	0	5	0
I-95	86070000/93220000	794	3	10	18	0	0	0	2	0
I-95	93220000	999	8	20	194	0	0	0	13	0
I-95	87270000	55	1	0	0	0	0	0	1	0
I-95	87270000	571	1	3	0	1	0	0	1	0
I-95	87270000/86070000	728	4	3	5	2	0	0	0	0
I-95	86070000	548	1	3	0	0	0	0	9	0
I-95	86070000/93220000	624	3	17	14	0	0	0	1	0

ROAD NAME	ROADWAYID	Road Condition at time of crash								
		1	2	3	4	5	6	7	8	9
I-95	93220000	808	7	11	162	0	0	0	8	0
TRN PIKE	87471000	102	0	1	0	0	0	0	1	0
TRN PIKE	87471000	257	1	0	0	0	0	0	1	1
TRN PIKE	87471000	193	1	0	0	0	0	0	1	0
TRN PIKE	87471000/86471000/86470000	514	1	3	96	0	0	0	24	1
TRN PIKE	87471000	116	1	0	0	0	0	0	3	0
TRN PIKE	87471000	256	1	0	0	0	0	0	0	0
TRN PIKE	87471000	163	0	0	0	0	0	0	1	0
TRN PIKE	87471000/86471000/86470000	449	2	3	61	0	0	0	11	1

Table B-3 Continues

ROAD NAME	ROADWAYID	Maximum posted speed					
		35	45	50	55	60	65
I-175	15003000	0	0	2	0	0	0
I-175	15003000	1	0	2	0	0	0
I-195	87004000	0	0	0	18	0	0
I-195	87004000	5	0	1	47	0	0
I-195	87004000	0	0	0	20	0	0
I-195	87004000	2	0	0	41	0	0
I-275	15190000	0	0	1	6	0	45
I-275	15190000	0	0	0	0	0	12
I-275	15190000/10190000	0	0	0	171	0	234
I-275	10190000	0	0	24	468	0	0
I-275	10190000	0	0	4	201	0	0
I-275	15190000	0	2	0	3	0	51
I-275	15190000	0	0	0	0	0	11
I-275	15190000/10190000	0	0	40	0	202	0
I-275	10190000	0	0	22	327	0	0
I-275	10190000	0	0	19	272	0	0
I-295	72001000	0	0	0	0	0	240
I-295	72001000	0	0	0	0	0	78
I-295	72001000	0	2	0	0	0	224
I-295	72001000	0	0	0	0	0	69
I-375	15002000	0	0	2	0	0	0
I-375	15002000		0	0	0	0	0
I-395	87200000	0	0	0	54	0	0
I-395	87200000	0	1	0	57	0	0
I-4	92130000	0	0	0	0	7	0
I-4	92130000/75280000	0	0	24	0	76	0
I-4	75280000	0	0	75	0	0	0
I-4	75280000	0	88	92	0	0	0
I-4	75280000	0	151	25	0	0	0
I-4	92130000	0	0	0	0	25	0

ROAD NAME	ROADWAYID	Maximum posted speed					
		35	45	50	55	60	65
I-4	92130000/75280000	0	0	10	0	149	0
I-4	75280000	0	0	70	0	0	0
I-4	75280000	0	85	98	0	0	0
I-4	75280000	0	173	21	0	0	0
I-4	10190000	0	0	0	114	0	81
I-4	10190000	0	0	0	0	0	15
I-4	10190000	0	0	0	194	0	58
I-4	10190000	0	0	0	0	0	29
I-75	87075000	0	1	0	0	0	0
I-75	87075000/86075000	1	0	0	0	0	1
I-75	86075000	0	0	0	0	0	0
I-75	87075000	0	0	0	0	0	0
I-75	87075000/86075000	0	0	0	0	0	0
I-75	86075000	0	0	0	0	0	0
I-95	87270000	0	0	0	79	0	0
I-95	87270000	0	0	0	58	0	0
I-95	72280000/72020000	0	13	0	80	0	123
I-95	72280000/72290000	0	0	0	239	0	7
I-95	72290000	0	0	0	11	0	1
I-95	72280000/72020000	1	0	0	2	0	116
SR 618	10002000	0	0	0	16	43	0
SR 618	10002000		1	0	10	0	49
SR 826	87260000	0	3	0	255	0	0
SR 826	87260000	0	0	187	206	0	0
SR 826	87260000	0	4	0	287	0	0
SR 826	87260000	0	0	0	184	0	0
SR 826	87260000	0	0	179	292	0	0
SR 826	87260000	0	5	0	289	0	0
SR 836	87200000	0	0	0	123	0	0
SR 836	87200000	0	0	0	353	0	0
SR 836	87200000	0	0	0	118	0	0
SR 836	87200000	0	0	0	488	0	0
SR 869	86472000	0	88	0	0	0	113
SR 869	86472000	0	65	0	0	0	104
SR 874	87005000	0	0	0	1	181	0
SR 874	87005000	0	0	0	2	228	0
TRN PIKE	86470000	0	0	0	0	86	0
TRN PIKE	86470000/93470000	0	0	0	0	167	0
TRN PIKE	86470000	0	0	0	0	0	64
TRN PIKE	86470000/93470000	0	0	0	0	0	143
I-75	17075000	0	0	0	0	0	0
I-75	17075000/13075000	0	0	0	0	0	0
I-75	13075000/10075000	1	0	0	1	0	0
I-75	10075000	0	0	0	0	0	0
I-75	17075000	0	0	0	0	0	0
I-75	17075000/13075000	0	0	0	0	0	0

ROAD NAME	ROADWAYID	Maximum posted speed					
		35	45	50	55	60	65
I-75	13075000/10075000	1	0	0	0	0	0
I-75	10075000	0	0	0	0	0	0
I-95	87270000	0	0	0	92	0	0
I-95	87270000	0	0	0	679	0	0
I-95	87270000/86070000	1	0	0	176	0	401
I-95	86070000	0	0	0	0	0	657
I-95	86070000/93220000	0	0	0	0	0	728
I-95	93220000	0	0	0	0	0	1187
I-95	87270000	0	0	0	58	0	0
I-95	87270000	0	0	0	582	0	0
I-95	87270000/86070000	0	0	0	253	0	405
I-95	86070000	0	0	0	0	0	564
I-95	86070000/93220000	0	0	0	0	0	557
I-95	93220000	0	0	0	0	0	956
TRN PIKE	87471000	0	0	0	0	0	0
TRN PIKE	87471000	1	0	5	0	117	0
TRN PIKE	87471000	0	0	0	0	0	196
TRN PIKE	87471000/86471000/86470000	0	0	1	0	0	545
TRN PIKE	87471000	0	0	0	0	0	0
TRN PIKE	87471000	1	0	4	0	0	110
TRN PIKE	87471000	0	0	0	0	0	166
TRN PIKE	87471000/86471000/86470000	0	0	0	0	0	445

Table B-3 Continues

ROAD NAME	ROADWAYID	Crash- level of Alcohol involved code				
		0	1	2	3	4
I-175	15003000	3	0	0	0	0
I-175	15003000	0	0	0	0	0
I-195	87004000	16	0	0	0	0
I-195	87004000	53	3	0	0	0
I-195	87004000	28	1	0	0	0
I-195	87004000	18	5	0	0	0
I-275	15190000	26	0	0	0	0
I-275	15190000	6	0	0	0	0
I-275	15190000/10190000	325	17	0	2	0
I-275	10190000	281	7	0	1	0
I-275	10190000	0	0	0	0	0
I-275	15190000	46	3	1	0	0
I-275	15190000	7	0	0	0	0
I-275	15190000/10190000	285	20	1	3	0
I-275	10190000	486	25	1	0	0
I-275	10190000	0	0	0	0	0
I-295	72001000	216	12	3	0	0

ROAD NAME	ROADWAYID	Crash- level of Alcohol involved code				
		0	1	2	3	4
I-295	72001000	53	1	0	0	0
I-295	72001000	213	11	0	0	0
I-295	72001000	58	1	2	0	0
I-375	15002000	0	0	0	0	0
I-375	15002000	1	0	0	0	0
I-395	87200000	34	5	0	0	0
I-395	87200000	45	2	0	0	0
I-4	92130000	1	0	0	0	0
I-4	92130000/75280000	8	0	0	0	0
I-4	75280000	4	0	0	0	0
I-4	75280000	4	0	1	0	0
I-4	75280000	10	1	0	0	0
I-4	92130000	0	0	0	0	0
I-4	92130000/75280000	6	1	2	0	0
I-4	75280000	2	0	0	0	0
I-4	75280000	7	0	0	0	0
I-4	75280000	12	2	0	0	0
I-4	10190000	186	6	0	0	0
I-4	10190000	190	9	0	0	0
I-4	10190000	215	8	2	0	0
I-4	10190000	141	5	0	1	0
I-75	87075000	55	3	0	0	0
I-75	87075000/86075000	124	5	0	2	0
I-75	86075000	33	3	1	0	0
I-75	87075000	45	2	0	0	0
I-75	87075000/86075000	129	5	0	0	0
I-75	86075000	50	4	1	2	0
I-95	87270000	57	4	1	0	0
I-95	87270000	46	4	0	0	0
I-95	72280000/72020000	126	4	0	0	0
I-95	72280000/72290000	0	0	0	0	0
I-95	72290000	0	0	0	0	0
I-95	72280000/72020000	112	6	0	0	0
SR 618	10002000	68	1	0	0	0
SR 618	10002000	57	3	0	0	0
SR 826	87260000	83	3	0	1	0
SR 826	87260000	0	0	0	0	0
SR 826	87260000	252	8	0	0	0
SR 826	87260000	93	2	0	0	0
SR 826	87260000	0	0	0	0	0
SR 826	87260000	251	10	0	0	0
SR 836	87200000	110	8	0	0	0
SR 836	87200000	432	27	0	0	0
SR 836	87200000	91	8	0	0	0
SR 836	87200000	391	13	1	0	0

ROAD NAME	ROADWAYID	Crash- level of Alcohol involved code				
		0	1	2	3	4
SR 869	86472000	71	6	0	0	0
SR 869	86472000	83	3	0	1	0
SR 874	87005000	172	10	0	0	0
SR 874	87005000	167	4	0	0	0
TRN PIKE	86470000	179	13	2	0	0
TRN PIKE	86470000/93470000	18	0	0	0	0
TRN PIKE	86470000	105	9	1	1	0
TRN PIKE	86470000/93470000	8	0	0	0	0
I-75	17075000	85	7	0	0	0
I-75	17075000/13075000	120	5	1	0	0
I-75	13075000/10075000	313	13	0	2	0
I-75	10075000	131	6	1	0	0
I-75	17075000	97	7	0	0	0
I-75	17075000/13075000	146	8	1	0	0
I-75	13075000/10075000	297	8	0	0	0
I-75	10075000	149	4	0	0	0
I-95	87270000	54	4	0	0	0
I-95	87270000	634	21	2	0	0
I-95	87270000/86070000	616	28	1	1	0
I-95	86070000	615	25	2	3	0
I-95	86070000/93220000	573	27	1	0	0
I-95	93220000	1052	37	1	1	0
I-95	87270000	77	3	0	0	0
I-95	87270000	515	15	0	1	0
I-95	87270000/86070000	641	32	1	2	0
I-95	86070000	515	31	1	0	0
I-95	86070000/93220000	631	28	0	1	0
I-95	93220000	990	34	0	1	0
TRN PIKE	87471000	85	3	0	0	0
TRN PIKE	87471000	139	3	0	0	0
TRN PIKE	87471000	83	3	0	0	0
TRN PIKE	87471000/86471000/86470000	222	9	0	0	0
TRN PIKE	87471000	51	0	0	0	0
TRN PIKE	87471000	92	4	0	0	0
TRN PIKE	87471000	140	10	0	0	0

ROAD NAME	ROADWAYID	Crash- level of Alcohol involved code	ROAD NAME	ROADWAY ID	Crash- level of Alcohol involved code
I-175	15003000	2	0	3	0
I-175	15003000	3	0	0	0
I-195	87004000	25	10	16	0
I-195	87004000	47	1	54	2
I-195	87004000	30	0	27	0
I-195	87004000	40	1	21	2
I-275	15190000	45	6	26	0

I-275	15190000	10	1	6	0
I-275	15190000/10190000	372	22	326	18
I-275	10190000	440	39	274	15
I-275	10190000	181	18	0	0
I-275	15190000	59	4	48	2
I-275	15190000	11	0	7	0
I-275	15190000/10190000	204	21	290	18
I-275	10190000	305	34	475	37
I-275	10190000	248	35	0	0
I-295	72001000	254	26	140	22
I-295	72001000	48	20	31	6
I-295	72001000	235	44	140	34
I-295	72001000	47	18	32	6
I-375	15002000	2	0	0	0
I-375	15002000	0	0	1	0
I-395	87200000	56	8	38	1
I-395	87200000	61	4	45	2
I-4	92130000	2	0	2	6
I-4	92130000/75280000	40	8	19	23
I-4	75280000	5	19	4	9
I-4	75280000	9	50	9	15
I-4	75280000	22	39	17	29
I-4	92130000	4	1	4	3
I-4	92130000/75280000	22	19	22	15
I-4	75280000	7	8	4	8
I-4	75280000	4	58	3	24
I-4	75280000	21	46	14	40
I-4	10190000	155	30	165	10
I-4	10190000	178	23	137	22
I-4	10190000	226	22	183	15
I-4	10190000	179	32	91	23
I-75	87075000	68	10	41	7
I-75	87075000/86075000	94	14	85	12
I-75	86075000	39	8	15	2
I-75	87075000	69	7	38	2
I-75	87075000/86075000	98	15	118	16
I-75	86075000	44	4	50	7
SR-826	87260000	405	43	61	0
SR-826	87260000	287	37	491	28
SR-836	72280000/70020000	164	56	105	24
SR-836	72280000/70020000	183	43	402	16
SR-836	72290000	180	3	90	9
SR-836	72280000/70020000	443	39	976	29
SR 869	86402000	208	22	46	9
SR 869	86402000	159	19	56	8
SR 824	87066000	232	19	174	9
SR 824	87066000	338	34	196	10
SR PIKE	87450000	263	28	208	29
SR PIKE	86470000/86934000	189	15	85	8

ROAD NAME	ROADWAYID				
TRN PIKE	86470000	48	7	101	15
TRN PIKE	86470000/93470000	116	15	2	0
I-75	17075000	79	41	72	20
I-75	17075000/13075000	96	24	106	20
I-75	13075000/10075000	357	42	285	42
I-75	10075000	138	31	131	7
I-75	17075000	49	16	85	18
I-75	17075000/13075000	108	28	132	23
I-75	13075000/10075000	323	44	275	30
I-75	10075000	111	24	133	20
I-95	87270000	85	1	52	6
I-95	87270000	606	35	610	47
I-95	87270000/86070000	594	50	587	58
I-95	86070000	517	61	575	70
I-95	86070000/93220000	706	78	422	64
I-95	93220000	1053	131	804	106
I-95	87270000	52	2	74	5
I-95	87270000	515	33	499	31
I-95	87270000/86070000	622	73	622	54
I-95	86070000	447	49	493	51
I-95	86070000/93220000	549	65	487	64
I-95	93220000	839	118	768	104
TRN PIKE	87471000	80	17	58	11
TRN PIKE	87471000	198	36	102	13
TRN PIKE	87471000	154	25	55	7

ROAD NAME	ROADWAYID	Number of persons in the crash		Total number of drivers		Total Number of vehicles in crash	
		single person	Two people	single person	Two people	One	Two
I-175	15003000	2	1	2	1	2	1
I-175	15003000	0	0	0	0	0	0
I-195	87004000	4	9	5	10	5	10
I-195	87004000	15	22	19	31	19	31
I-195	87004000	2	13	2	21	2	21
I-195	87004000	2	15	3	16	3	16
I-275	15190000	12	6	13	11	13	11
I-275	15190000	1	2	3	2	3	2
I-275	15190000/10190000	61	134	78	203	78	203
I-275	10190000	21	148	27	199	27	199
I-275	10190000	0	0	0	0	0	0
I-275	15190000	18	12	22	19	22	19
I-275	15190000	0	2	0	5	0	5
I-275	15190000/10190000	49	118	64	172	64	172
I-275	10190000	29	228	40	337	40	337
I-275	10190000	0	0	0	0	0	0
I-295	72001000	52	90	69	112	69	112
I-295	72001000	10	30	17	30	17	30
I-295	72001000	37	112	50	141	50	141
I-295	72001000	19	17	23	28	23	28

ROAD NAME	ROADWAYID	Number of persons in the crash		Total number of drivers		Total Number of vehicles in crash	
		single person	Two people	single person	Two people	One	Two
I-375	15002000	0	0	0	0	0	0
I-375	15002000	1	0	1	0	1	0
I-395	87200000	12	13	13	19	13	19
I-395	87200000	8	21	12	28	12	28
I-4	92130000	4	5	5	2	5	2
I-4	92130000/75280000	66	49	86	27	86	27
I-4	75280000	25	29	39	14	39	14
I-4	75280000	65	102	112	49	112	49
I-4	75280000	72	66	91	39	91	39
I-4	92130000	8	7	11	4	11	4
I-4	92130000/75280000	39	53	60	27	60	27
I-4	75280000	25	33	38	19	38	19
I-4	75280000	54	75	75	51	75	51
I-4	75280000	78	69	104	36	104	36
I-4	10190000	15	90	17	139	17	139
I-4	10190000	28	94	40	133	40	133
I-4	10190000	20	104	27	151	27	151
I-4	10190000	19	74	32	94	32	94
I-75	87075000	9	31	10	41	10	41
I-75	87075000/86075000	25	72	34	81	34	81
I-75	86075000	14	8	20	13	20	13
I-75	87075000	5	26	7	31	7	31
I-75	87075000/86075000	29	55	34	72	34	72
I-75	86075000	15	19	26	27	26	27
I-95	87270000	15	26	20	33	20	33
I-95	87270000	6	30	8	35	8	35
I-95	72280000/72020000	56	5	25	52	34	72
I-95	72280000/72290000	0	0	0	0	0	0
I-95	72290000	0	0	0	0	0	0
I-95	72280000/72020000	44	8	20	53	34	64
SR 618	10002000	10	41	15	44	15	44
SR 618	10002000	6	33	9	43	9	43
SR 826	87260000	6	47	11	60	11	60
SR 826	87260000	0	0	0	0	0	0
SR 826	87260000	28	136	33	167	33	167
SR 826	87260000	7	38	13	57	13	57
SR 826	87260000	0	0	0	0	0	0
SR 826	87260000	33	127	42	161	42	161
SR 836	87200000	15	54	18	79	18	79
SR 836	87200000	41	216	53	303	53	303
SR 836	87200000	5	52	6	69	6	69
SR 836	87200000	45	194	59	264	59	264
SR 869	86472000	18	32	26	43	26	43
SR 869	86472000	21	36	29	39	29	39
SR 874	87005000	26	86	31	113	31	113

