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IDENTIFYING FACTORS AND MITIGATION TECHNOLOGIES IN TRUCK CRASHES IN NEW JERSEY

FINAL REPORT

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16. Abstract

This report summarizes the results of the work performed under the project *Identifying Factors and Mitigation Technologies in Truck Accidents in New Jersey*. The goals of the research project were to identify statistically significant factors that contribute to truck accidents in New Jersey and to recommend technologies and strategies holding potential for use as countermeasures for the most prevalent of these factors. These goals of this research compliment the goals of the Federal Motor Carrier Safety Administration (FMCSA) to reduce the number of truck-related fatalities by 50 percent. The results and findings of this research provide a basis for identifying factors that should be targeted to achieve these goals.

It is well known that the roadways in New Jersey have the highest design standards: the New Jersey Turnpike, the Garden State Parkway, the Atlantic City Expressway and the Interstate system also have the lowest accident rates. Recognizing this fact, legislation was passed in 1999, restricting through truck traffic to these higher type facilities. This legislation, however, does not address the large number of trucks that make deliveries to locations within the state or that originate at industries and businesses throughout New Jersey. These trucks must use all roadways in the state to reach their destinations. To better assist the state's transportation agencies, this report provides documentation of truck crash characteristics for the state of New Jersey.

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Executive Summary

This report summarizes the results of the work performed under the project *Identifying Factors and Mitigation Technologies in Truck Accidents in New Jersey*. The goals of the research project were to identify statistically significant factors that contribute to truck accidents in New Jersey and to recommend technologies and strategies holding potential for use as countermeasures for the most prevalent of these factors.

Truck crashes are of particular importance because the size and weight of these vehicles results in a greater likelihood of fatalities when they are involved in a crash than compared to passenger cars. Truck accidents in the state of New Jersey represent about 8 percent of all accidents. In 1998, 1999, and 2000, there were 20,025[*], 21,561*, and 28,328 accidents respectively, involving trucks in the State. These accidents represent all fatal, injury and property damage accidents for all types of trucks, with the majority of these accidents property damage accidents. The top two roadways with the highest accident frequency are US 1 and Interstate 95.

Variables influencing overall truck crash risk may be grouped into three broad categories: truck equipment, driver performance, and operating environment. Physical characteristics of the truck equipment, including the number of trailers, trailer length, and weight capacity, influence the occurrence and severity of truck crashes. Truck crash data collected for New Jersey showed that among all truck accidents, single-unit 2-axle trucks were found to be the truck configuration most involved in truck crashes. A majority of truck crashes are multi-vehicle accidents. Multi-vehicle truck accidents involve three primary types of collisions: side-swipes in the same direction, angle collision, and rear-end collision. For single-unit 2-axle trucks and tractor/semi-trailers, there is a slightly higher percent of rear-end and angle accidents under wet roadway conditions when compared to all truck accidents under all roadway surface conditions. Rear-end collision types primarily occur on higher speed roadways such as Interstate and State highways.

Driver performance is another key variable that influences overall truck crash risk. The skill level and experience of the driver can be critical in the ability of the truck to avoid truck crashes. The age of the driver is related to skill level. Younger drivers tend to be involved in a greater percentage of truck fatal accidents than passenger car crashes. In New Jersey, these ages are slightly higher. The highest percent of truck accidents involved truck drivers falling in the age group between 31-35 years old, followed by age group of 36-40.

One of the major contributors related to truck accidents related to driver performance is truck driver fatigue. Although the majority of truck accidents in New Jersey occurred during daylight conditions, a higher percentage of single-vehicle truck accidents occurred in dark conditions when compared to multi-vehicle truck accidents.

[*] Truck Data incomplete for 1998, 1999

This indicates the possibility of driver fatigue during dark conditions that may contribute to a higher proportion of single-vehicle truck crashes during these conditions.

The operating environment is also a critical factor in truck crash risk. About half of all truck accidents occurred on State highways and municipal roadways. County roadways also showed a large percent of truck accidents with 20 percent of truck accidents on these roadways. Truck accidents occurred on roadways with a variety of speed limits. The highest percentage of truck accidents, however, occurred on roadways with a posted speed limit of 25 mph. This posted speed limit accounted for 26 percent of truck accidents and involved a large percentage of single unit 2-axle trucks and truck trailers. Over 35 percent of truck crashes occurred at intersections in New Jersey. Of the top 10 intersections where truck crashes occurred in New Jersey, 8 of the locations are along Route 1.

Chapter I

INTRODUCTION

1.0 OVERVIEW

This report summarizes the results of the work performed under the project *Identifying Factors and Mitigation Technologies in Truck Accidents in New Jersey*. The goals of the research project were to identify statistically significant factors that contribute to truck accidents in New Jersey and to recommend technologies and strategies holding potential for use as countermeasures for the most prevalent of these factors. These goals of this research compliment the goals of the Federal Motor Carrier Safety Administration (FMCSA) to reduce the number of truck-related fatalities by 50 percent. The results and findings of this research provide a basis for identifying factors that should be targeted to achieve these goals.

1.1 BACKGROUND

According to the National Highway Traffic Safety Administration[(1)], 475,000 large trucks were involved in traffic crashes in the United States. One out of eight traffic fatalities in 1999 resulted from a collision involving a large truck. Large trucks are defined as vehicles with a gross vehicle weight rating greater than 10,000 pounds. These vehicles account for 3 percent of all registered vehicles, 7 percent of total vehicle miles traveled, 9 percent of all vehicles involved in fatal crashes, and 4 percent of all vehicles involved in injury and property-damage-only crashes in 1998. Large trucks have unique operating characteristics that impact the occurrence and severity of accidents. The higher gross weight, longer vehicle lengths and increased stopping distance, when compared to passenger vehicles, contribute to truck-car accidents that result in severe injuries or fatalities. In addition, large trucks find it difficult to accelerate, brake and corner, which combined with roadway geometrics and environmental conditions, make trucks susceptible to crash occurrences.

It is well known that the roadways in New Jersey have the highest design standards: the New Jersey Turnpike, the Garden State Parkway, the Atlantic City Expressway and the Interstate system also have the lowest accident rates. Recognizing this fact, legislation was passed in 1999, restricting through truck traffic to these higher type facilities. This legislation, however, does not address the large number of trucks that make deliveries to locations within the state or that originate at industries and businesses throughout New Jersey. These trucks must use all roadways in the state to reach their destinations. To better assist the state's transportation agencies, this report provides documentation of truck crash characteristics for the state of New Jersey.

Truck accidents are generally grouped with auto accidents; consequently, accident analyses do not address specific roadway geometry or other conditions that may affect truck accidents to a much greater degree than autos. If these specific causes of truck accidents could be identified, then innovative measures, including advanced technologies, could be identified and implemented to help reduce the number of truck accidents.

1.2 OBJECTIVES

The objectives of work performed under Task Order No. TO-30, Identifying Factors and Mitigation Technologies in Truck Accidents in New Jersey, are to:

- Identify statistically significant factors that contribute to truck accidents in New Jersey; and

- Recommend technologies and strategies holding potential for use as countermeasures for the most prevalent of these factors.

The tasks to be performed to achieve these objectives include:

Task 1. Review and analysis of statistical crash data;

Task 2. Identify statistically significant factors in truck crashes;

Task 3. Prepare case study;

Task 4. Review existing technologies and strategies;

Task 5: Field evaluation of a speed management technology or strategy; and

Task 6: Prepare documentation and deliverables.

This report documents the results of the work performed under each task.

1.3 ORGANIZATION

This report is organized into 7 chapters. Chapter I provides an introduction to the research, stating the research objectives and the tasks performed to accomplish these objectives. Chapter II provides a literature review covering topics on large truck safety, contributing factors and mitigation measures aimed at truck safety. Chapter III describes truck crash characteristics within New Jersey. Statistics on the type, location and other characteristics of truck crashes are provided. Chapter IV further provides statistics on fatal truck crashes within the state. Chapter V provides case studies of the top truck accident locations. The case studies identify factors that contribute to the crashes and possible mitigation technologies or approaches for reducing crashes. Chapter VI describes the Truck Accident Information Management System (TAIMS) developed in the research. The system is a geographic information system (GIS) that can be used to assist in further analyzing truck crashes across the state. Finally, Chapter VII provides a summary and conclusions of the research. Included are findings and further research.

Chapter II

LITERATURE REVIEW

2.0 OVERVIEW

Much research has been performed to understand characteristics of large truck crashes and to develop countermeasures to reduce these types of crashes. The following provides an overview of some of the research performed in these areas. This review identifies factors that have been documented as impacting truck crashes and describes alternative countermeasures that may be used to improve safety and reduce truck crashes.