ROAD NAME	ROADWAYID	Number of persons in the crash		Total number of drivers		Total Number of vehicles in crash	
		single person	Two people	single person	Two people	One	Two
SR 874	87005000	22	85	24	119	24	119
TRN PIKE	86470000	35	87	49	116	49	116
TRN PIKE	86470000/93470000	2	5	5	10	5	10
TRN PIKE	86470000	20	46	26	65	26	65
TRN PIKE	86470000/93470000	4	1	6	2	6	2
I-75	17075000	24	40	31	49	31	49
I-75	17075000/13075000	21	46	31	73	31	73
I-75	13075000/10075000	76	146	101	185	101	185
I-75	10075000	28	47	33	75	33	75
I-75	17075000	20	39	30	55	30	55
I-75	17075000/13075000	25	72	38	84	38	84
I-75	13075000/10075000	81	129	116	151	116	151
I-75	10075000	26	60	33	86	33	86
I-95	87270000	8	28	9	39	9	39
I-95	87270000	49	344	57	448	57	448
I-95	87270000/86070000	68	280	85	418	85	418
I-95	86070000	73	283	95	367	95	367
I-95	86070000/93220000	91	277	125	349	125	349
I-95	93220000	127	492	179	661	179	661
I-95	87270000	5	37	9	52	9	52
I-95	87270000	40	283	50	364	50	364
I-95	87270000/86070000	77	297	105	395	105	395
I-95	86070000	49	236	67	333	67	333
I-95	86070000/93220000	94	296	112	400	112	400
I-95	93220000	121	496	152	654	152	654
TRN PIKE	87471000	13	38	19	50	19	50
TRN PIKE	87471000	18	67	27	84	27	84
TRN PIKE	87471000	18	36	24	45	24	45
TRN PIKE	87471000/86471000/86470000	69	100	82	124	82	124
TRN PIKE	87471000	10	18	13	27	13	27
TRN PIKE	87471000	18	44	19	60	19	60
TRN PIKE	87471000	29	69	44	83	44	83
TRN PIKE	87471000/86471000/86470000	64	96	84	135	84	135

Table B-3 Continues

ROAD NAME	ROADWAYID	Total Number of traffic fatalities		total number of injuries in the crash	
		one	two	one	Two
I-175	15003000	3	0	3	0
I-175	15003000	0	0	0	0
I-195	87004000	16	0	15	1
I-195	87004000	56	0	47	5
I-195	87004000	29	0	24	2
I-195	87004000	23	0	16	6
I-275	15190000	26	0	24	2

ROAD NAME	ROADWAYID	Total Number of traffic fatalities		total number of injuries in the crash	
		one	two	one	Two
I-275	15190000	6	0	4	1
I-275	15190000/10190000	344	0	295	29
I-275	10190000	289	0	268	11
I-275	10190000	0	0	0	0
I-275	15190000	50	0	42	4
I-275	15190000	7	0	7	0
I-275	15190000/10190000	309	0	250	38
I-275	10190000	512	0	458	31
I-275	10190000	0	0	0	0
I-295	72001000	230	1	196	23
I-295	72001000	54	0	43	11
I-295	72001000	224	0	184	26
I-295	72001000	60	1	44	8
I-375	15002000	0	0	0	0
I-375	15002000	0	0	0	0
I-395	87200000	39	0	28	5
I-395	87200000	47	0	40	4
I-4	92130000	0	0	0	0
I-4	92130000/75280000	0	0	10	8
I-4	75280000	0	0	9	6
I-4	75280000	0	0	19	11
I-4	75280000	0	0	17	10
I-4	92130000	0	0	0	2
I-4	92130000/75280000	0	0	12	12
I-4	75280000	0	0	10	6
I-4	75280000	0	0	16	10
I-4	75280000	0	0	16	8
I-4	10190000	192	0	170	10
I-4	10190000	197	2	169	15
I-4	10190000	224	1	204	13
I-4	10190000	147	0	122	16
I-75	87075000	58	0	49	6
I-75	87075000/86075000	131	0	108	15
I-75	86075000	36	0	28	3
I-75	87075000	47	0	37	6
I-75	87075000/86075000	133	0	115	10
I-75	86075000	56	0	43	6
I-95	87270000	62	0	45	10
I-95	87270000	50	0	44	5
I-95	72280000/72020000	34	72	130	0
I-95	72280000/72290000	0	0	0	0
I-95	72290000	0	0	0	0
I-95	72280000/72020000	34	64	118	0
SR 618	10002000	69	0	66	3
SR 618	10002000	60	0	53	6

ROAD NAME	ROADWAYID	Total Number of traffic fatalities		total number of injuries in the crash	
		one	two	one	Two
SR 826	87260000	87	0	79	6
SR 826	87260000	0	0	0	0
SR 826	87260000	260	0	202	39
SR 826	87260000	95	0	74	15
SR 826	87260000	0	0	0	0
SR 826	87260000	261	0	207	33
SR 836	87200000	118	0	94	14
SR 836	87200000	459	0	350	65
SR 836	87200000	99	0	79	12
SR 836	87200000	404	1	311	62
SR 869	86472000	77	0	61	10
SR 869	86472000	86	1	69	10
SR 874	87005000	182	0	143	20
SR 874	87005000	171	0	143	15
TRN PIKE	86470000	193	0	148	26
TRN PIKE	86470000/93470000	18	0	11	2
TRN PIKE	86470000	116	0	92	16
TRN PIKE	86470000/93470000	8	0	7	0
I-75	17075000	92	0	81	6
I-75	17075000/13075000	126	0	104	9
I-75	13075000/10075000	327	0	290	20
I-75	10075000	138	0	123	9
I-75	17075000	104	0	86	15
I-75	17075000/13075000	155	0	129	16
I-75	13075000/10075000	305	0	271	20
I-75	10075000	153	0	134	12
I-95	87270000	58	0	43	9
I-95	87270000	657	0	486	108
I-95	87270000/86070000	645	1	509	89
I-95	86070000	645	0	518	89
I-95	86070000/93220000	601	0	502	48
I-95	93220000	1090	1	867	120
I-95	87270000	80	0	60	12
I-95	87270000	531	0	418	76
I-95	87270000/86070000	676	0	529	87
I-95	86070000	547	0	473	40
I-95	86070000/93220000	659	1	541	71
I-95	93220000	1024	1	846	101
TRN PIKE	87471000	88	0	71	10
TRN PIKE	87471000	142	0	122	6
TRN PIKE	87471000	86	0	73	7
TRN PIKE	87471000/86471000/86470000	231	0	192	25
TRN PIKE	87471000	51	0	40	7
TRN PIKE	87471000	96	0	84	5
TRN PIKE	87471000	150	0	114	21

ROAD NAME	ROADWAYID	Total Number of traffic fatalities		total number of injuries in the crash	
		one	two	one	Two
TRN PIKE	87471000/86471000/86470000	246	0	198	30
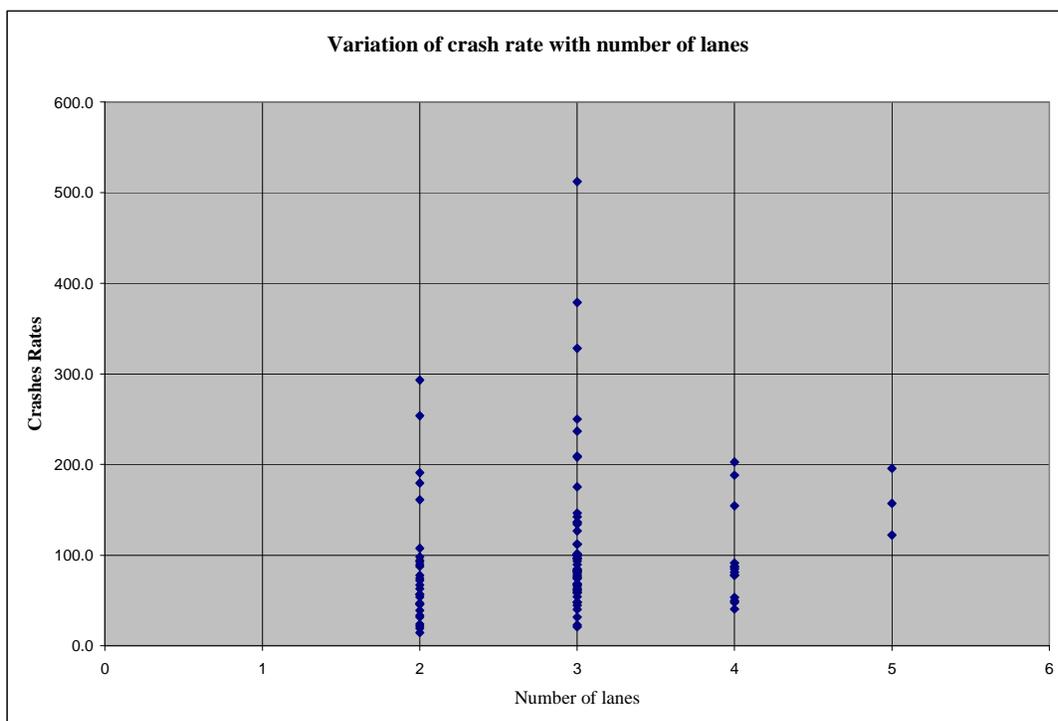
Figure B-2: Distribution of Crashes with number of lanes
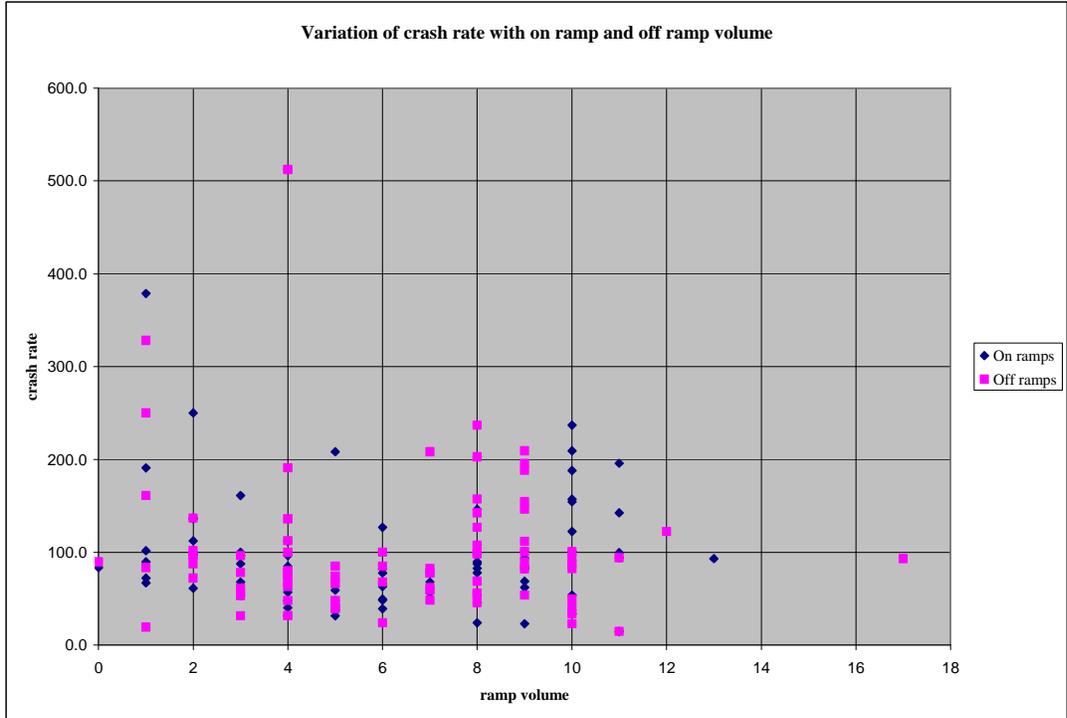
Figure B-3: Distribution of crashes with number of ramps
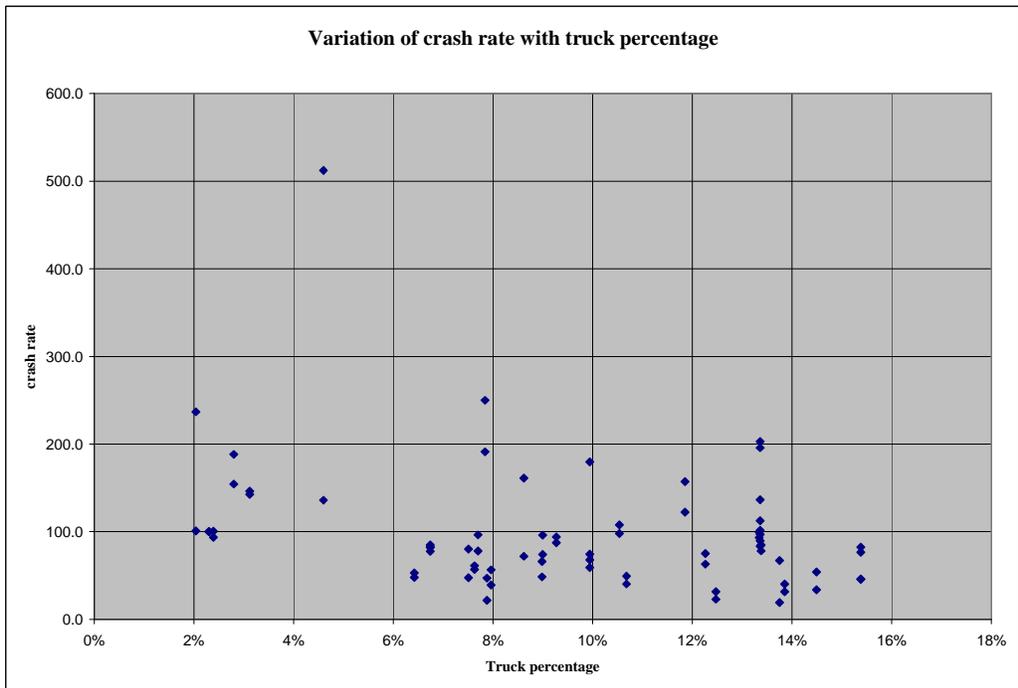
Figure B-4: Distribution of Crashes with Truck Percentage
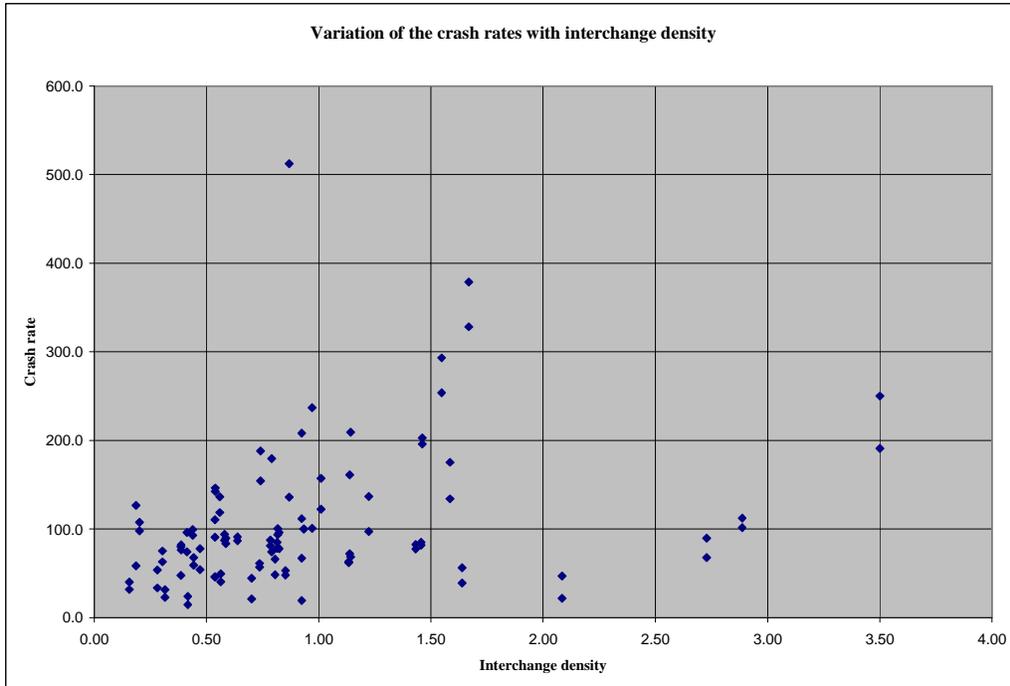
Figure B-5: Distribution of Crashes with Interchange Density

APPENDIX C: Before-After Analysis Data

Table C-1: Analysis Corridors for Before-After Analysis

Region	Roadway ID	Beginning exit	End Exit	years before	years after	Before	After
MIAMI	17075000	182	200	2	2	141	229
MIAMI	17075000/13075000	200	228	2	2	328	283
TAMPA	13075000/10075000	228	261	2	2	360	725
TAMPA	10075000	261	270	2	2	233	318
TAMPA	17075000	182	200	2	2	117	141
TAMPA	17075000/13075000	200	228	2	2	220	284
TAMPA	13075000/10075000	228	261	2	2	388	660
TAMPA	10075000	261	270	2	2	206	290
JACKSONVILLE	72290000	362	366	2	2	115	48
JACKSONVILLE	72290000	362	366	2	2	108	79
MIAMI	87471000	12	18	1	1	48	95
MIAMI	87471000	18	26B	1	1	150	180
MIAMI	87471000	26B	39	1	1	78	106
MIAMI	87471000/86471000/86470000	39	54	1	1	161	192
MIAMI	87471000	12	18	1	1	49	73
MIAMI	87471000	18	26B	1	1	137	126
MIAMI	87471000	26B	39	1	1	107	129
MIAMI	87471000/86471000/86470000	39	54	1	1	140	182