Truck crashes are of particular importance because the size and weight of these vehicles results in a greater likelihood of fatalities when they are involved in a crash than compared to passenger cars. This consequence of truck size and weight is confirmed by accident data and previous research which has shown that accidents involving trucks have an increased likelihood of producing a severe injury or fatality due to the car/truck size disparity and other factors. Large truck fatality rate is 75 percent higher than the rate for all vehicles, with this high fatality rate a function of the vehicle mass(2). Truck crashes occur at different rates than compared to passenger cars because of the special characteristics of trucks. These characteristics include that trucks are much heavier and larger in dimension compared with passenger cars (3). Trucks have less effective acceleration capabilities than passenger cars and have greater difficulty maintaining their speeds on upgrades. Also, trucks have a lower deceleration in response to braking than do passenger cars.

2.1 SIZE AND WEIGHT

The size and weight of heavy vehicles have several impacts on roadway safety. The turning radii of large trucks and the swept paths of these vehicles are much larger than that of passenger vehicles. Truck weight is also a significant factor in determining a driver’s ability to maintain control under various traffic, roadway, and environmental conditions. Although it may be assumed that heavier trucks are more likely to be involved in fatal accidents than lighter trucks, research has shown this assumption is not completely accurate. Some drivers have indicated that a heavier truck is not necessarily a less safe truck. Tractor-semitrailer combination accident rates peak at about 65,000 pounds, with the rate for heavier vehicles falling substantially (2). This may indicate that the most heavily loaded vehicles stay on the safest (limited-access) highways and other vehicles operate more often on less safe roads.

The performance of heavier trucks varies and depends upon the driver's experience and other roadway conditions. Some heavier trucks are more prone to roll over than other, smaller trucks; some are less capable of successfully avoiding an unforeseen obstacle when traveling at highway speeds; some negotiate tight turns and exit ramps better than others; and some can be stably stopped in shorter distances than others; some climb hills and maneuver in traffic better than others [(4)].

2.2 TRUCK CONFIGURATION

Truck safety is not only impacted by size and weight, but also by the vehicle configuration and roadway characteristics. In one study performed by the National Highway Transportation Safety Administration (NHTSA), single-unit trucks were shown to be significantly under-involved in crashes relative to other vehicle types [(5)]. In another study performed by the University of Michigan Transportation Research Institute (UMTRI), a total of 25,278 large trucks were involved in fatal accidents during the 5-year period, 1980-1984 [(2)]. The largest percentage of these accidents, however, involved tractor-semitrailer combinations.

2.3 ROADWAY CHARACTERISTICS

The UMTRI study, though, revealed that roadway characteristics are much more important than the kind of truck in determining accident risk. Limited-access highways were found to be approximately four times safer for truck operations than other highways. Numerous analyses of crash databases have noted that truck travel on lower performance roads (e.g. undivided, higher speed-limit roads with numerous intersections and entrances), significantly increase crash risks compared to travel on Interstates and other higher quality roads. Higher traffic densities, which are common in urban and populous areas, exacerbate this problem. The majority of fatal crashes involving trucks occur on non-Interstate, U.S. and State routes, many of which are undivided and have high posted speed limits [(4)].

Factors that may make vehicle accident rates differ from one roadway class to another include the physical nature of the roadway, such as geometric design[(6)]. Roadway markings, traffic signs, the type of incurred travel, traffic control and traffic conditions also impact the accident rates by roadway type. The geometric design elements that may influence accident rate include horizontal curvature, vertical grade, lane width, shoulder width, and the type and presence of a median. Their effects on vehicle accidents are, however, difficult to quantify because of large confounding influences from the vehicle, driver and environment.

2.4 CONTRIBUTING FACTORS

To develop countermeasures and reduce the incidence and severity of crashes involving heavy vehicles, Sweatman [(7)] researched the types, severity and causes of crashes involving heavy vehicles in urban areas. The most important factors found in the causation of heavy truck crashes included: inappropriate behavior by pedestrian/cyclist; excess speed by car/motorcycle driver; excess speed by car/motorcycle driver; inattention on the part of car/motorcycle (mainly car) drivers; disregard of traffic control by heavy vehicle driver; and disregard of traffic control by car/motorcycle driver; and alcohol or drug use by car drivers. Additional factors contributing to the crashes included: road geometric standard; truck driver inattention; car/motorcycle driver inattention; pedestrian/cyclist inappropriate behavior; car/motorcycle driver attitude; car/motorcycle driver excess speed; roadside objects; and road alignment. The severity of truck crashes was found to be influenced by high speed limits, accidents occurring when a vehicle is making a right or left-turn, and rear-end type of collisions.