Table C-2: Naïve Before-After data

Section number	Years before	Years After	Crashes before	Crashes After	Duration ratio	Predicted Crashes	Variance
1	2	2	141	229	1	141	141
2	2	2	328	283	1	328	328
3	2	2	360	725	1	360	360
4	2	2	233	318	1	233	233
5	2	2	117	141	1	117	117
6	2	2	220	284	1	220	220
7	2	2	388	660	1	388	388
8	2	2	206	290	1	206	206
9	2	2	115	48	1	115	115
10	2	2	108	79	1	108	108
11	1	1	48	95	1	48	48
12	1	1	150	180	1	150	150
13	1	1	78	106	1	78	78
14	1	1	161	192	1	161	161
15	1	1	49	73	1	49	49
16	1	1	137	126	1	137	137
17	1	1	107	129	1	107	107
18	1	1	140	182	1	140	140
				4140		3086	3086

Table C-3: Improved Naïve Before-After Data

Section number	Years before	Years After	Traffic Flow before	Traffic Flow After	Crashes before	Crashes After	Duration ratio	Predicted Crashes	Variance
1	2	2	23328	35388	141	229	1	141	141
2	2	2	48632	53011	328	283	1	328	328
3	2	2	38789	54678	360	725	1	360	360
4	2	2	29617	54608	233	318	1	233	233
5	2	2	19672	33487	117	141	1	117	117
6	2	2	41012	42989	220	284	1	220	220
7	2	2	32711	42320	388	660	1	388	388
8	2	2	24975	42267	206	290	1	206	206
9	2	2	36598	36598	115	48	1	115	115
10	2	2	33152	33152	108	79	1	108	108
11	1	1	69948	76442	48	95	1	48	48
12	1	1	70528	69155	150	180	1	150	150
13	1	1	48086	47526	78	106	1	78	78
14	1	1	61398	56740	161	192	1	161	161
15	1	1	50652	52858	49	73	1	49	49
16	1	1	51072	47886	137	126	1	137	137
17	1	1	32164	31971	107	129	1	107	107
18	1	1	41069	43267	140	182	1	140	140
			41855.72	47463.50		4140		3086	3086
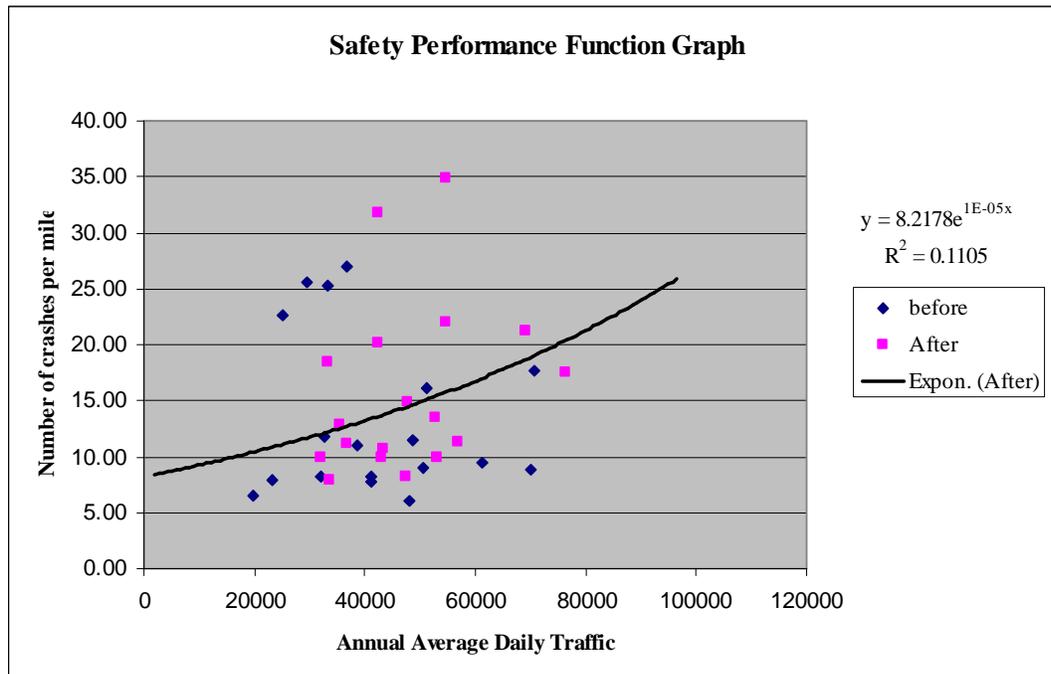
Figure C-1: Safety Performance Function for Collected Data

The equation shown on the graph:

$$y = 8.2178e^{1E-05x}$$
$$R^2 = 0.1105$$

Table C-4: Comparison Group Before-After Data

Treatment sites							
Section number	Years before	Years After	Crashes before	Crashes After	Duration ratio	Predicted Crashes	Variance
1	2	2	141	229	1	141	141
2	2	2	328	283	1	328	328
3	2	2	360	725	1	360	360
4	2	2	233	318	1	233	233
5	2	2	117	141	1	117	117
6	2	2	220	284	1	220	220
7	2	2	388	660	1	388	388
8	2	2	206	290	1	206	206
9	2	2	115	48	1	115	115
10	2	2	108	79	1	108	108
		Sum	2216	3057		2216	2216

Ratio of the treatment sites   1.38

Comparison sites							
Section number	Years before	Years After	Crashes before	Crashes After	Duration ratio	Predicted Crashes	Variance
1	2	2	99	104	1	99	99
2	2	2	401	469	1	401	401
3	2	2	700	1088	1	700	700
4	2	2	88	69	1	88	88
5	2	2	364	510	1	364	364
6	2	2	87	115	1	87	87
7	2	2	379	496	1	379	379
8	2	2	544	687	1	544	544
9	2	2	120	139	1	120	120
10	2	2	419	566	1	419	419
11	2	2	493	389	1	493	493
12	2	2	499	444	1	499	499
13	2	2	469	362	1	469	469
14	2	2	631	570	1	631	631
15	2	2	727	462	1	727	727
16	2	2	211	171	1	211	211
17	2	2	541	428	1	541	541
18	2	2	132	144	1	132	132
		Sum	6904	7213		6904	6904

Ratio of the Comparison sites   1.045

Table C-5: Empirical Bayes Before-After Data

Region	years before	years after	Before	After	Length	truck%	Number of interchanges	Number of on ramps	Number of off ramps	Number of Lanes	Total AADT	FFS(using BFFS = 70)
MIAMI	2	2	141	229	17.81	0.14	5	10	9	2	35388	64.2
MIAMI	2	2	328	283	28.56	0.12	9	9	10	3	53011	65.7
TAMPA	2	2	360	725	32.86	0.12	10	6	4	2	54678	64.2
TAMPA	2	2	233	318	9.12	0.13	4	13	17	2	54608	64.2
TAMPA	2	2	117	141	17.81	0.14	5	10	10	2	33487	64.2
TAMPA	2	2	220	284	28.56	0.12	9	5	3	3	42989	65.7
TAMPA	2	2	388	660	32.86	0.12	10	4	4	3	42320	65.7
TAMPA	2	2	206	290	9.12	0.13	4	11	8	3	42267	65.7
JACKSONVILLE	2	2	115	48	4.27	0.10	3	3	3	3	36598	65.7
JACKSONVILLE	2	2	108	79	4.27	0.10	3	4	4	3	33152	65.7
MIAMI	1	1	48	95	5.43	0.08	4	4	3	2	76442	64.2
MIAMI	1	1	150	180	8.49	0.08	7	4	4	3	69155	64.5
MIAMI	1	1	78	106	12.95	0.08	5	4	5	3	47526	65.7
MIAMI	1	1	161	192	16.96	0.09	7	4	5	3	56740	65.7
MIAMI	1	1	49	73	5.43	0.08	4	2	3	3	52858	65.7
MIAMI	1	1	137	126	8.49	0.08	7	4	3	3	47886	64.5
MIAMI	1	1	107	129	12.95	0.08	5	4	4	3	31971	65.7
MIAMI	1	1	140	182	16.96	0.09	7	3	2	3	43267	65.7

Table C-6: Regression Analysis for the Empirical Bayes Analysis

Regression Statistics	
Multiple R	0.908
R Square	0.825
Adjusted R Square	0.670
Standard Error	57.682
Observations	18

Analysis of Variance

	df	SS	MS	F	Significance F
Regression	8	141317.43	17664.68	5.31	0.01
Residual	9	29945.01	3327.22		
Total	17	171262.44			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	-5385.31	6217.61	-0.87	0.41	-19450.53	8679.91	-19450.53	8679.91
Length	-8.36	12.56	-0.67	0.52	-36.78	20.05	-36.78	20.05
Percent Trucks	2005.80	1503.22	1.33	0.21	-1394.73	5406.32	-1394.73	5406.32
Interchanges	63.16	51.21	1.23	0.25	-52.68	178.99	-52.68	178.99
On Ramps	-2.80	16.41	-0.17	0.87	-39.92	34.33	-39.92	34.33
Off Ramps	7.35	10.12	0.73	0.49	-15.54	30.24	-15.54	30.24
Number of lanes	-97.24	182.19	-0.53	0.61	-509.39	314.90	-509.39	314.90
Total AADT	0.00	0.00	-0.01	0.99	-0.01	0.01	-0.01	0.01
Free Flow Speed	81.89	101.82	0.80	0.44	-148.46	312.23	-148.46	312.23

Observation	Predicted crashes	Residuals		Percentile	Crashes
1	172.20	-31.20		2.78	48
2	329.91	-1.91		8.33	49
3	291.58	68.42		13.89	78
4	208.71	24.29		19.44	107
5	179.59	-62.59		25.00	108
6	289.85	-69.85		30.56	115
7	323.00	65.00		36.11	117
8	173.97	32.03		41.67	137
9	69.30	45.70		47.22	140
10	73.91	34.09		52.78	141
11	46.91	1.09		58.33	150
12	146.97	3.03		63.89	161
13	85.62	-7.62		69.44	206
14	208.15	-47.15		75.00	220
15	78.55	-29.55		80.56	233
16	140.03	-3.03		86.11	328
17	78.57	28.43		91.67	360
18	189.16	-49.16		97.22	388

Figure C-2: Graphs of Residuals Produced by the Regressor Variables

Truck Percent Residual Plot

Number of Interchanges Residual Plot

Figure C-2 Continues

Number of On Ramps Residual Plot

Number of Off Ramps Residual Plot

Figure C-2 Continues

Total AADT Residual Plot

Number of Lanes Residual Plot
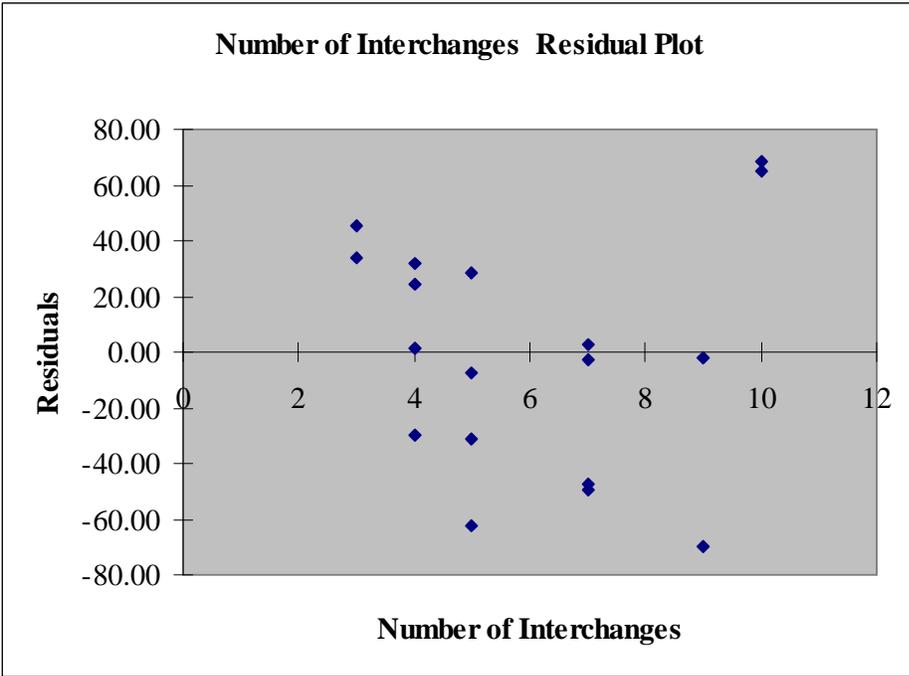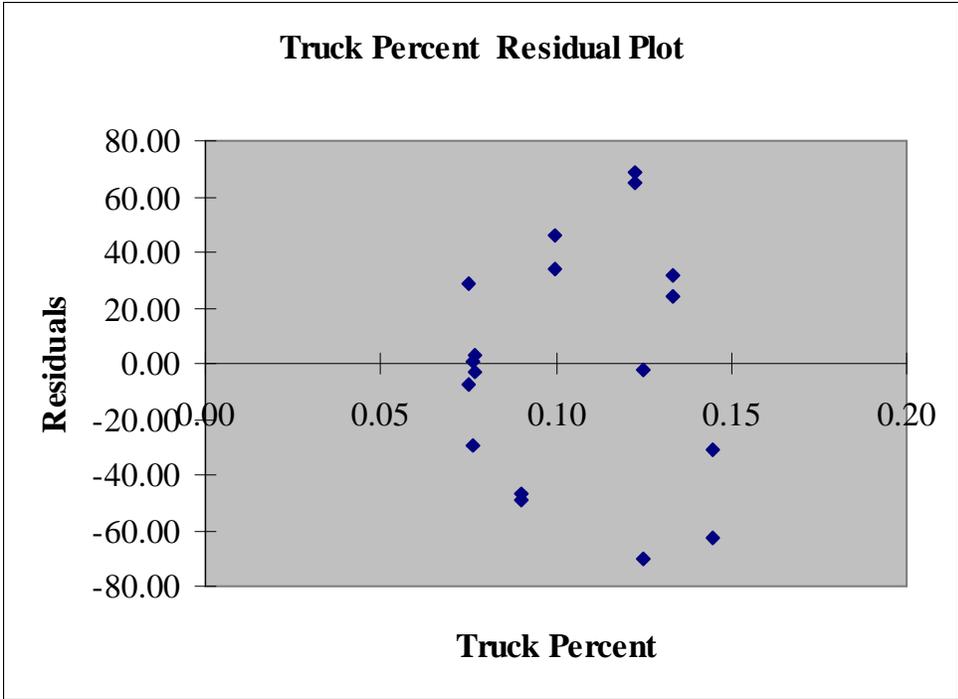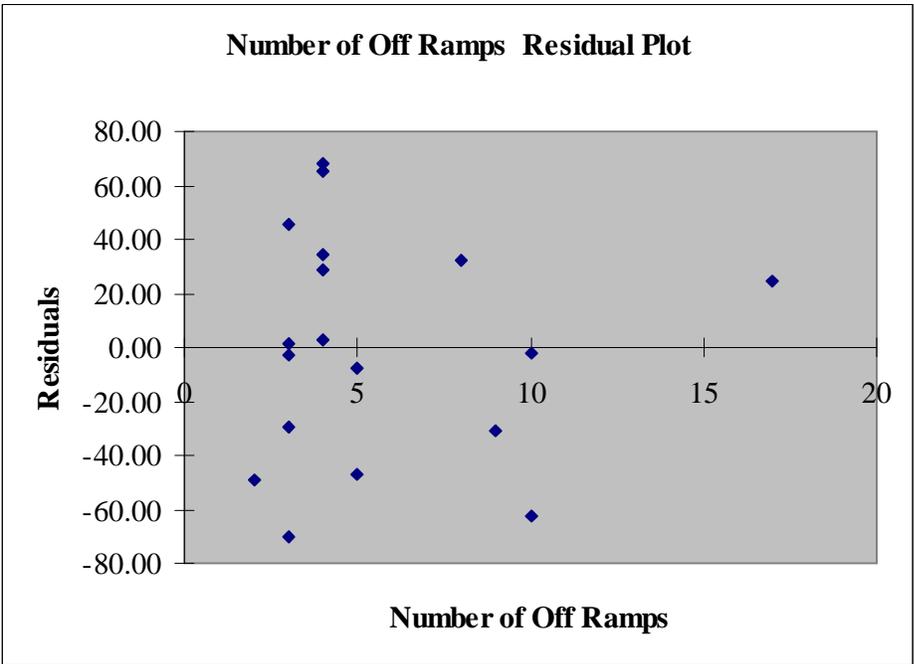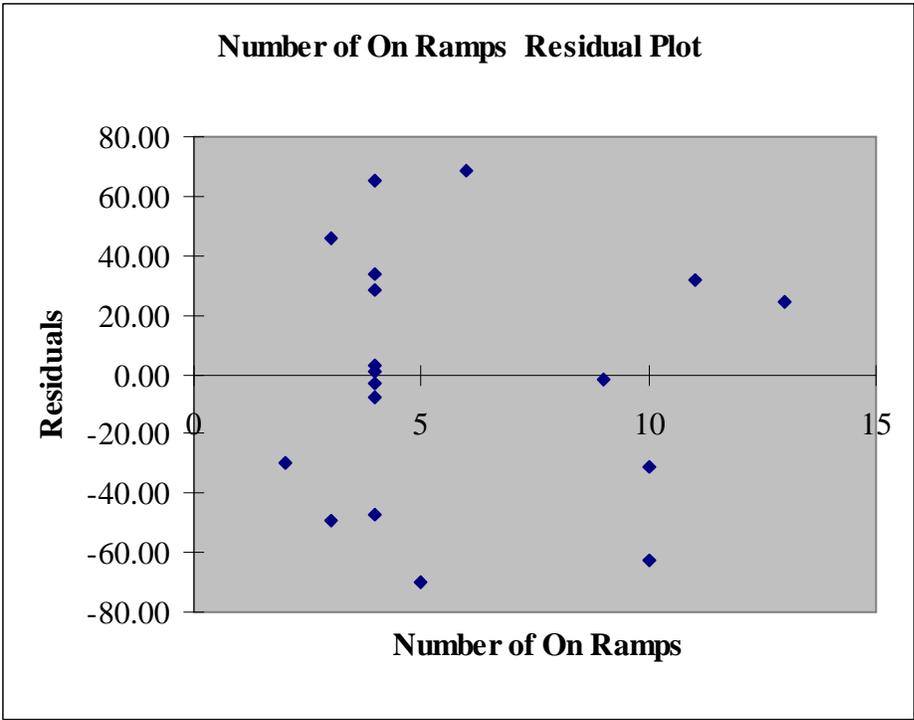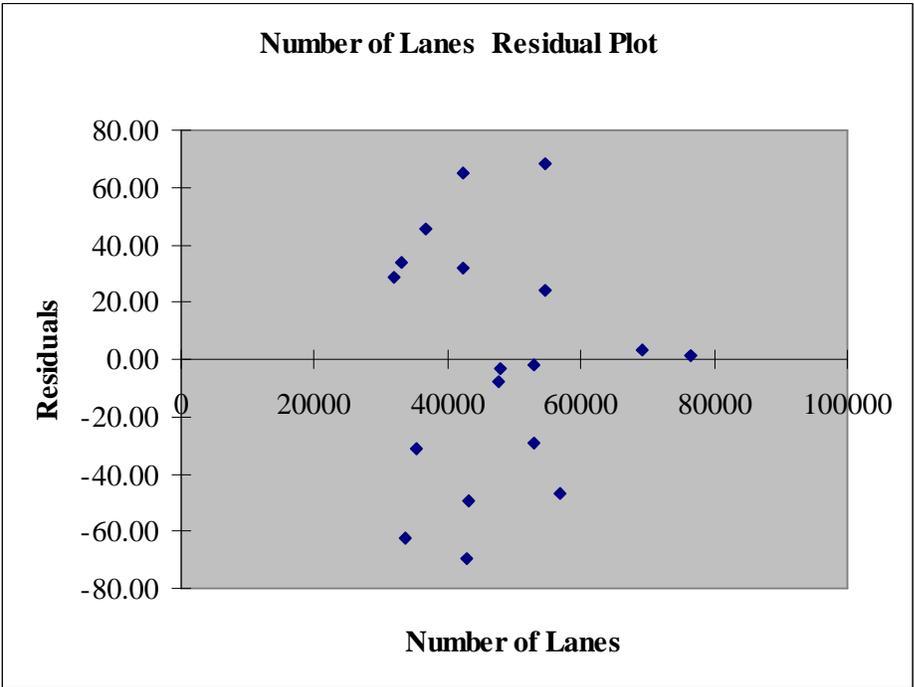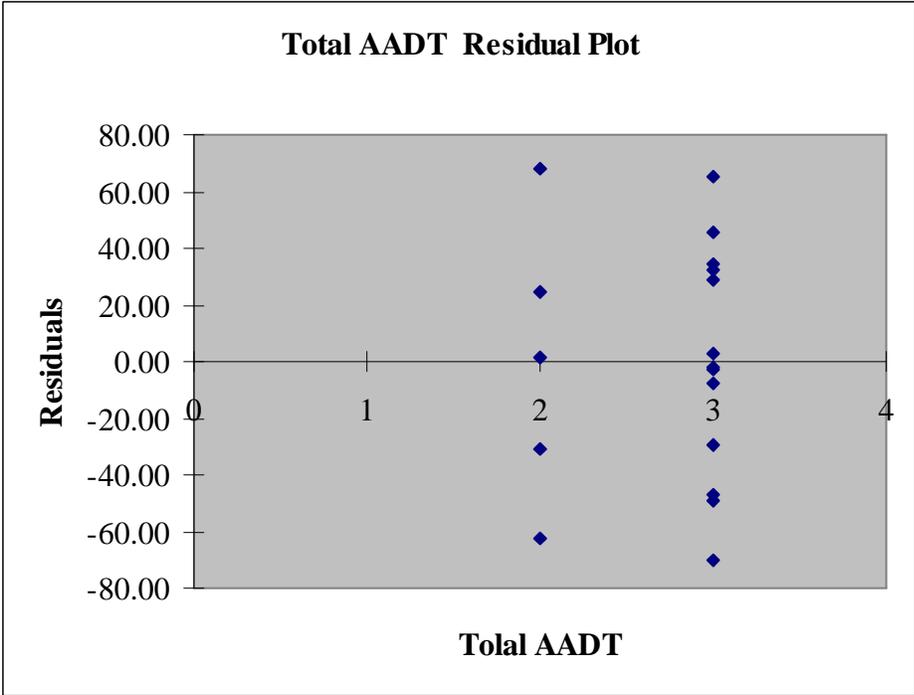
Figure C-2 Continues

Free Flow Speed Residual Plot

Normal Probability Plot
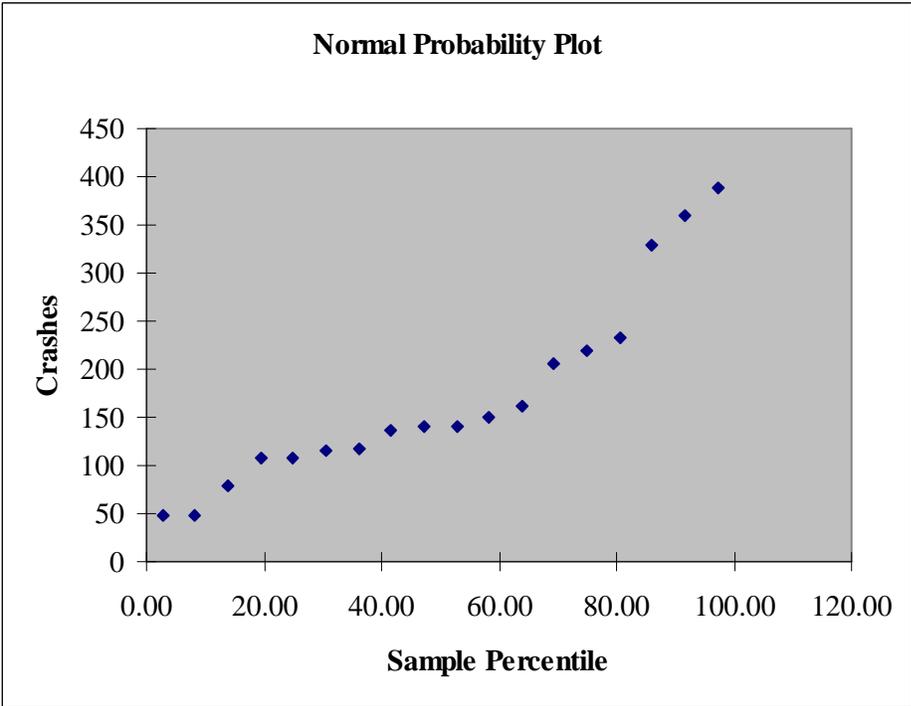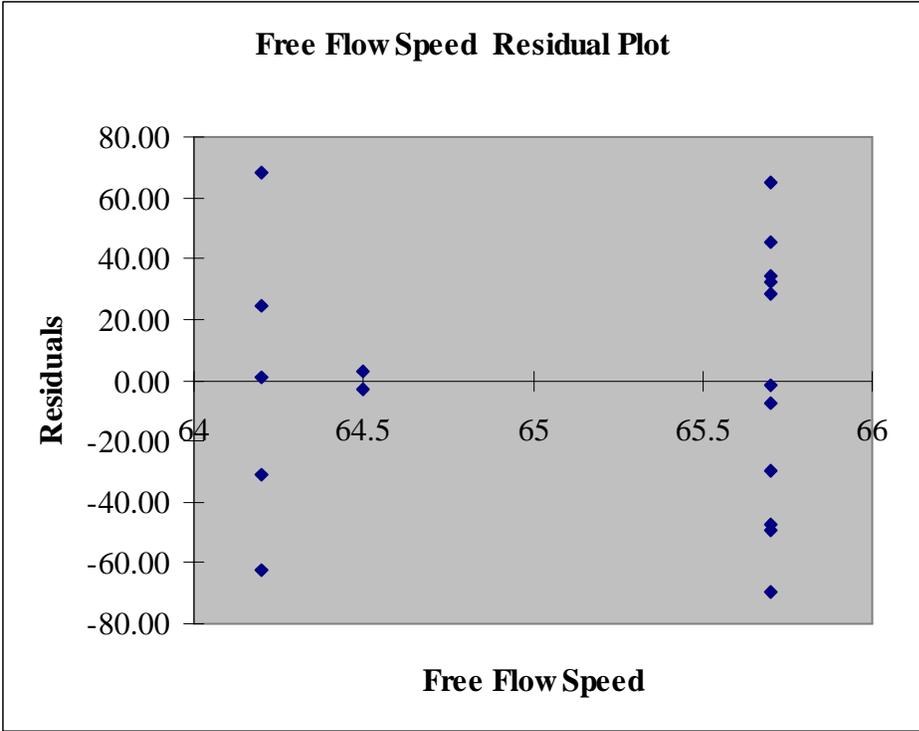
Figure C-2 Continues

APPENDIX D: Crash Prediction Model Data

Table D-1: Distribution of the 2005 Data

Number of Crashes					
Lower limit	Upper Limit	Frequency	Cumulative Frequency	Percentile	Cumulative Percentile
0	30	27	27	21%	21%
31	60	19	46	15%	36%
61	90	16	62	13%	48%
91	120	10	72	8%	56%
121	150	10	82	8%	64%
151	180	10	92	8%	72%
181	210	3	95	2%	74%
211	240	4	99	3%	77%
241	270	3	102	2%	80%
271	300	8	110	6%	86%
301	330	2	112	2%	88%
331	360	0	112	0%	88%
361	390	2	114	2%	89%
391	420	2	116	2%	91%
421	450	1	117	1%	91%
451	480	0	117	0%	91%
481	510	0	117	0%	91%
511	540	1	118	1%	92%
541	570	3	121	2%	95%
571	600	1	122	1%	95%
601	630	0	122	0%	95%
631	660	1	123	1%	96%
661	690	1	124	1%	97%
691	720	1	125	1%	98%
721	750	0	125	0%	98%
751	780	1	126	1%	98%
781	810	0	126	0%	98%
811	840	0	126	0%	98%
841	870	0	126	0%	98%
871	900	0	126	0%	98%
901	930	0	126	0%	98%
931	960	1	127	1%	99%
961	990	0	127	0%	99%
991	1020	0	127	0%	99%
1021	1050	0	127	0%	99%
1051	1080	0	127	0%	99%
1081	1110	0	127	0%	99%
1111	1140	0	127	0%	99%
1141	1170	1	128	1%	100%

Crash Distribution
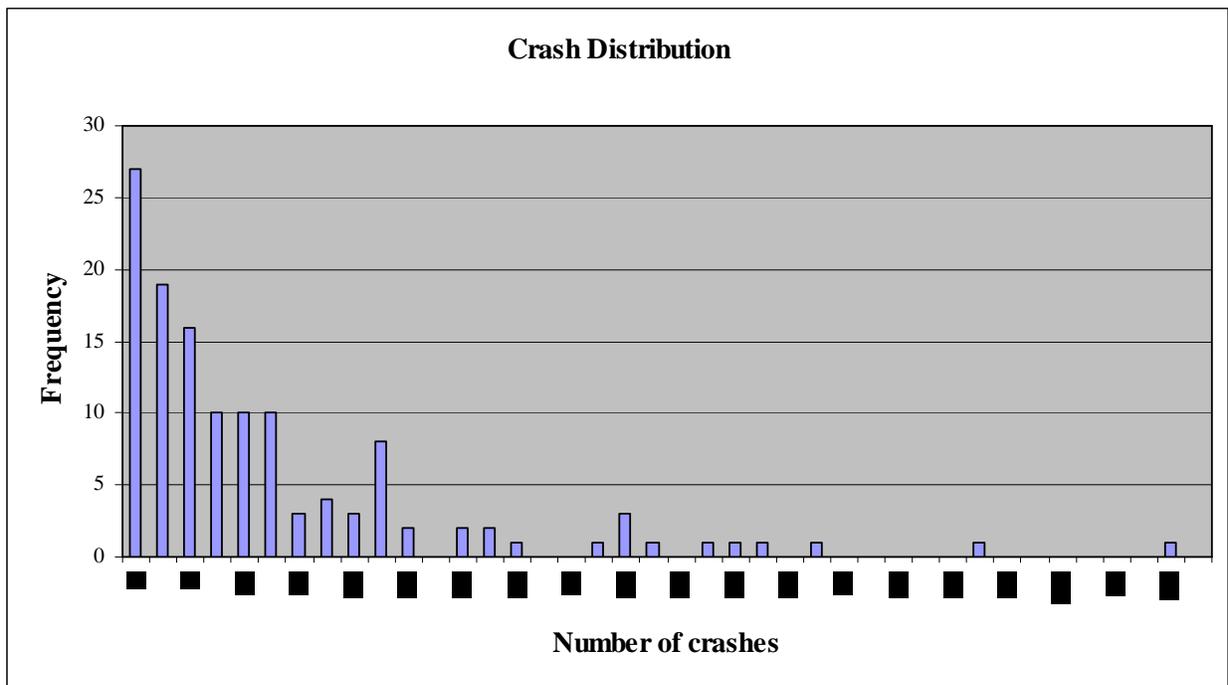
Figure D-1: 2005 Crash Distribution

Table D-2: Crash Data Used for Modeling (Crashes as the Response variable)

Region	Roadway ID	Crashes	Length	truck%	Number of interchanges	Interchange Density	Number of on ramps
TAMPA	15003000	4	1.439	0.0788	3	2.08	0
TAMPA	15003000	1	1.439	0.0788	3	2.08	0
MIAMI	87004000	17	0.857	0.0784	3	3.50	1
MIAMI	87004000	48	3.411	0.1336	2	0.59	1
MIAMI	87004000	29	0.857	0.0784	3	3.50	2
MIAMI	87004000	32	3.411	0.1336	2	0.59	0
TAMPA	15190000	11	10.28	0.0884	2	0.19	6
TAMPA	15190000	6	3.353	0.1023	0	0.00	2
TAMPA	15190000/10190000	0	0.935	0.082	1	1.07	1
TAMPA	10190000	40	4.724	0.0798	5	1.06	1
TAMPA	10190000	12	0.733	0.0632	1	1.36	1
TAMPA	10190000	275	14.39	0.07601	9	0.63	7
TAMPA	10190000	691	7.273	0.0894	10	1.37	5
TAMPA	10190000	31	0.498	0.1023	2	4.02	6
TAMPA	10190000	265	15.523	0.064	8	0.52	2
TAMPA	15190000	8	10.28	0.0884	2	0.19	4
TAMPA	15190000	7	3.353	0.1023	0	0.00	1
TAMPA	15190000/10190000	3	0.935	0.082	1	1.07	1
TAMPA	10190000	64	4.724	0.0798	5	1.06	1
TAMPA	10190000	14	0.733	0.0632	1	1.36	1
TAMPA	10190000	275	14.39	0.07601	9	0.63	1

Region	Roadway ID	Crashes	Length	truck%	Number of interchanges	Interchange Density	Number of on ramps
TAMPA	10190000	384	7.273	0.0894	10	1.37	7
TAMPA	10190000	54	0.498	0.1023	2	4.02	4
TAMPA	10190000	318	15.523	0.064	8	0.52	7
JACKSONVILLE	72001000	240	20.659	0.1538	8	0.39	9
JACKSONVILLE	72001000	78	14.852	0.1538	8	0.54	8
JACKSONVILLE	72001000	224	20.659	0.1538	8	0.39	9
JACKSONVILLE	72001000	69	14.852	0.1538	8	0.54	8
TAMPA	15002000	0	1.22	0.0796	2	1.64	6
TAMPA	15002000	2	1.22	0.0796	2	1.64	7
MIAMI	87200000	21	1.292	0.0239	2	1.55	0
MIAMI	87200000	1	1.292	0.0239	2	1.55	0
ORLANDO	92130000	7	2.162	0.1375	2	0.93	0
ORLANDO	92130000/75280000	118	9.935	0.08985	8	0.81	6
ORLANDO	75280000	75	4.691	0.0642	4	0.85	3
ORLANDO	75280000	67	4.397	0.0642	9	2.05	8
ORLANDO	75280000	145	7.68	0.0674	10	1.30	7
ORLANDO	75280000	16	1.067	0.0735	0	0.00	1
ORLANDO	92130000	24	2.162	0.1375	2	0.93	1
ORLANDO	92130000/75280000	156	9.935	0.08985	8	0.81	6
ORLANDO	75280000	71	4.691	0.0642	4	0.85	5
ORLANDO	75280000	76	4.397	0.0642	9	2.05	6
ORLANDO	75280000	175	7.68	0.0674	10	1.30	10
ORLANDO	75280000	8	1.067	0.0735	0	0.00	2
TAMPA	10190000	87	1.851	0.1117	2	1.08	2
TAMPA	10190000	25	1.06	0.0627	1	0.94	1
TAMPA	10190000	79	4.656	0.0843	4	0.86	6
TAMPA	10190000	34	2.124	0.1023	2	0.94	1
TAMPA	10190000	171	14.826	0.1002	6	0.40	6
TAMPA	10190000	117	1.851	0.1117	2	1.08	2
TAMPA	10190000	51	1.06	0.0627	1	0.94	1
TAMPA	10190000	57	4.656	0.0843	4	0.86	5
TAMPA	10190000	42	2.124	0.1023	2	0.94	1
TAMPA	10190000	165	14.826	0.1002	6	0.40	6
MIAMI	87075000	63	4.905	0.1338	4	0.82	4
MIAMI	87075000/86075000	107	12.418	0.1068	7	0.56	5
MIAMI	86075000	50	32.049	0.1385	5	0.16	4
MIAMI	87075000	64	4.905	0.1338	4	0.82	4
MIAMI	87075000/86075000	131	12.418	0.1068	7	0.56	6
MIAMI	86075000	53	32.049	0.1385	5	0.16	4
MIAMI	87270000	77	2.771	0.1336	8	2.89	2
MIAMI	87270000	57	2.771	0.1336	8	2.89	1
JACKSONVILLE	72280000/72020000	212	14.11	0.0996	16	1.13	2
JACKSONVILLE	72280000/72290000	244	10.089	0.0996	16	1.59	4
JACKSONVILLE	72290000	13	4.273	0.0996	3	0.70	3
JACKSONVILLE	72280000/72020000	187	14.11	0.0996	16	1.13	2