Some of the factors contributing to truck crashes include the operation of the vehicle and mechanical factors. Although both UMTRI and the Federal Highway Administration (FHWA) identify all mechanical factors as being involved in less than 10 percent of truck accidents, the NHTSA believe that vehicle-related factors play a critical and sometimes unrecognized and underreported role in truck accidents [(2)]. Mechanical and vehicle-related factors may make it difficult for a driver to recover from an error or avoid an unforseen conflict. In fact, NHTSA estimates that brake system performance could be involved in as many as one-third of all truck accidents. In a U.S. Congressional report, three factors were identified as most frequently associated with heavy vehicle accidents: speed too fast for conditions; driver training; and vehicle age. Truck age as a factor frequently associated with accidents is probably a surrogate for maintenance quality, with poorer maintenance being found on older vehicles [(8)].

Variables influencing overall crash risk may be grouped into three broad categories: truck equipment, driver performance, operating environment [(4)]. Physical characteristics of the truck equipment, including the number of trailers, trailer length, and weight capacity, influence the occurrence and severity of truck crashes. In addition to the physical characteristics, the dynamic performance of the truck under varying load conditions also influence truck crashes. Other mechanical systems of the truck, such as brakes and engine characteristics, may also influence truck crashes.

Driver performance is another key variable that influences overall truck crash risk. The skill level and experience of the driver can be critical in the ability of the truck to avoid truck crashes. The age of the driver is related to skill level. Younger drivers tend to be involved in a greater percentage of truck fatal accidents than passenger car crashes. Truck drivers under 21 years of age have about five times the average accident rate. The rate falls to twice the average at age 21, and by age 27 younger truck drivers are safer than the average of all truck drivers [(2)].

One of the major contributors to truck accidents related to driver performance is truck driver fatigue. About 1.67 percent of fatal truck crashes in 1993 were coded as related to truck driver fatigue. This estimate is very conservative and the occurrence of fatigue in truck accidents is likely to be much higher. The National Highway Safety Board determined that fatigue was the most frequently cited probable cause of fatal-to-the-driver heavy truck accidents [(9)]. The number of hours since the driver's last rest period and the number of consecutive days of worked, can influence the driver's ability and affect truck crash risk. The National Transportation Safety Board (NTSB) investigated 113 heavy-vehicle truck accidents and assigned them into one of two accident groups: fatigue-related or non-fatigue related [(10)]. The most important variables which predicted fatigue-related accidents were: the duration of the last sleep period (in hours); the total number of hours asleep in the 24 hours prior to the accident; and the presence/absence of split-sleep patterns.

The operating environment is also a critical factor in truck crash risk. Weather conditions, lighting, roadway geometry, congestion, roadway classification, region of the country, pavement condition, and traffic control and warning devices, such as traffic signals, guardrails, warning signs, all can have an impact on the occurrence and severity of truck crashes.

2.5 TRUCK SPEEDING

One of the contributing factors related to truck crashes is speeding. In 1997 there were 4,614 fatal crashes involving large trucks with 21 percent of these crashes involving speeding [(11)]. Of the total fatal truck crashes in 1997, 19 percent were single-vehicle crashes and 81 percent were multi-vehicle crashes. Twenty-two percent of the multi-vehicle large truck fatal crashes were speeding-related with seven percent involved speeding on the part of the truck driver, while 15 percent of the crashes involved speeding on the part of the other driver. Adverse weather conditions appear to be associated with an increased incidence of speeding-related crashes involving large trucks. Twenty-five percent of all speeding-related multivehicle large truck crashes occurred during adverse weather conditions. Speed-related crashes occur on interstates and urban expressways at a higher rate than non-speed-related crashes. About 35 percent of the speed-related crashes occur on rural interstates, urban interstate, or urban expressways. Angle crashes, which are more prevalent at intersections, are less common in speed-related crashes than non-speed-related crashes. For speeding-related crashes, rear-end collisions occur with the greatest frequency.

The NHTSA[5] report on commercial vehicle speed found that although commercial vehicle drivers are often under economic pressure to move goods quickly and thus possibly to speed, there are also significant economic incentives not to speed. Professional truck drivers may be reluctant to speed to avoid speeding citations which could lead to the suspension of their commercial driver's license. If trucks do speed, it is often related to long-haul routes which, because of the competitive environment, result in tight delivery schedules. Just-in-time delivery, which is economically attractive to manufacturers and distributors, can also result in added schedule pressure on truckers.

In general, however, trucks are generally more compliant with highway speed limits than are cars. When trucks speed, it is typically at levels just over the speed limit. On highways posted at 55 mph, about 3 percent of trucks speed in excess of 70 mph compared to 10 percent of all passenger vehicles. On roads posted at 65 mph, about 14 percent of trucks exceed 70 mph compared to 23 percent for passenger vehicles. Trucks are more likely to be involved in a speed-related crash, however, because they have a greater exposure than other vehicles to high speed highway situations. In another study by Pezoldt and Brackett [12], speeds of trucks and other vehicles were measured by both detectable and non-detectable radar at 14 locations in four states. Non-detectable radar measurements showed that both trucks and passenger vehicles frequently traveled at speeds exceeding posted limits and 65 mph. However, the majority of the data suggested that trucks travel at a high speed less frequently than do passenger vehicles. Overall, most heavy truck crashes do not occur on roadways with speed limits greater than 70 mph. More than 90 percent of combination-unit truck crashes and 95 percent of single-unit truck crashes occur on roadways where the speed limit is less than 65 mph, and where the incidence of truck speeding in excess of 70 mph or even 65 mph is low.

2.6 COUNTERMEASURES

Countermeasures are generally developed for reducing crashes for all motor vehicles. Countermeasures aimed at reducing truck crashes are few. One approach that can be taken to reduce speeds of trucks and thereby to reduce truck crashes is to require these vehicles to be equipped with devices to control their maximum speed [5]. Two principal forms of speed control include: (1) speed-limiting devices ("governors"), which directly limit engine and/or road speed; and (2) speed-monitoring devices, which do not control vehicle speed directly, but rather provide a continuous record of vehicle speed that may be used to determine if speeding has occurred.

Sweatman [7] identified several countermeasures that could be applied for both heavy and passenger vehicles. These countermeasures applied to roadway geometry, driver behavior and condition, Intelligent Transportation System (ITS) technologies, and vehicle design. Included in roadway geometry is grade separation to reduce the potential for traffic conflicts. Improved road shoulders, intersection design, clear zones were other countermeasures related to roadway geometry. Driver behavior and condition countermeasures include more appropriate behavior on the part of road users, including drivers. Enforcement of speed and local laws, countermeasures focused on the driving skills of heavy vehicle drivers, driver fatigue control, and occupant restraint usage were other measures related to drivers. ITS technologies that could be used as countermeasures to truck crashes include detectors of the presence of pedestrians at the front nearside of heavy vehicles, in-vehicle indicators of red signals for both trucks and cars; in-vehicle stability warning for heavy vehicles; signals responsive to heavy vehicle speed and position; route guidance; and emergency advice. Countermeasures focused on improvements to the design of trucks include side under-run protection, car crashworthiness, and improved heavy vehicle field of view (nearside).

Middleton (13) investigated truck accident countermeasures for urban freeways. The countermeasures were directly related to roadway design and operations and were selected based on their accident reduction capability, data or information availability, and regional representation. The countermeasures found to be used to reduce truck accidents included: lane restriction - trucks are restricted to certain lanes; restrictive truck facilities; ramp treatments; tall barriers; urban inspection stations; increased enforcement; incident response and clearance; truck diversions or bans; reduced shoulder parking; differential speed limits; and mainline treatments.

Chapter III

TRUCK CRASHES IN NEW JERSEY

3.0 OVERVIEW

For this research, a truck-accident database was developed which included accidents involving trucks for 1998 through 2000 for the state of New Jersey. The truck accident database for 1998 and 1999, however, is incomplete with missing accident records from those years. The types of trucks included in the database are vehicles whose classification on the accident record is one of the following: single unit truck (2 axle), singe unit truck (3+axle), truck/trailer, truck/tractor (bobtail), tractor/semi-trailer, tractor/doubles, tractor/triples and heavy truck other. The accident database did not include accidents for "Pick-up/Sport Utility" or "Van/Shop Van" vehicle types, which have unique vehicle type codes on the accident reports, unless a truck, as defined above, was involved in the accident. The accident database includes almost all crash information "fields" found on the police accident report except for the name and full address of the drivers or passengers involved in the accidents.