Region	Roadway ID	Crashes	Length	truck%	Number of interchanges	Interchange Density	Number of on ramps
JACKSONVILLE	72280000/72290000	288	10.089	0.0996	16	1.59	3
JACKSONVILLE	72290000	23	4.273	0.0996	3	0.70	4
TAMPA	16470000	13	15.18	0.0994	9	0.59	0
TAMPA	16470000	2	2.92	0.0994	1	0.34	0
TAMPA	16470000	14	15.18	0.0994	9	0.59	0
TAMPA	16470000	1	2.92	0.0994	1	0.34	0
TAMPA	10002000	60	14.063	0.0862	16	1.14	1
TAMPA	10002000	109	14.063	0.0862	16	1.14	3
MIAMI	87260000	276	6.353	0.0204	5	0.79	8
MIAMI	87260000	105	1.964	0.028	1	0.51	3
TAMPA	87260000	280	3.935	0.028	3	0.76	4
TAMPA	87260000	45	2.193	0.028	1	0.46	2
MIAMI	87260000	53	8.67	0.0312	3	0.35	4
MIAMI	87260000	193	7.207	0.0204	5	0.69	7
MIAMI	87260000	123	1.964	0.028	1	0.51	3
MIAMI	87260000	297	3.935	0.028	3	0.76	4
MIAMI	87260000	85	2.193	0.028	1	0.46	3
MIAMI	87260000	44	8.67	0.0312	3	0.35	10
MIAMI	87200000	123	4.284	0.023	4	0.93	3
MIAMI	87200000	393	8.557	0.0239	7	0.82	9
MIAMI	87200000	118	4.284	0.023	4	0.93	2
MIAMI	87200000	537	8.557	0.0239	7	0.82	9
MIAMI	86472000	113	20.673	0.0927	12	0.58	11
MIAMI	86472000	101	20.673	0.0927	12	0.58	8
MIAMI	87005000	176	6.903	0.046	6	0.87	2
MIAMI	87005000	224	6.903	0.046	6	0.87	4
MIAMI	86470000	196	15.815	0.0994	7	0.44	5
MIAMI	86470000/93470000	545	44.525	0.1054	9	0.20	8
MIAMI	86470000	165	15.815	0.0994	7	0.44	7
MIAMI	86470000/93470000	445	44.525	0.1054	9	0.20	8
MIAMI	17075000	124	17.814	0.1449	5	0.28	10
MIAMI	17075000/13075000	147	28.555	0.1247	9	0.32	9
TAMPA	13075000/10075000	364	32.855	0.1226	10	0.30	6
TAMPA	10075000	169	9.12	0.1334	4	0.44	13
TAMPA	17075000	73	17.814	0.1449	5	0.28	10
TAMPA	17075000/13075000	141	28.555	0.1247	9	0.32	5
TAMPA	13075000/10075000	312	32.855	0.1226	10	0.30	4
TAMPA	10075000	142	9.12	0.1334	4	0.44	11
TAMPA	87270000	92	1.635	0.1336	2	1.22	2
TAMPA	87270000	679	7.525	0.1336	11	1.46	8
MIAMI	87270000	287	7.422	0.1185	7	0.94	4
MIAMI	93220000	1146	21.71	0.115	15	0.69	12
MIAMI	93220000	52	5.953	0.1231	2	0.34	10
MIAMI	87270000	58	1.635	0.1336	2	1.22	2
MIAMI	87270000	579	7.525	0.1336	11	1.46	11

Region	Roadway ID	Crashes	Length	truck%	Number of interchanges	Interchange Density	Number of on ramps
MIAMI	87270000/86070000	401	7.422	0.1185	7	0.94	10
MIAMI	86070000	251	5.447	0.1185	5	0.92	4
MIAMI	86070000	560	15.669	0.1279	10	0.64	4
MIAMI	86070000/93220000	561	18.107	0.115	9	0.50	13

Table D-2 Continues

Region	Roadway ID	Crashes	Length	truck%	Number of interchanges	Interchange Density	Number of on ramps
MIAMI	93220000	946	21.71	0.115	15	0.69	12
MIAMI	93220000	44	5.953	0.1231	2	0.34	12
MIAMI	87471000	86	5.428	0.0763	4	0.74	4
MIAMI	87471000	167	8.494	0.077	7	0.82	4
MIAMI	87471000	107	12.949	0.0751	5	0.39	4
MIAMI	87471000/86471000/86470000	176	16.955	0.09	7	0.41	4
MIAMI	87471000	65	5.428	0.0763	4	0.74	2
MIAMI	87471000	143	8.494	0.077	7	0.82	4
MIAMI	87471000	122	12.949	0.0751	5	0.39	4
MIAMI	87471000/86471000/86470000	156	16.955	0.09	7	0.41	3

Table D-2 Continues

Region	Roadway ID	Number of off ramps	Truck Lane Restriction	Region	Number of Lanes	Total AADT	AADT/lane
TAMPA	15003000	0	0	3	2	17518	8759.0
TAMPA	15003000	0	0	3	2	12149	6074.5
MIAMI	87004000	4	0	4	2	51884	25942.0
MIAMI	87004000	0	0	4	2	46622	23311.0
MIAMI	87004000	1	0	4	3	46047	15349.0
MIAMI	87004000	1	0	4	3	41378	13792.7
TAMPA	15190000	5	0	3	2	26106	13053.0
TAMPA	15190000	2	0	3	2	24863	12431.5
TAMPA	15190000/10190000	1	0	3	2	27487	13743.5
TAMPA	10190000	1	0	3	3	43022	14340.7
TAMPA	10190000	1	0	3	3	66136	22045.3
TAMPA	10190000	1	0	3	3	78942	26314.0
TAMPA	10190000	6	0	3	3	79891	26630.3
TAMPA	10190000	5	0	3	3	80022	26674.0
TAMPA	10190000	8	0	3	3	67720	22573.3
TAMPA	15190000	5	0	3	2	18519	9259.5
TAMPA	15190000	1	0	3	2	17638	8819.0
TAMPA	15190000/10190000	1	0	3	2	19500	9750.0
TAMPA	10190000	1	0	3	2	29835	14917.5
TAMPA	10190000	1	0	3	3	45864	15288.0
TAMPA	10190000	5	0	3	3	54745	18248.3
TAMPA	10190000	5	0	3	3	65180	21726.7
TAMPA	10190000	6	0	3	2	58978	29489.0
TAMPA	10190000	7	0	3	3	55251	18417.0
JACKSONVILLE	72001000	8	0	2	3	55376	18458.7

Region	Roadway ID	Number of off ramps	Truck Lane Restriction	Region	Number of Lanes	Total AADT	AADT/lane
JACKSONVILLE	72001000	6	0	2	2	31272	15636.0
JACKSONVILLE	72001000	10	0	2	3	50162	16720.7
JACKSONVILLE	72001000	8	0	2	2	27867	13933.5
TAMPA	15002000	5	0	3	2	11495	5747.5
TAMPA	15002000	8	0	3	2	7972	3986.0
MIAMI	87200000	0	0	4	2	54296	27148.0
MIAMI	87200000	0	0	4	2	49204	24602.0
ORLANDO	92130000	1	0	1	2	46000	23000.0
ORLANDO	92130000/75280000	7	0	1	3	57032	19010.7
ORLANDO	75280000	3	0	1	4	82357	20589.3
ORLANDO	75280000	7	0	1	3	77871	25957.0
ORLANDO	75280000	13	0	1	4	97306	24326.5
ORLANDO	75280000	2	0	1	3	83801	27933.7
ORLANDO	92130000		0	1	2	47250	23625.0
ORLANDO	92130000/75280000	5	0	1	3	66912	22304.0
ORLANDO	75280000	4	0	1	4	85444	21361.0
ORLANDO	75280000	7	0	1	4	73129	18282.3
ORLANDO	75280000	7	0	1	3	91382	30460.7
ORLANDO	75280000	1	0	1	3	78699	26233.0
TAMPA	10190000	2	0	3	2	63479	31739.5
TAMPA	10190000	1	0	3	3	60231	20077.0
TAMPA	10190000	5	0	3	3	63971	21323.7
TAMPA	10190000	1	0	3	3	75879	25293.0
TAMPA	10190000	6	0	3	3	63184	21061.3
TAMPA	10190000	2	0	3	2	44021	22010.5
TAMPA	10190000	1	0	3	3	41769	13923.0
TAMPA	10190000	4	0	3	3	44362	14787.3
TAMPA	10190000	1	0	3	3	52621	17540.3
TAMPA	10190000	6	0	3	3	43484	14494.7
MIAMI	87075000	3	0	4	4	61525	15381.3
MIAMI	87075000/86075000	10	0	4	4	70327	17581.8
MIAMI	86075000	4	0	4	2	13786	6893.0
MIAMI	87075000	5	0	4	4	52642	13160.5
MIAMI	87075000/86075000	10	0	4	4	60174	15043.5
MIAMI	86075000	5	0	4	3	10838	3612.7
MIAMI	87270000	4	0	4	3	71258	23752.7
MIAMI	87270000	2	0	4	3	63241	21080.3
JACKSONVILLE	72280000/72020000	2	0	2	3	74390	24796.7
JACKSONVILLE	72280000/72290000	4	0	2	3	50212	16737.3
JACKSONVILLE	72290000	3	0	2	3	36598	12199.3
JACKSONVILLE	72280000/72020000	2	0	2	3	67320	22440.0
JACKSONVILLE	72280000/72290000	3	0	2	3	45543	15181.0
JACKSONVILLE	72290000	4	0	2	3	33152	11050.7
TAMPA	16470000	0	0	3	2	11855	5927.5
TAMPA	16470000	0	0	3	2	3311	1655.5

Region	Roadway ID	Number of off ramps	Truck Lane Restriction	Region	Number of Lanes	Total AADT	AADT/lane
TAMPA	16470000	0	0	3	2	8734	4367.0
TAMPA	16470000	0	0	3	2	2439	1219.5
TAMPA	10002000	2	0	3	2	20821	10410.5
TAMPA	10002000	1	0	3	2	16452	8226.0
MIAMI	87260000	6	0	4	3	91128	30376.0
MIAMI	87260000	3	0	4	4	91260	22815.0
TAMPA	87260000	4	0	3	4	90062	22515.5
TAMPA	87260000	4	0	3	4	73361	18340.3
MIAMI	87260000	9	0	4	3	60378	20126.0
MIAMI	87260000	9	0	4	3	29015	9671.7
MIAMI	87260000	3	0	4	4	89740	22435.0
MIAMI	87260000	4	0	4	4	88562	22140.5
MIAMI	87260000	2	0	4	4	72139	18034.8
MIAMI	87260000	6	0	4	3	59372	19790.7
MIAMI	87200000	4	0	4	3	78648	26216.0
MIAMI	87200000	9	0	4	3	112484	37494.7
MIAMI	87200000	6	0	4	3	32602	10867.3
MIAMI	87200000	10	0	4	3	40373	13457.7
MIAMI	86472000	11	0	4	2	33790	16895.0
MIAMI	86472000	10	0	4	2	29108	14554.0
MIAMI	87005000	4	0	4	3	58152	19384.0
MIAMI	87005000	4	0	4	3	18515	6171.7
MIAMI	86470000	7	0	4	3	57494	19164.7
MIAMI	86470000/93470000	8	0	4	2	40260	20130.0
MIAMI	86470000	6	0	4	3	42356	14118.7
MIAMI	86470000/93470000	8	0	4	2	30360	15180.0
MIAMI	17075000	9	1	4	2	35388	17694.0
MIAMI	17075000/13075000	10	1	4	3	53011	17670.3
TAMPA	13075000/10075000	4	1	3	2	54678	27339.0
TAMPA	10075000	17	1	3	2	54608	27304.0
TAMPA	17075000	10	1	3	2	33487	16743.5
TAMPA	17075000/13075000	3	1	3	3	42989	14329.7
TAMPA	13075000/10075000	4	1	3	3	42320	14106.7
TAMPA	10075000	8	1	3	3	42267	14089.0
TAMPA	87270000	2	1	3	3	112847	37615.7
TAMPA	87270000	8	1	3	4	121942	30485.5
MIAMI	87270000	4	1	4	5	116888	23377.6
MIAMI	93220000	12	1	4	4	86278	21569.5
MIAMI	93220000	9	1	4	4	50993	12748.3
MIAMI	87270000	2	1	4	3	100153	33384.3
MIAMI	87270000	9	1	4	5	108224	21644.8
MIAMI	87270000/86070000	8	1	4	5	99812	19962.4
MIAMI	86070000	4	1	4	4	124964	31241.0
MIAMI	86070000	4	1	4	4	108096	27024.0
MIAMI	86070000/93220000	11	1	4	4	71017	17754.3

Region	Roadway ID	Number of off ramps	Truck Lane Restriction	Region	Number of Lanes	Total AADT	AADT/lane
MIAMI	93220000	12	1	4	4	55837	13959.3
MIAMI	93220000	9	1	4	4	33001	8250.3
MIAMI	87471000	3	1	4	2	76442	38221.0
MIAMI	87471000	4	1	4	3	69155	23051.7
MIAMI	87471000	5	1	4	3	47526	15842.0
MIAMI	87471000/86471000/86470000	5	1	4	3	56740	18913.3
MIAMI	87471000	3	1	4	3	52858	17619.3
MIAMI	87471000	3	1	4	3	47886	15962.0
MIAMI	87471000	4	1	4	3	31971	10657.0
MIAMI	87471000/86471000/86470000	2	1	4	3	43267	14422.3

Table D-2 Continues

Region	Roadway ID	FFS(using BFFS = 70)	HOV	Female	und18	above65	white
TAMPA	15003000	58.0	0	0.521	0.199	0.21	0.859
TAMPA	15003000	58.0	0	0.521	0.199	0.21	0.859
MIAMI	87004000	58.0	0	0.516	0.218	0.136	0.764
MIAMI	87004000	64.2	0	0.516	0.218	0.136	0.764
MIAMI	87004000	59.5	0	0.516	0.218	0.136	0.764
MIAMI	87004000	65.7	0	0.516	0.218	0.136	0.764
TAMPA	15190000	64.2	0	0.521	0.199	0.21	0.859
TAMPA	15190000	64.2	0	0.521	0.199	0.21	0.859
TAMPA	15190000/10190000	61.8	0	0.52	0.228	0.163	0.825
TAMPA	10190000	63.3	0	0.509	0.257	0.115	0.79
TAMPA	10190000	62.0	0	0.509	0.257	0.115	0.79
TAMPA	10190000	65.7	0	0.509	0.257	0.115	0.79
TAMPA	10190000	62.0	0	0.509	0.257	0.115	0.79
TAMPA	10190000	59.5	0	0.509	0.257	0.115	0.79
TAMPA	10190000	65.7	0	0.509	0.257	0.115	0.79
TAMPA	15190000	64.2	0	0.521	0.199	0.21	0.859
TAMPA	15190000	64.2	0	0.521	0.199	0.21	0.859
TAMPA	15190000/10190000	61.8	0	0.52	0.228	0.163	0.825
TAMPA	10190000	61.8	0	0.509	0.257	0.115	0.79
TAMPA	10190000	62.0	0	0.509	0.257	0.115	0.79
TAMPA	10190000	65.7	0	0.509	0.257	0.115	0.79
TAMPA	10190000	62.0	0	0.509	0.257	0.115	0.79
TAMPA	10190000	58.0	0	0.509	0.257	0.115	0.79
TAMPA	10190000	65.7	0	0.509	0.257	0.115	0.79
JACKSONVILLE	72001000	65.7	0	0.514	0.268	0.103	0.652
JACKSONVILLE	72001000	64.2	0	0.514	0.268	0.103	0.652
JACKSONVILLE	72001000	65.7	0	0.514	0.268	0.103	0.652
JACKSONVILLE	72001000	64.2	0	0.514	0.268	0.103	0.652
TAMPA	15002000	59.2	0	0.521	0.199	0.21	0.859
TAMPA	15002000	59.2	0	0.521	0.199	0.21	0.859

Region	Roadway ID	FFS(using BFFS = 70)	HOV	Female	und18	above65	white
MIAMI	87200000	59.2	0	0.516	0.249	0.136	0.764
MIAMI	87200000	59.2	0	0.516	0.249	0.136	0.764
ORLANDO	92130000	63.0	0	0.503	0.264	0.11	0.849
ORLANDO	92130000/75280000	64.5	0	0.503	0.262	0.103	0.79
ORLANDO	75280000	66.0	0	0.503	0.26	0.096	0.73
ORLANDO	75280000	59.5	0	0.503	0.26	0.096	0.73
ORLANDO	75280000	63.5	0	0.503	0.26	0.096	0.73
ORLANDO	75280000	65.7	0	0.503	0.26	0.096	0.73
ORLANDO	92130000	63.0	0	0.503	0.264	0.11	0.849
ORLANDO	92130000/75280000	64.5	0	0.503	0.262	0.103	0.79
ORLANDO	75280000	66.0	0	0.503	0.26	0.096	0.73
ORLANDO	75280000	61.0	0	0.503	0.26	0.096	0.73
ORLANDO	75280000	62.0	0	0.503	0.26	0.096	0.73
ORLANDO	75280000	65.7	0	0.503	0.26	0.096	0.73
TAMPA	10190000	61.8	0	0.509	0.257	0.115	0.79
TAMPA	10190000	64.5	0	0.509	0.257	0.115	0.79
TAMPA	10190000	64.5	0	0.509	0.257	0.115	0.79
TAMPA	10190000	64.5	0	0.509	0.257	0.115	0.79
TAMPA	10190000	65.7	0	0.509	0.257	0.115	0.79
TAMPA	10190000	61.8	0	0.509	0.257	0.115	0.79
TAMPA	10190000	64.5	0	0.509	0.257	0.115	0.79
TAMPA	10190000	64.5	0	0.509	0.257	0.115	0.79
TAMPA	10190000	64.5	0	0.509	0.257	0.115	0.79
TAMPA	10190000	65.7	0	0.509	0.257	0.115	0.79
MIAMI	87075000	66.0	0	0.516	0.294	0.136	0.764
MIAMI	87075000/86075000	67.2	0	0.52	0.247	0.139	0.737
MIAMI	86075000	64.2	0	0.515	0.246	0.142	0.71
MIAMI	87075000	66.0	0	0.516	0.249	0.136	0.764
MIAMI	87075000/86075000	67.2	0	0.515	0.247	0.139	0.737
MIAMI	86075000	65.7	0	0.515	0.246	0.142	0.71
MIAMI	87270000	59.5	0	0.516	0.249	0.136	0.764
MIAMI	87270000	59.5	0	0.516	0.249	0.136	0.764
JACKSONVILLE	72280000/72020000	63.3	0	0.514	0.268	0.103	0.652
JACKSONVILLE	72280000/72290000	60.7	0	0.514	0.268	0.103	0.652
JACKSONVILLE	72290000	65.7	0	0.514	0.268	0.103	0.652
JACKSONVILLE	72280000/72020000	63.3	0	0.514	0.268	0.103	0.652
JACKSONVILLE	72280000/72290000	60.7	0	0.514	0.268	0.103	0.652
JACKSONVILLE	72290000	65.7	0	0.514	0.268	0.103	0.652
TAMPA	16470000	64.2	0	0.508	0.247	0.177	0.83
TAMPA	16470000	64.2	0	0.508	0.247	0.177	0.83
TAMPA	16470000	64.2	0	0.508	0.247	0.177	0.83
TAMPA	16470000	64.2	0	0.508	0.247	0.177	0.83
TAMPA	10002000	61.8	0	0.509	0.257	0.115	0.79
TAMPA	10002000	61.8	0	0.509	0.257	0.115	0.79
MIAMI	87260000	64.5	0	0.516	0.249	0.136	0.764