3.1 TRUCK ACCIDENT SUMMARY

Truck accidents in the state of New Jersey represent about 8 percent of all accidents. In 1998, 1999, and 2000, there were 20,025, 21,561, and 28,328 accidents respectively, involving trucks in the state. These accidents represent all fatal, injury and property damage accidents for all types of trucks, with the majority of these accidents property damage accidents. The types of trucks included in these statistics are described above as the trucks included in the accident database. Table 1 shows totals and accident rates for all motor vehicles and trucks for 1998 through 2000.

Table 1. Truck Crashes for 1998-2000 in New Jersey

	Motor Vehicle Crashes[a]	Vehicle Miles Traveled ($x 10^6$) [a]	Motor Vehicle Crash Rate (MVM) [a]	Truck Crashes[b]	Truck VMT ($x 10^6$) [a]	Truck Crash Rate (MVM)[b]
1998	248,930	64.51	3.86	20,025	N/A	-
1999	263,238	65.92	3.99	21,561	14.23	1.52
2000	286,700	67.17	4.27	28,328	13.74	2.06

[a] Source: NJDOT Reference Data, 2002.
[b] Truck Accident Data Incomplete for 1998, 1999

Table 2: Truck Configuration of Truck Crashes

Truck Configuration	1998-2000	
	Total	Percent
Single Unit Truck (2 Axle)	24631	33.0%
Single Unit Truck (3+ Axle)	7008	9.4%
Truck/Trailer	17717	23.7%
Truck/Tractor	2122	2.8%
Tractor/Semi Trailer	18672	25.0%
Tractor Doubles	457	0.6%
Tractor /Triples	110	0.1%
Heavy Truck Other	3921	5.3%

3.2 TRUCK CONFIGURATION

Among truck accidents, single-unit 2-axle trucks are found to be the truck configuration most involved in truck crashes, with about 33% of truck crashes involving these vehicles as shown in Table 2. Their large percentage involvement is due to the fact that these vehicles contribute about 80% of the truck vehicle miles travel in the state. Truck /Trailer and Tractor/Semi Trailer are the second highest percent of truck vehicle configuration with an involvement of between 23 and 25 percent of truck crashes.

3.3 ROADWAY SYSTEM

As shown in Table 3, about half or 51 percent of truck accidents occurred on State highways and municipal roadways. County roadways also showed a large percent of truck accidents with 20 percent of truck accidents on these roadways.

Table 4 further shows the road system on which truck accidents occurred by three types of truck configuration: single-unit 2-axle trucks; truck-trailers; and tractor/semi-trailers. Tractor/Semi-Trailer trucks have significantly higher percent of accidents on Interstate and Toll roadways than single-unit 2-axle trucks and truck-trailers. This may be due to the fact that a large portion of tractor/Semi-trailer trucks vehicle-miles travel occur on these roadways. Single-unit 2-axle trucks and truck-trailers, however, have a higher percent of truck accidents on county and municipal roadways, than tractor/Semi-trailer trucks.

A majority of truck crashes are multi-vehicle accidents with about 80 percent of all truck crashes in New Jersey multi-vehicle accidents. A comparison made of differences in the roadway system between single-vehicle truck accidents and multi-

Table 3: Truck Crashes by Road System

Road System	1998-2000	
	Total	Percent
Interstate	5640	8.1%
State Highway	18316	26.2%
Toll Road	5721	8.2%
State Part or Inst.	122	0.2%
County	13910	19.9%
Co. Auth Park/Institution	54	0.1%
Municipal	17321	24.8%
Private Property	8854	12.7%

Table 4: Truck Crashes by Road System and Truck Configuration

Road System	1998-1999					
	SUT(2Axle)		Truck Trailer		Tractor/Semi Trailer	
	Total	%	Total	%	Total	%
Interstate	519	4.4	706	7.8	1616	18.0
State Highway	3353	28.4	3165	35.0	2501	27.9
Toll Road	599	5.1	374	4.1	2020	22.5
County	3260	27.7	2047	22.6	1418	15.8
Municipal	4058	34.4	2761	30.5	1406	15.7