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Region	Roadway ID	FFS(using BFFS = 70)	HOV	Female	und18	above65	white
MIAMI	87260000	67.2	0	0.516	0.249	0.136	0.764
TAMPA	87260000	66.0	0	0.516	0.249	0.136	0.764
TAMPA	87260000	67.2	0	0.516	0.249	0.136	0.764
MIAMI	87260000	65.7	0	0.516	0.249	0.136	0.764
MIAMI	87260000	65.7	0	0.516	0.249	0.136	0.764
MIAMI	87260000	67.2	0	0.516	0.249	0.136	0.764
MIAMI	87260000	66.0	0	0.516	0.249	0.136	0.764
MIAMI	87260000	67.2	0	0.516	0.249	0.136	0.764
MIAMI	87260000	65.7	0	0.516	0.249	0.136	0.764
MIAMI	87200000	64.5	0	0.516	0.249	0.136	0.764
MIAMI	87200000	64.5	0	0.516	0.249	0.136	0.764
MIAMI	87200000	64.5	0	0.516	0.249	0.136	0.764
MIAMI	87200000	64.5	0	0.516	0.249	0.136	0.764
MIAMI	86472000	64.2	0	0.515	0.246	0.142	0.71
MIAMI	86472000	64.2	0	0.515	0.246	0.142	0.71
MIAMI	87005000	64.5	0	0.516	0.249	0.136	0.764
MIAMI	87005000	64.5	0	0.516	0.249	0.136	0.764
MIAMI	86470000	65.7	0	0.515	0.246	0.142	0.71
MIAMI	86470000/93470000	64.2	0	0.514	0.247	0.179	0.759
MIAMI	86470000	65.7	0	0.515	0.246	0.142	0.71
MIAMI	86470000/93470000	64.2	0	0.514	0.231	0.179	0.759
MIAMI	17075000	64.2	0	0.522	0.168	0.297	0.936
MIAMI	17075000/13075000	65.7	0	0.518	0.192	0.262	0.913
TAMPA	13075000/10075000	64.2	0	0.516	0.237	0.171	0.84
TAMPA	10075000	64.2	0	0.509	0.257	0.115	0.79
TAMPA	17075000	64.2	0	0.522	0.168	0.297	0.936
TAMPA	17075000/13075000	65.7	0	0.518	0.192	0.262	0.913
TAMPA	13075000/10075000	65.7	0	0.516	0.237	0.171	0.84
TAMPA	10075000	65.7	0	0.509	0.257	0.115	0.79
TAMPA	87270000	63.3	0	0.516	0.249	0.136	0.764
TAMPA	87270000	63.5	0	0.516	0.249	0.136	0.764
MIAMI	87270000	67.5	1	0.516	0.249	0.136	0.764
MIAMI	93220000	67.2	1	0.514	0.218	0.215	0.808
MIAMI	93220000	67.2	0	0.514	0.218	0.215	0.808
MIAMI	87270000	63.3	0	0.516	0.249	0.136	0.764
MIAMI	87270000	65.0	0	0.516	0.249	0.136	0.764
MIAMI	87270000/86070000	67.5	1	0.515	0.247	0.139	0.737
MIAMI	86070000	66.0	1	0.515	0.246	0.142	0.71
MIAMI	86070000	67.2	1	0.514	0.246	0.142	0.71
MIAMI	86070000/93220000	67.2	1	0.514	0.232	0.176	0.759
MIAMI	93220000	67.2	1	0.514	0.218	0.215	0.808
MIAMI	93220000	67.2	0	0.514	0.218	0.215	0.808
MIAMI	87471000	64.2	0	0.516	0.249	0.136	0.764
MIAMI	87471000	64.5	0	0.516	0.249	0.136	0.764
MIAMI	87471000	65.7	0	0.516	0.249	0.136	0.764

Region	Roadway ID	FFS(using BFFS = 70)	HOV	Female	und18	above65	white
MIAMI	87471000/86471000/86470000	65.7	0	0.515	0.247	0.139	0.737
MIAMI	87471000	65.7	0	0.516	0.249	0.136	0.764
MIAMI	87471000	64.5	0	0.516	0.249	0.136	0.764
MIAMI	87471000	65.7	0	0.516	0.249	0.136	0.764
MIAMI	87471000/86471000/86470000	65.7	0	0.515	0.247	0.139	0.71

Table D-2 Continues

Region	Roadway ID	black	AIAN	AP	NHOP	TMR	LOTE
TAMPA	15003000	0.1	0.003	0.026	0.001	0.012	0.12
TAMPA	15003000	0.1	0.003	0.026	0.001	0.012	0.12
MIAMI	87004000	0.206	0.003	0.015	0.001	0.011	0.679
MIAMI	87004000	0.206	0.003	0.015	0.001	0.011	0.679
MIAMI	87004000	0.206	0.003	0.015	0.001	0.011	0.679
MIAMI	87004000	0.206	0.003	0.015	0.001	0.011	0.679
TAMPA	15190000	0.1	0.003	0.026	0.001	0.012	0.12
TAMPA	15190000	0.1	0.003	0.026	0.001	0.012	0.12
TAMPA	15190000/10190000	0.131	0.004	0.027	0.001	0.014	0.165
TAMPA	10190000	0.161	0.005	0.027	0.001	0.015	0.209
TAMPA	10190000	0.161	0.005	0.027	0.001	0.015	0.209
TAMPA	10190000	0.161	0.005	0.027	0.001	0.015	0.209
TAMPA	10190000	0.161	0.005	0.027	0.001	0.015	0.209
TAMPA	10190000	0.161	0.005	0.027	0.001	0.015	0.209
TAMPA	10190000	0.161	0.005	0.027	0.001	0.015	0.209
TAMPA	15190000	0.1	0.003	0.026	0.001	0.012	0.12
TAMPA	15190000	0.1	0.003	0.026	0.001	0.012	0.12
TAMPA	15190000/10190000	0.131	0.004	0.027	0.001	0.014	0.165
TAMPA	10190000	0.161	0.005	0.027	0.001	0.015	0.209
TAMPA	10190000	0.161	0.005	0.027	0.001	0.015	0.209
TAMPA	10190000	0.161	0.005	0.027	0.001	0.015	0.209
TAMPA	10190000	0.161	0.005	0.027	0.001	0.015	0.209
TAMPA	10190000	0.161	0.005	0.027	0.001	0.015	0.209
TAMPA	10190000	0.161	0.005	0.027	0.001	0.015	0.209
JACKSONVILLE	72001000	0.296	0.004	0.032	0.001	0.015	0.095
JACKSONVILLE	72001000	0.296	0.004	0.032	0.001	0.015	0.095
JACKSONVILLE	72001000	0.296	0.004	0.032	0.001	0.015	0.095
JACKSONVILLE	72001000	0.296	0.004	0.032	0.001	0.015	0.095
TAMPA	15002000	0.1	0.003	0.026	0.001	0.012	0.12
TAMPA	15002000	0.1	0.003	0.026	0.001	0.012	0.12
MIAMI	87200000	0.206	0.003	0.015	0.001	0.011	0.679
MIAMI	87200000	0.206	0.003	0.015	0.001	0.011	0.679
ORLANDO	92130000	0.097	0.006	0.027	0.002	0.018	0.333
ORLANDO	92130000/75280000	0.151	0.005	0.034	0.0015	0.018	0.294
ORLANDO	75280000	0.205	0.004	0.041	0.001	0.018	0.254

Region	Roadway ID	black	AIAN	AP	NHOP	TMR	LOTE
ORLANDO	75280000	0.205	0.004	0.041	0.001	0.018	0.254
ORLANDO	75280000	0.205	0.004	0.041	0.001	0.018	0.254
ORLANDO	75280000	0.205	0.004	0.041	0.001	0.018	0.254
ORLANDO	92130000	0.097	0.006	0.027	0.002	0.018	0.333
ORLANDO	92130000/75280000	0.151	0.005	0.034	0.0015	0.018	0.294
ORLANDO	75280000	0.205	0.004	0.041	0.001	0.018	0.254
ORLANDO	75280000	0.205	0.004	0.041	0.001	0.018	0.254
ORLANDO	75280000	0.205	0.004	0.041	0.001	0.018	0.254
ORLANDO	75280000	0.205	0.004	0.041	0.001	0.018	0.254
TAMPA	10190000	0.161	0.005	0.027	0.001	0.015	0.209
TAMPA	10190000	0.161	0.005	0.027	0.001	0.015	0.209
TAMPA	10190000	0.161	0.005	0.027	0.001	0.015	0.209
TAMPA	10190000	0.161	0.005	0.027	0.001	0.015	0.209
TAMPA	10190000	0.161	0.005	0.027	0.001	0.015	0.209
TAMPA	10190000	0.161	0.005	0.027	0.001	0.015	0.209
TAMPA	10190000	0.161	0.005	0.027	0.001	0.015	0.209
TAMPA	10190000	0.161	0.005	0.027	0.001	0.015	0.209
TAMPA	10190000	0.161	0.005	0.027	0.001	0.015	0.209
TAMPA	10190000	0.161	0.005	0.027	0.001	0.015	0.209
MIAMI	87075000	0.206	0.003	0.015	0.001	0.011	0.679
MIAMI	87075000/86075000	0.225	0.003	0.022	0.001	0.0125	0.4835
MIAMI	86075000	0.244	0.003	0.029	0.001	0.014	0.288
MIAMI	87075000	0.206	0.003	0.015	0.001	0.011	0.679
MIAMI	87075000/86075000	0.225	0.003	0.022	0.001	0.0125	0.4835
MIAMI	86075000	0.244	0.003	0.029	0.001	0.014	0.288
MIAMI	87270000	0.206	0.003	0.015	0.001	0.011	0.679
MIAMI	87270000	0.206	0.003	0.015	0.001	0.011	0.679
JACKSONVILLE	72280000/72020000	0.296	0.004	0.032	0.001	0.015	0.095
JACKSONVILLE	72280000/72290000	0.296	0.004	0.032	0.001	0.015	0.095
JACKSONVILLE	72290000	0.296	0.004	0.032	0.001	0.015	0.095
JACKSONVILLE	72280000/72020000	0.296	0.004	0.032	0.001	0.015	0.095
JACKSONVILLE	72280000/72290000	0.296	0.004	0.032	0.001	0.015	0.095
JACKSONVILLE	72290000	0.296	0.004	0.032	0.001	0.015	0.095
TAMPA	16470000	0.143	0.005	0.12	0.001	0.01	0.121
TAMPA	16470000	0.143	0.005	0.12	0.001	0.01	0.121
TAMPA	16470000	0.143	0.005	0.12	0.001	0.01	0.121
TAMPA	16470000	0.143	0.005	0.12	0.001	0.01	0.121
TAMPA	10002000	0.161	0.005	0.027	0.001	0.015	0.209
TAMPA	10002000	0.161	0.005	0.027	0.001	0.015	0.209
MIAMI	87260000	0.206	0.003	0.015	0.001	0.011	0.679
MIAMI	87260000	0.206	0.003	0.015	0.001	0.011	0.679
TAMPA	87260000	0.206	0.003	0.015	0.001	0.011	0.679
TAMPA	87260000	0.206	0.003	0.015	0.001	0.011	0.679
MIAMI	87260000	0.206	0.003	0.015	0.001	0.011	0.679
MIAMI	87260000	0.206	0.003	0.015	0.001	0.011	0.679

Region	Roadway ID	black	AIAN	AP	NHOP	TMR	LOTE
MIAMI	87260000	0.206	0.003	0.015	0.001	0.011	0.679
MIAMI	87260000	0.206	0.003	0.015	0.001	0.011	0.679
MIAMI	87260000	0.206	0.003	0.015	0.001	0.011	0.679
MIAMI	87260000	0.206	0.003	0.015	0.001	0.011	0.679
MIAMI	87200000	0.206	0.003	0.015	0.001	0.011	0.679
MIAMI	87200000	0.206	0.003	0.015	0.001	0.011	0.679
MIAMI	87200000	0.206	0.003	0.015	0.001	0.011	0.679
MIAMI	87200000	0.206	0.003	0.015	0.001	0.011	0.679
MIAMI	86472000	0.244	0.003	0.029	0.001	0.014	0.288
MIAMI	86472000	0.244	0.003	0.029	0.001	0.014	0.288
MIAMI	87005000	0.206	0.003	0.015	0.001	0.011	0.679
MIAMI	87005000	0.206	0.003	0.015	0.001	0.011	0.679
MIAMI	86470000	0.244	0.003	0.029	0.001	0.014	0.288
MIAMI	86470000/93470000	0.201	0.0035	0.024	0.001	0.012	0.253
MIAMI	86470000	0.244	0.003	0.029	0.001	0.014	0.288
MIAMI	86470000/93470000	0.201	0.0035	0.024	0.001	0.012	0.253
MIAMI	17075000	0.045	0.002	0.01	0	0.007	0.105
MIAMI	17075000/13075000	0.0655	0.0025	0.011	0.005	0.008	0.114
TAMPA	13075000/10075000	0.124	0.004	0.0195	0.001	0.12	0.166
TAMPA	10075000	0.161	0.005	0.027	0.001	0.015	0.209
TAMPA	17075000	0.045	0.002	0.01	0	0.007	0.105
TAMPA	17075000/13075000	0.0655	0.0025	0.011	0.005	0.008	0.114
TAMPA	13075000/10075000	0.124	0.004	0.0195	0.001	0.12	0.166
TAMPA	10075000	0.161	0.005	0.027	0.001	0.015	0.209
TAMPA	87270000	0.206	0.003	0.015	0.001	0.011	0.679
TAMPA	87270000	0.206	0.003	0.015	0.001	0.011	0.679
MIAMI	87270000	0.206	0.003	0.015	0.001	0.011	0.679
MIAMI	93220000	0.158	0.004	0.019	0.001	0.01	0.217
MIAMI	93220000	0.158	0.004	0.019	0.001	0.01	0.217
MIAMI	87270000	0.206	0.003	0.015	0.001	0.011	0.679
MIAMI	87270000	0.206	0.003	0.015	0.001	0.011	0.679
MIAMI	87270000/86070000	0.225	0.003	0.022	0.001	0.0125	0.4835
MIAMI	86070000	0.244	0.003	0.029	0.001	0.014	0.288
MIAMI	86070000	0.244	0.003	0.029	0.001	0.014	0.288
MIAMI	86070000/93220000	0.201	0.0035	0.024	0.001	0.012	0.253
MIAMI	93220000	0.158	0.004	0.019	0.001	0.01	0.217
MIAMI	93220000	0.158	0.004	0.019	0.001	0.01	0.217
MIAMI	87471000	0.206	0.003	0.015	0.001	0.011	0.679
MIAMI	87471000	0.206	0.003	0.015	0.001	0.011	0.679
MIAMI	87471000	0.206	0.003	0.015	0.001	0.011	0.679
MIAMI	87471000/86471000/86470000	0.225	0.003	0.022	0.001	0.0125	0.4835
MIAMI	87471000	0.206	0.003	0.015	0.001	0.011	0.679
MIAMI	87471000	0.206	0.003	0.015	0.001	0.011	0.679
MIAMI	87471000	0.206	0.003	0.015	0.001	0.011	0.679
MIAMI	87471000/86471000/86470000	0.244	0.003	0.029	0.001	0.014	0.288