Table 5: Single and Multi-Vehicle Truck Accidents by Roadway System

Road System	1998-1999			
	Single Vehicle		Multi-Vehicle	
	Total	Percentage	Total	Percentage
Interstate	495	6.0	2750	8.3
State Highway	1618	19.6	9285	28.1
Toll Road	494	6.0	2823	8.5
State Park and Inst.	26	0.3	39	0.1
County	1761	21.3	6494	19.6
Co. Auth Park or Inst.	8	0.1	24	0.1
Municipal	2182	26.4	8131	24.6
Private Property	1689	20.4	3517	10.6

vehicle truck accidents showed differences in the roadway system under which these accidents occur. As shown in Table 5, the greatest number of single-vehicle truck accidents occur on municipal roadways, while the greatest number of multi-vehicle truck accidents occur on State highways. Possible conclusions to be drawn from this may be that shoulder rumble strips may be investigated for their use on non-Interstate locations where many single-vehicle truck crashes are occurring.

3.4 COLLISION PATTERN

The three primary types of collisions in which trucks are involved are side-swipes in the same direction (26.2%), angle collisions (20.5%), and rear-end collisions (13.9%). Together these collision types represent 60 percent of all truck accidents. There are some differences, however, in the types of collisions between truck configuration. For truck-trailer and tractor/semi-trailer truck accidents, same direction side-swipe collisions are the highest proportion of collision types among these truck configurations. These type of collisions are generally associated with lane-changing maneuvers. As shown in Table 6, for single-unit 2-axle trucks, rear end accidents are the highest proportion of collision types with 29 percent of rear-end collisions compared to 21 and 23 percent for truck-trailer and tractor/semi-trailer trucks respectively.

The types of collisions involved in truck accidents are also affected by the surface condition of the roadway. Table 7 shows collision types for single-unit 2-axle trucks, truck trailers and tractor/semi-trailers under wet roadway conditions. No significant differences can be seen in the collision types for wet conditions compared to all truck accidents under all roadway surface conditions. For single-unit 2-axle trucks and tractor/semi-trailers, however, there is a slight increase in the percent of rear-end and angle accidents under wet roadway conditions than compared to all truck accidents under all roadway surface conditions.

For dark conditions, the collision types in which truck crashes are involved slightly differ when compared to truck accidents under all light conditions. As shown in Table 8, for dark conditions, there is a higher percent of "Struck Parked Vehicle" type collisions for single-unit 2-axle trucks and for tractor-semi-trailers. For truck trailers under dark conditions, there is a higher proportion of same direction side-swipe crashes than compared to truck accidents under all light conditions.

Table 9 and Figure 1 show collision types by roadway system. Rear-end collision types primarily occur on higher speed roadways such as Interstate and State highways with a smaller percentage on municipal roadways. Same direction side-swipe collisions comprise a significant portion of truck crashes on Interstate and

Table 6: Collision Types by Vehicle Configuration

Collision Type	1998-1999					
	SUT (2Axle)		Truck Trailer		Tractor/Semi Trailer	
	Total	%	Total	%	Total	%
Rear End	3072	29.1	1523	20.9	1633	22.7
Side Swipe	2549	24.1	2763	37.9	3360	46.7
Angle	2057	19.5	1297	17.8	1060	14.7
Head On	197	1.9	126	1.7	73	1.0
Left Turn	428	4.1	298	4.1	211	2.9
Struck Parked Vehicle	2254	21.4	1282	17.6	864	12.0

Table 7: Percent Truck Crashes for Wet Roadway Conditions by Collision Type and Vehicle Configuration

	1998-1999					
	SUT(2Axle)		Truck Trailer		Tractor/Semi Trailer	
Collision Type	All	Wet	All	Wet	All	Wet
Rear End	29.1	34.3	20.9	20.6	22.7	25.5
Side Swipe	24.1	21.3	37.9	38.5	46.7	41.6
Angle	19.5	22.8	17.8	20.1	14.7	16.9
Head On	1.9	2.2	1.7	2.6	1	1.7
Left Turn	4.1	5	4.1	4.4	2.9	4
Struck Parked Vehicle	21.4	14.4	17.6	13.8	12	10.3