Table D-2 Continues

Region	Roadway ID	HS	B	MTT	PBP	ppp
TAMPA	15003000	0.84	0.229	23.6	0.121	38.95
TAMPA	15003000	0.84	0.229	23.6	0.121	38.95
MIAMI	87004000	0.679	0.27	30.1	0.189	68.21
MIAMI	87004000	0.679	0.27	30.1	0.189	68.21
MIAMI	87004000	0.679	0.27	30.1	0.189	68.21
MIAMI	87004000	0.679	0.27	30.1	0.189	68.21
TAMPA	15190000	0.84	0.229	23.6	0.121	38.95
TAMPA	15190000	0.84	0.229	23.6	0.121	38.95
TAMPA	15190000/10190000	0.824	0.24	0.247	0.126	38.95
TAMPA	10190000	0.808	0.251	25.8	0.13	38.95
TAMPA	10190000	0.808	0.251	25.8	0.13	38.95
TAMPA	10190000	0.808	0.251	25.8	0.13	38.95
TAMPA	10190000	0.808	0.251	25.8	0.13	38.95
TAMPA	10190000	0.808	0.251	25.8	0.13	38.95
TAMPA	10190000	0.808	0.251	25.8	0.13	38.95
TAMPA	15190000	0.84	0.229	23.6	0.121	38.95
TAMPA	15190000	0.84	0.229	23.6	0.121	38.95
TAMPA	15190000/10190000	0.824	0.24	0.247	0.126	38.95
TAMPA	10190000	0.808	0.251	25.8	0.13	38.95
TAMPA	10190000	0.808	0.251	25.8	0.13	38.95
TAMPA	10190000	0.808	0.251	25.8	0.13	38.95
TAMPA	10190000	0.808	0.251	25.8	0.13	38.95
TAMPA	10190000	0.808	0.251	25.8	0.13	38.95
TAMPA	10190000	0.808	0.251	25.8	0.13	38.95
JACKSONVILLE	72001000	0.827	0.219	25.2	0.128	64.45
JACKSONVILLE	72001000	0.827	0.219	25.2	0.128	64.45
JACKSONVILLE	72001000	0.827	0.219	25.2	0.128	64.45
JACKSONVILLE	72001000	0.827	0.219	25.2	0.128	64.45
TAMPA	15002000	0.84	0.229	23.6	0.121	38.95
TAMPA	15002000	0.84	0.229	23.6	0.121	38.95
MIAMI	87200000	0.679	0.27	0.301	0.189	68.21
MIAMI	87200000	0.679	0.27	0.301	0.189	68.21
ORLANDO	92130000	0.791	0.157	0.281	0.131	60.51
ORLANDO	92130000/75280000	0.805	0.209	27.35	0.132	60.51
ORLANDO	75280000	0.818	0.261	26.6	0.132	60.51
ORLANDO	75280000	0.818	0.261	26.6	0.132	60.51
ORLANDO	75280000	0.818	0.261	26.6	0.132	60.51
ORLANDO	75280000	0.818	0.261	26.6	0.132	60.51
ORLANDO	92130000	0.791	0.157	0.281	0.131	60.51
ORLANDO	92130000/75280000	0.805	0.209	27.35	0.132	60.51
ORLANDO	75280000	0.818	0.261	26.6	0.132	60.51
ORLANDO	75280000	0.818	0.261	26.6	0.132	60.51
ORLANDO	75280000	0.818	0.261	26.6	0.132	60.51

Region	Roadway ID	HS	B	MTT	PBP	ppp
ORLANDO	75280000	0.818	0.261	26.6	0.132	60.51
TAMPA	10190000	0.808	0.251	25.8	0.13	38.95
TAMPA	10190000	0.808	0.251	25.8	0.13	38.95
TAMPA	10190000	0.808	0.251	25.8	0.13	38.95
TAMPA	10190000	0.808	0.251	25.8	0.13	38.95
TAMPA	10190000	0.808	0.251	25.8	0.13	38.95
TAMPA	10190000	0.808	0.251	25.8	0.13	38.95
TAMPA	10190000	0.808	0.251	25.8	0.13	38.95
TAMPA	10190000	0.808	0.251	25.8	0.13	38.95
TAMPA	10190000	0.808	0.251	25.8	0.13	38.95
TAMPA	10190000	0.808	0.251	25.8	0.13	38.95
MIAMI	87075000	0.679	0.27	0.301	0.189	68.21
MIAMI	87075000/86075000	0.75	0.231	0.288	0.157	68.21
MIAMI	86075000	0.82	0.245	27.4	0.125	68.21
MIAMI	87075000	0.679	0.27	0.301	0.189	68.21
MIAMI	87075000/86075000	0.75	0.231	0.288	0.157	68.21
MIAMI	86075000	0.82	0.245	27.4	0.125	68.21
MIAMI	87270000	0.679	0.27	0.301	0.189	68.21
MIAMI	87270000	0.679	0.27	0.301	0.189	68.21
JACKSONVILLE	72280000/72020000	0.827	0.219	25.2	0.128	64.45
JACKSONVILLE	72280000/72290000	0.827	0.219	25.2	0.128	64.45
JACKSONVILLE	72290000	0.827	0.219	25.2	0.128	64.45
JACKSONVILLE	72280000/72020000	0.827	0.219	25.2	0.128	64.45
JACKSONVILLE	72280000/72290000	0.827	0.219	25.2	0.128	64.45
JACKSONVILLE	72290000	0.827	0.219	25.2	0.128	64.45
TAMPA	16470000	0.748	0.149	25.4	0.14	38.95
TAMPA	16470000	0.748	0.149	25.4	0.14	38.95
TAMPA	16470000	0.748	0.149	25.4	0.14	38.95
TAMPA	16470000	0.748	0.149	25.4	0.14	38.95
TAMPA	10002000	0.808	0.251	25.8	0.13	38.95
TAMPA	10002000	0.808	0.251	25.8	0.13	38.95
MIAMI	87260000	0.679	0.27	0.301	0.189	68.21
MIAMI	87260000	0.679	0.27	0.301	0.189	68.21
TAMPA	87260000	0.679	0.27	0.301	0.189	38.95
TAMPA	87260000	0.679	0.27	0.301	0.189	38.95
MIAMI	87260000	0.679	0.27	0.301	0.189	68.21
MIAMI	87260000	0.679	0.27	0.301	0.189	68.21
MIAMI	87260000	0.679	0.27	0.301	0.189	68.21
MIAMI	87260000	0.679	0.27	0.301	0.189	68.21
MIAMI	87260000	0.679	0.27	0.301	0.189	68.21
MIAMI	87260000	0.679	0.27	0.301	0.189	68.21
MIAMI	87200000	0.679	0.27	0.301	0.189	68.21
MIAMI	87200000	0.679	0.27	0.301	0.189	68.21
MIAMI	87200000	0.679	0.27	0.301	0.189	68.21
MIAMI	87200000	0.679	0.27	0.301	0.189	68.21

Region	Roadway ID	HS	B	MTT	PBP	ppp
MIAMI	86472000	0.82	0.245	27.4	0.125	68.21
MIAMI	86472000	0.82	0.245	27.4	0.125	68.21
MIAMI	87005000	0.679	0.27	0.301	0.189	68.21
MIAMI	87005000	0.679	0.27	0.301	0.189	68.21
MIAMI	86470000	0.82	0.245	27.4	0.125	68.21
MIAMI	86470000/93470000	0.828	0.261	26.55	0.117	68.21
MIAMI	86470000	0.82	0.245	27.4	0.125	68.21
MIAMI	86470000/93470000	0.828	0.261	26.55	0.117	63.12
MIAMI	17075000	0.871	0.274	21.8	0.084	68.21
MIAMI	17075000/13075000	0.843	0.24	0.226	0.096	63.12
TAMPA	13075000/10075000	0.811	0.2295	24.55	0.119	38.95
TAMPA	10075000	0.808	0.251	25.8	0.13	38.95
TAMPA	17075000	0.871	0.274	21.8	0.084	38.95
TAMPA	17075000/13075000	0.843	0.24	0.226	0.096	38.95
TAMPA	13075000/10075000	0.811	0.2295	24.55	0.119	38.95
TAMPA	10075000	0.808	0.251	25.8	0.13	38.95
TAMPA	87270000	0.679	0.27	0.301	0.189	38.95
TAMPA	87270000	0.679	0.27	0.301	0.189	38.95
MIAMI	87270000	0.679	0.27	0.301	0.189	68.21
MIAMI	93220000	0.836	0.277	25.7	0.109	68.21
MIAMI	93220000	0.836	0.277	25.7	0.109	63.43
MIAMI	87270000	0.679	0.27	0.301	0.189	63.43
MIAMI	87270000	0.679	0.27	0.301	0.189	63.43
MIAMI	87270000/86070000	0.75	0.231	0.288	0.157	68.21
MIAMI	86070000	0.82	0.245	27.4	0.125	68.21

Table D-2 Continues

Region	Roadway ID	HS	B	MTT	PBP	ppp
MIAMI	86070000	0.82	0.245	27.4	0.125	68.21
MIAMI	86070000/93220000	0.828	0.261	26.55	0.117	68.21
MIAMI	93220000	0.836	0.277	25.7	0.109	68.21
MIAMI	93220000	0.836	0.277	25.7	0.109	63.43
MIAMI	87471000	0.679	0.27	0.301	0.189	63.43
MIAMI	87471000	0.679	0.27	0.301	0.189	63.43
MIAMI	87471000	0.679	0.27	0.301	0.189	68.21
MIAMI	87471000/86471000/86470000	0.75	0.231	0.288	0.157	68.21
MIAMI	87471000	0.679	0.27	0.301	0.189	68.21
MIAMI	87471000	0.679	0.27	0.301	0.189	68.21
MIAMI	87471000	0.679	0.27	0.301	0.189	68.21
MIAMI	87471000/86471000/86470000	0.82	0.245	27.4	0.125	68.21

Table D-3: Key for the Abbreviations

Abbreviation	Meaning
AADT	Annual Average Daily Traffic
AADT/lane	Annual Average Daily Traffic per lane
FFS	Free Flow Speed

BFFS	Base Free Flow Speed
HOV	High Occupancy Vehicle
Und18	Percent persons under 18 years old
Above65	Percent persons above 65 years old
Female	Percent female
white	Percent white persons
Black	Percent black persons
AIAN	Percent American Indian and Alaska natives
AP	Percent Asian persons
NHOP	Percent Native Hawaiian and other Pacific Islanders
TMR	Percent persons reporting two or more races
LOTE	Percent persons speaking language other than English at home
HS	Percent persons with high school education age >25
B	Percent persons with Bachelor's degree age>25
MTT	Mean travel time to work (minutes)
PBP	Percent persons below poverty
PPP	Precipitation (inch)

Table D-4: Regression Analyses for the Different Combinations of the Region Variable

Variables	Coef.	Std. Err.	z	P>z
length	0.00673	0.01	0.760	0.447
truck percentage	-3.99972	1.94	-2.070	0.039
Number of interchange	0.19674	0.02	9.540	0.000
Number of ramps	0.04377	0.01	3.930	0.000
Truck lane restriction	-0.13517	0.18	-0.770	0.440

Table D-4 Continues

	Coef.	Std. Err.	z	P>z
Region (1)	0.32256	0.07	4.300	0.000
AADT/lane	0.00007	0.00	8.040	0.000
Free Flow Speed	0.19036	0.03	5.830	0.000
High occupancy vehicle lane	-0.24507	0.30	-0.820	0.410
Constant	-11.26045	2.22	-5.070	0.000
$\ln(\alpha)$	-0.9808249	0.13		
α	0.3750016	0.05		
Variables	Coef.	Std. Err.	z	P>z
length	0.00658	0.01	0.770	0.442
truck percentage	-4.14051	1.77	-2.340	0.019
Number of interchange	0.20526	0.02	10.570	0.000
Number of ramps	0.03967	0.01	3.730	0.000
Truck lane restriction	-0.18382	0.17	-1.080	0.278
Region (2)	0.28209	0.06	5.440	0.000
AADT/lane	0.00007	0.00	8.180	0.000
Free Flow Speed	0.18679	0.03	6.000	0.000
High occupancy vehicle lane	-0.23679	0.28	-0.830	0.405

Variables	Coef.	Std. Err.	z	P>z
Constant	-10.90679	2.09	-5.220	0.000
ln (α)	-1.046185	0.13		
α	0.3512753	0.05		

Variables	Coef.	Std. Err.	z	P>z
length	0.01479	0.01	1.680	0.093
truck percentage	-6.23924	1.88	-3.320	0.001
Number of interchange	0.17576	0.02	8.230	0.000
Number of ramps	0.04171	0.01	3.480	0.001
Truck lane restriction	0.07747	0.18	0.440	0.660
Region (3)	0.23548	0.09	-0.590	0.558
AADT/lane	0.00007	0.00	6.760	0.000
Free Flow Speed	0.18214	0.03	5.330	0.000
High occupancy vehicle lane	0.03213	0.31	0.100	0.917
Constant	-9.20331	2.26	-4.070	0.000
ln (α)	-0.8525759	0.13		
α	0.4263154	0.06		

Variables	Coef.	Std. Err.	z	P>z
length	0.01310	0.01	1.460	0.143
truck percentage	-5.67694	1.96	-2.900	0.004
Number of interchange	0.17426	0.02	8.360	0.000
Number of ramps	0.04191	0.01	3.560	0.000
Truck lane restriction	0.02724	0.18	0.150	0.878
Region (4)	0.22591	0.06	1.940	0.053

Table D-4 Continues

AADT/lane	0.00007	0.00	7.410	0.000
Free Flow Speed	0.17804	0.03	5.210	0.000
High occupancy vehicle lane	-0.10305	0.31	-0.330	0.740
Constant	-9.58075	2.27	-4.210	0.000
ln (α)	-0.8779334	0.13		
α	0.415641	0.06		

Variables	Coef.	Std. Err.	z	P>z
length	0.01167	0.01	1.290	0.198
truck percentage	-5.04311	2.00	-2.530	0.012
Number of interchange	0.18282	0.02	8.760	0.000
Number of ramps	0.04035	0.01	3.450	0.001
Truck lane restriction	-0.00947	0.18	-0.050	0.958
Region (5)	0.19671	0.06	2.160	0.031
AADT/lane	0.00007	0.00	7.450	0.000
Free Flow Speed	0.18172	0.03	5.330	0.000
High occupancy vehicle lane	-0.12844	0.31	-0.410	0.680

Variables	Coef.	Std. Err.	z	P>z
Constant	-9.82852	2.28	-4.320	0.000
ln (α)	-0.8807569	0.13		
α	0.4144691	0.05		

Variables	Coef.	Std. Err.	z	P>z
length	0.01484	0.01	1.680	0.094
truck percentage	-6.23250	1.92	-3.240	0.001
Number of interchange	0.17312	0.02	8.220	0.000
Number of ramps	0.04201	0.01	3.500	0.000
Truck lane restriction	0.07814	0.18	0.440	0.660
Region (6)	0.14065	0.05	0.090	0.932
AADT/lane	0.00007	0.00	6.920	0.000
Free Flow Speed	0.18043	0.03	5.250	0.000
High occupancy vehicle lane	0.01197	0.31	0.040	0.969
Constant	-9.26302	2.27	-4.080	0.000
ln (α)	-0.8503596	0.13		
α	0.4272612	0.06		

Variables	Coef.	Std. Err.	z	P>z
length	0.01408	0.01	1.640	0.102
truck percentage	-6.24768	1.81	-3.450	0.001
Number of interchange	0.18360	0.02	8.670	0.000
Number of ramps	0.04200	0.01	3.550	0.000

Table D-4 Continues

Variables	Coef.	Std. Err.	z	P>z
Truck lane restriction	0.06669	0.17	0.390	0.698
Region (7)	0.10548	0.06	-1.950	0.052
AADT/lane	0.00006	0.00	6.440	0.000
Free Flow Speed	0.18891	0.03	5.620	0.000
High occupancy vehicle lane	0.07738	0.30	0.260	0.798
Constant	-9.45383	2.21	-4.280	0.000
ln (α)	-0.8817514	0.13		
α	0.4140571	0.06		

Variables	Coef.	Std. Err.	z	P>z
length	0.01474	0.01	1.660	0.097
truck percentage	-6.17394	1.96	-3.150	0.002
Number of interchange	0.17334	0.02	8.240	0.000
Number of ramps	0.04191	0.01	3.490	0.000
Truck lane restriction	0.07578	0.18	0.430	0.670
Region (8)	0.10019	0.05	0.180	0.854
AADT/lane	0.00007	0.00	7.050	0.000

Variables	Coef.	Std. Err.	z	P>z
Free Flow Speed	0.18015	0.03	5.240	0.000
High occupancy vehicle lane	0.00613	0.31	0.020	0.984
Constant	-9.26255	2.27	-4.080	0.000
ln (α)	-0.8502748	0.13		
α	0.4272975	0.06		

Variables	Coef.	Std. Err.	z	P>z
length	0.00879	0.01	1.090	0.276
truck percentage	-5.81495	1.69	-3.440	0.001
Number of interchange	0.20329	0.02	10.100	0.000
Number of ramps	0.04520	0.01	4.140	0.000
Truck lane restriction	-0.06828	0.16	-0.420	0.673
Region (9)	0.09135	0.07	5.160	0.000
AADT/lane	0.00006	0.00	7.330	0.000
Free Flow Speed	0.20289	0.03	6.530	0.000
High occupancy vehicle lane	0.01583	0.28	0.060	0.955
Constant	-11.87162	2.11	-5.620	0.000
ln (α)	-1.040857	0.14		
α	0.3531518	0.05		

Variables	Coef.	Std. Err.	z	P>z
length	0.01525	0.01	1.780	0.076
truck percentage	-6.83613	1.87	-3.650	0.000
Number of interchange	0.17465	0.02	8.350	0.000
Number of ramps	0.04350	0.01	3.640	0.000
Truck lane restriction	0.08975	0.17	0.520	0.604

Table D-4 Continues

Region (10)	0.07945	0.06	-1.650	0.100
AADT/lane	0.00007	0.00	7.000	0.000
Free Flow Speed	0.18643	0.03	5.540	0.000
High occupancy vehicle lane	0.08308	0.30	0.270	0.785
Constant	-9.34129	2.22	-4.210	0.000
ln (α)	-0.876523	0.13		
α	0.4162276	0.06		

Variables	Coef.	Std. Err.	z	P>z
length	0.01433	0.01	1.600	0.109
truck percentage	-5.95747	2.02	-2.950	0.003
Number of interchange	0.17545	0.02	8.160	0.000
Number of ramps	0.04145	0.01	3.440	0.001
Truck lane restriction	0.06704	0.18	0.370	0.708
Region (11)	0.04862	0.09	0.450	0.649
AADT/lane	0.00007	0.00	7.080	0.000
Free Flow Speed	0.18018	0.03	5.250	0.000

Variables	Coef.	Std. Err.	z	P>z
High occupancy vehicle lane	-0.00444	0.31	-0.010	0.989
Constant	-9.35768	2.28	-4.100	0.000
ln (α)	-0.8504346	0.13		
α	0.4272292	0.06		

Variables	Coef.	Std. Err.	z	P>z
length	0.00693	0.01	0.840	0.401
truck percentage	-4.51412	1.71	-2.640	0.008
Number of interchange	0.21690	0.02	10.440	0.000
Number of ramps	0.04224	0.01	3.900	0.000
Truck lane restriction	-0.10775	0.16	-0.660	0.509
Region (12)	0.04292	0.07	5.090	0.000
AADT/lane	0.00006	0.00	6.480	0.000
Free Flow Speed	0.20570	0.03	6.580	0.000
High occupancy vehicle lane	-0.00637	0.28	-0.020	0.982
Constant	-12.06006	2.13	-5.670	0.000
ln (α)	-1.038224	0.14		
α	0.3540831	0.05		

Variables	Coef.	Std. Err.	z	P>z
length	0.00693	0.01	0.840	0.401
truck percentage	-4.51412	1.71	-2.640	0.008
Number of interchange	0.21690	0.02	10.440	0.000
Number of ramps	0.04224	0.01	3.900	0.000
Truck lane restriction	-0.10775	0.16	-0.660	0.509
Region (13)	-0.04292	0.07	-5.090	0.000
AADT/lane	0.00006	0.00	6.480	0.000

Table D-2 Continues

Variables	Coef.	Std. Err.	z	P>z
Free Flow Speed	0.20570	0.03	6.580	0.000
High occupancy vehicle lane	-0.00637	0.28	-0.020	0.982
Constant	-10.24491	2.05	-5.000	0.000
ln (α)	-1.038224	0.14		
α	0.3540831	0.05		

Variables	Coef.	Std. Err.	z	P>z
length	0.01433	0.01	1.600	0.109
truck percentage	-5.95747	2.02	-2.950	0.003
Number of interchange	0.17545	0.02	8.160	0.000
Number of ramps	0.04145	0.01	3.440	0.001
Truck lane restriction	0.06704	0.18	0.370	0.708
Region (14)	-0.04862	0.09	-0.450	0.649
AADT/lane	0.00007	0.00	7.080	0.000
Free Flow Speed	0.18018	0.03	5.250	0.000
High occupancy vehicle	-0.00444	0.31	-0.010	0.989

Variables	Coef.	Std. Err.	z	P>z
lane				
Constant	-9.14300	2.29	-4.000	0.000
ln (α)	-0.8504346	0.13		
α	0.4272292	0.06		

Variables	Coef.	Std. Err.	z	P>z
length	0.01525	0.01	1.780	0.076
truck percentage	-6.83613	1.87	-3.650	0.000
Number of interchange	0.17465	0.02	8.350	0.000
Number of ramps	0.04350	0.01	3.640	0.000
Truck lane restriction	0.08975	0.17	0.520	0.604
Region (15)	-0.07945	0.06	1.650	0.100
AADT/lane	0.00007	0.00	7.000	0.000
Free Flow Speed	0.18643	0.03	5.540	0.000
High occupancy vehicle lane	0.08308	0.30	0.270	0.785
Constant	-9.86886	2.25	-4.380	0.000
ln (α)	-0.876523	0.13		
α	0.4162276	0.06		

Variables	Coef.	Std. Err.	z	P>z
length	0.00879	0.01	1.090	0.276
truck percentage	-5.81495	1.69	-3.440	0.001
Number of interchange	0.20329	0.02	10.100	0.000
Number of ramps	0.04520	0.01	4.140	0.000
Truck lane restriction	-0.06828	0.16	-0.420	0.673
Region (16)	-0.09135	0.07	-5.160	0.000
AADT/lane	0.00006	0.00	7.330	0.000
Free Flow Speed	0.20289	0.03	6.530	0.000
High occupancy vehicle lane	0.01583	0.28	0.060	0.955
Constant	-10.06635	2.04	-4.930	0.000
ln (α)	-1.040857	0.14		
α	0.3531518	0.05		

Variables	Coef.	Std. Err.	z	P>z
length	0.01474	0.01	1.660	0.097
truck percentage	-6.17394	1.96	-3.150	0.002
Number of interchange	0.17334	0.02	8.240	0.000
Number of ramps	0.04191	0.01	3.490	0.000
Truck lane restriction	0.07578	0.18	0.430	0.670
Region (17)	-0.10019	0.05	-0.180	0.854
AADT/lane	0.00007	0.00	7.050	0.000
Free Flow Speed	0.18015	0.03	5.240	0.000
High occupancy vehicle lane	0.00613	0.31	0.020	0.984
Constant	-9.21865	2.29	-4.030	0.000
ln (α)	-	0.13		

Variables	Coef.	Std. Err.	z	P>z
	0.8502748			
α	0.4272975	0.06		

Variables	Coef.	Std. Err.	z	P>z
length	0.01408	0.01	1.640	0.097
truck percentage	-6.24768	1.81	-3.450	0.002
Number of interchange	0.18360	0.02	8.670	0.000
Number of ramps	0.04200	0.01	3.550	0.000
Truck lane restriction	0.06669	0.17	0.390	0.670
Region (18)	-0.10548	0.06	1.950	0.854
AADT/lane	0.00006	0.00	6.440	0.000
Free Flow Speed	0.18891	0.03	5.620	0.000
High occupancy vehicle lane	0.07738	0.30	0.260	0.984
Constant	-10.06893	2.25	-4.480	0.000
ln (α)	-0.8817514	0.13		
α	0.4140571	0.06		

Variables	Coef.	Std. Err.	z	P>z
length	0.01485	0.01	1.680	0.093
truck percentage	-6.23913	1.93	-3.240	0.001
Number of interchange	0.17316	0.02	8.220	0.000
Number of ramps	0.04202	0.01	3.500	0.000
Truck lane restriction	0.07866	0.18	0.440	0.657
Region (19)	-0.14065	0.05	-0.060	0.955
AADT/lane	0.00007	0.00	6.950	0.000
Free Flow Speed	0.18049	0.03	5.250	0.000
High occupancy vehicle lane	0.01361	0.31	0.040	0.965
Constant	-9.24819	2.29	-4.050	0.000
ln (α)	-0.8503801	0.13		
α	0.4272525	0.06		

Variables	Coef.	Std. Err.	z	P>z
length	0.01135	0.01	1.250	0.213
truck percentage	-4.68896	2.07	-2.270	0.023
Number of interchange	0.18412	0.02	8.740	0.000
Number of ramps	0.03997	0.01	3.410	0.001
Truck lane restriction	-0.00606	0.18	-0.030	0.973
Region (20)	-0.19671	0.06	-2.140	0.032
AADT/lane	0.00007	0.00	7.320	0.000
Free Flow Speed	0.17865	0.03	5.240	0.000
High occupancy vehicle lane	-0.12731	0.31	-0.410	0.682
Constant	-8.98625	2.26	-3.970	0.000
ln (α)	-0.88074	0.13273		

Variables	Coef.	Std. Err.	z	P>z
α	0.4144747	0.06		

Variables	Coef.	Std. Err.	z	P>z
length	0.01312	0.01	1.470	0.142
truck percentage	-5.62490	1.96	-2.860	0.004
Number of interchange	0.17447	0.02	8.350	0.000
Number of ramps	0.04184	0.01	3.550	0.000
Truck lane restriction	0.03111	0.18	0.180	0.861
Region (21)	-0.22591	0.06	-1.880	0.061
AADT/lane	0.00007	0.00	7.380	0.000
Free Flow Speed	0.17734	0.03	5.180	0.000
High occupancy vehicle lane	-0.09600	0.31	-0.310	0.757
Constant	-8.91558	2.27	-3.920	0.000
ln (α)	-0.8763578	0.13		
α	0.4162964	0.06		

Variables	Coef.	Std. Err.	z	P>z
length	0.01478	0.01	1.680	0.094
truck percentage	-6.21463	1.89	-3.280	0.001
Number of interchange	0.17474	0.02	8.100	0.000
Number of ramps	0.04187	0.01	3.480	0.000
Truck lane restriction	0.07859	0.18	0.450	0.656
Region (22)	-0.23548	0.10	0.300	0.764
AADT/lane	0.00007	0.00	6.670	0.000
Free Flow Speed	0.18152	0.03	5.290	0.000
High occupancy vehicle lane	0.02490	0.31	0.080	0.935
Constant	-9.37790	2.30	-4.080	0.000

Table D-4 Continues

Variables	Coef.	Std. Err.	z	P>z
length	0.00287	0.01	0.320	0.751
truck percentage	-2.07952	2.08	-1.000	0.317
Number of interchange	0.21808	0.02	10.160	0.000
Number of ramps	0.03802	0.01	3.520	0.000
Truck lane restriction	-0.21500	0.18	-1.210	0.227
Region (23)	-0.28209	0.08	-4.700	0.000
AADT/lane	0.00007	0.00	7.560	0.000
Free Flow Speed	0.19849	0.03	6.110	0.000
High occupancy vehicle lane	-0.30882	0.30	-1.050	0.296
Constant	-10.12108	2.14	-4.730	0.000
ln (α)	-1.013521	0.13		
α	0.3629388	0.05		

Variables	Coef.	Std. Err.	z	P>z

length	0.00673	0.01	0.760	0.447
truck percentage	-3.99972	1.94	-2.070	0.039
Number of interchange	0.19674	0.02	9.540	0.000
Number of ramps	0.04377	0.01	3.930	0.000
Truck lane restriction	-0.13517	0.18	-0.770	0.440
Region (24)	-0.32256	0.07	-4.300	0.000
AADT/lane	0.00007	0.00	8.040	0.000
Free Flow Speed	0.19036	0.03	5.830	0.000
High occupancy vehicle lane	-0.24507	0.30	-0.820	0.410
Constant	-9.64766	2.16	-4.470	0.000
ln (α)	-0.9808249	0.13		
α	0.3750016	0.05		
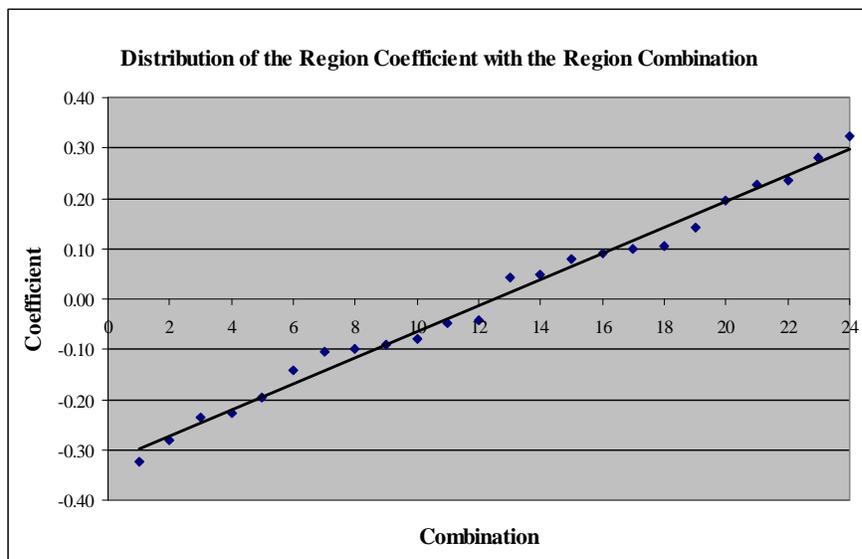
Figure D-2: Graphical Representation of the Coefficients for the Region Variable

Table D-5: Principal Component Coefficients (EigenVectors)

Variable	1	2	3	4	5	6	7	8
Female	0.18	-0.35	0.25	-0.09	-0.17	0.21	-0.53	0.04
Persons under 18	0.07	0.47	-0.15	0.05	0.12	0.04	-0.17	-0.17
Persons above 65	-0.08	-0.47	0.12	-0.17	-0.11	0.05	0.15	-0.06
Percent White	-0.16	-0.39	-0.37	0.10	-0.05	-0.06	0.16	-0.14
Percent Black	0.22	0.35	0.36	-0.14	0.01	0.10	-0.17	0.18
Percent American Indian and Alska Natives	-0.29	0.28	-0.31	0.15	0.05	-0.13	-0.07	-0.23
Percent Asian	-0.24	0.17	-0.16	-0.49	-0.40	0.09	0.24	0.28
Percent Native Hawaiian and Pacific Islanders	-0.06	-0.13	-0.17	-0.32	0.81	0.06	0.00	0.41
Percent reporting two or more races	-0.10	0.02	-0.03	0.40	0.06	0.87	0.19	0.06
Percent speaking language other than English at home	0.41	-0.02	-0.23	0.04	-0.06	-0.01	0.20	0.06
Percent High school graduates	-0.38	-0.01	0.34	0.07	0.17	-0.07	-0.09	-0.21
Percent with Bachelor's or higher	0.26	-0.10	0.14	0.55	0.11	-0.35	0.19	0.27
Mean travel time ot work	-0.32	0.13	0.31	0.16	-0.16	-0.12	0.29	0.50
Percent below poverty	0.39	0.05	-0.29	-0.02	-0.17	0.04	-0.01	0.22

Variable	1	2	3	4	5	6	7	8
Amount of precipitation	0.29	0.07	0.33	-0.26	0.17	0.07	0.59	-0.44

Variable	9	10	11	12	13	14	15
Female	-0.19	0.33	0.10	0.41	0.29	-0.01	-0.04
Persons under 18	0.29	0.25	0.72	0.09	-0.06	0.06	-0.01
Persons above 65	0.23	0.48	0.15	-0.49	-0.25	0.29	-0.05
Percent White	-0.05	0.04	0.22	0.17	-0.01	-0.35	0.65
Percent Black	0.06	0.19	-0.20	-0.33	-0.05	-0.26	0.60
Percent American Indian and Alska Natives	-0.29	0.61	-0.39	-0.02	0.14	0.12	0.00
Percent Asian	0.42	0.09	-0.12	0.28	0.26	0.03	0.02
Percent Native Hawaiian and Pacific Islanders	-0.04	0.10	0.01	0.07	0.05	0.03	0.00
Percent reporting two or more races	0.07	0.02	-0.08	0.01	0.01	0.02	0.01
Percent speaking language other than English at home	-0.14	-0.05	0.16	-0.38	0.71	0.18	0.06
Percent High school graduates	0.14	-0.24	0.01	0.09	0.27	0.58	0.39
Percent with Bachelor's or higher	0.46	0.26	-0.15	0.25	0.07	0.00	-0.01
Mean travel time ot work	-0.48	0.12	0.37	0.02	-0.02	0.02	-0.01
Percent below poverty	-0.20	-0.03	-0.08	0.22	-0.42	0.58	0.27
Amount of precipitation	-0.18	0.16	-0.01	0.31	-0.01	-0.02	0.00

Principal Component Calculations

Let n = number of sections

k = number of variables (principal component variables)

P = Principal Component

$$P_1 = \begin{pmatrix} x_{11} & x_{12} & - & - & - & x_{1k} \\ x_{21} & x_{22} & - & - & - & x_{2k} \\ | & | & - & - & - & | \\ | & | & - & - & - & | \\ x_{n1} & x_{n2} & - & - & - & x_{nk} \end{pmatrix} \begin{pmatrix} a_{11} \\ a_{21} \\ | \\ | \\ | \\ a_{n1} \end{pmatrix} = \begin{pmatrix} x_{11}a_{11} + x_{12}a_{21} + - - - + x_{1k}a_{n1} \\ x_{21}a_{11} + x_{22}a_{21} + - - - + x_{2k}a_{n1} \\ | \\ | \\ | \\ x_{n1}a_{11} + x_{n2}a_{21} + - - - + x_{nk}a_{n1} \end{pmatrix} \qquad \text{(d-1)}$$

$$P_2 = \begin{pmatrix} x_{11} & x_{12} & - & - & - & x_{1k} \\ x_{21} & x_{22} & - & - & - & x_{2k} \\ | & | & - & - & - & | \\ | & | & - & - & - & | \\ x_{n1} & x_{n2} & - & - & - & x_{nk} \end{pmatrix} \begin{pmatrix} a_{12} \\ a_{22} \\ | \\ | \\ | \\ a_{n2} \end{pmatrix} = \begin{pmatrix} x_{11}a_{12} + x_{12}a_{22} + - - - + x_{1k}a_{n2} \\ x_{21}a_{12} + x_{22}a_{22} + - - - + x_{2k}a_{n2} \\ | \\ | \\ | \\ x_{n1}a_{12} + x_{n2}a_{22} + - - - + x_{nk}a_{n2} \end{pmatrix} \qquad \text{(d-2)}$$

$$P_3 = \begin{pmatrix} x_{11} & x_{12} & - & - & - & x_{1k} \\ x_{21} & x_{22} & - & - & - & x_{2k} \\ | & | & - & - & - & | \\ | & | & - & - & - & | \\ x_{n1} & x_{n2} & - & - & - & x_{nk} \end{pmatrix} \begin{pmatrix} a_{13} \\ a_{23} \\ | \\ | \\ | \\ a_{n3} \end{pmatrix} = \begin{pmatrix} x_{11}a_{13} + x_{12}a_{23} + - - - + x_{1k}a_{n3} \\ x_{21}a_{13} + x_{22}a_{23} + - - - + x_{2k}a_{n3} \\ | \\ | \\ | \\ x_{n1}a_{13} + x_{n2}a_{23} + - - - + x_{nk}a_{n3} \end{pmatrix} \qquad \text{(d-3)}$$

$$P_4 = \begin{pmatrix} x_{11} & x_{12} & - & - & - & x_{1k} \\ x_{21} & x_{22} & - & - & - & x_{2k} \\ | & | & - & - & - & | \\ | & | & - & - & - & | \\ x_{n1} & x_{n2} & - & - & - & x_{nk} \end{pmatrix} \begin{pmatrix} a_{14} \\ a_{24} \\ | \\ | \\ | \\ a_{n4} \end{pmatrix} = \begin{pmatrix} x_{11}a_{14} + x_{12}a_{24} + - - - + x_{1k}a_{n4} \\ x_{21}a_{14} + x_{22}a_{24} + - - - + x_{2k}a_{n4} \\ | \\ | \\ | \\ x_{n1}a_{14} + x_{n2}a_{24} + - - - + x_{nk}a_{n4} \end{pmatrix} \qquad \text{(d-4)}$$

$$P_5 = \begin{pmatrix} x_{11} & x_{12} & - & - & - & x_{1k} \\ x_{21} & x_{22} & - & - & - & x_{2k} \\ | & | & - & - & - & | \\ | & | & - & - & - & | \\ x_{n1} & x_{n2} & - & - & - & x_{nk} \end{pmatrix} \begin{pmatrix} a_{15} \\ a_{25} \\ | \\ | \\ | \\ a_{n5} \end{pmatrix} = \begin{pmatrix} x_{11}a_{15} + x_{12}a_{25} + - - - + x_{1k}a_{n5} \\ x_{21}a_{15} + x_{22}a_{25} + - - - + x_{2k}a_{n5} \\ | \\ | \\ | \\ x_{n1}a_{15} + x_{n2}a_{25} + - - - + x_{nk}a_{n5} \end{pmatrix} \qquad \text{(d-5)}$$

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