Table 8: Percent Truck Crashes for Dark Conditions by Collision Type

Collision Type	1998-1999					
	SUT(2Axle)		Truck Trailer		Tractor/Semi Trailer	
	All	Dark	All	Dark	All	Dark
Rear End	29.1	23.7	20.9	15.4	22.7	19.3
Side Swipe	24.1	23.9	37.9	42.3	46.7	48.1
Angle	19.5	19.6	17.8	19.2	14.7	14.3
Head On	1.9	1.2	1.7	1.9	1	0.8
Left Turn	4.1	3.6	4.1	3.2	2.9	2.4
Struck Parked Vehicle	21.4	28	17.6	18	12	15.1

Table 9: Truck Crashes by Collision Type and Roadway System

Collision Type	1998-1999									
	Interstate		State Highway		Toll Roadway		County		Municipality	
	Total	%	Total	%	Total	%	Total	%	Total	%
Rear End	844	33.3	3133	35.2	773	30.2	1584	26.5	1049	14.8
Swipe	1409	55.6	3761	42.2	1438	56.1	1644	27.5	1708	24.0
Angle	200	7.9	1379	15.5	213	8.3	1461	24.4	1410	19.8
Head On	7	0.3	108	1.2	7	0.3	161	2.7	168	2.36
Left Turn	7	0.3	309	3.5	10	0.4	445	7.4	290	4.08
Struck Parked Vehicle	65	2.6	222	2.5	121	4.7	683	11.4	2481	34.9

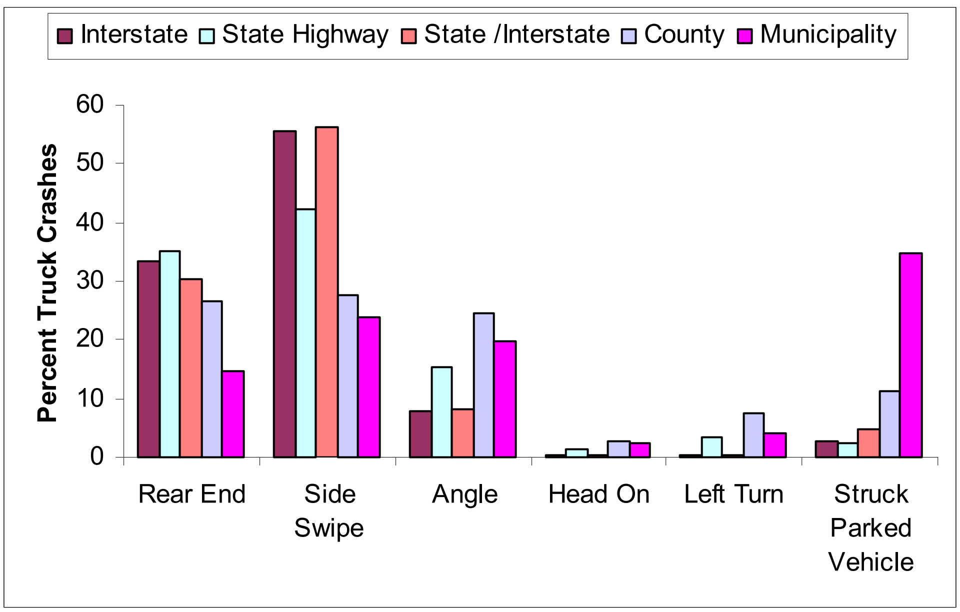


Figure 1. Percent Truck Crashes by Collision Type and Roadway System

Table 10: Percent Truck Accidents in Dark Condition by Roadway System and Vehicle Configuration

Roadway System	1998-1999					
	SUT(2Axle)		Tractor Trailer		Truck Trailer	
	All	Dark	All	Dark	All	Dark
Interstate	4.4	4.4	7.8	7.6	18	18.3
State Highway	28.4	30.2	35	41.9	27.9	24.1
Toll Road	5.1	7.6	4.1	5.3	22.5	28.3
County	27.7	22.9	22.6	19.2	15.8	15.5
Municipal	34.4	20.9	30.5	34.9	15.7	13.8

State/Interstate roadways. Angle collisions predominantly occur on county and municipal roadways. Struck parked vehicle collisions are a large percentage of the collision types on municipal roadways.

3.5 LIGHT AND DARK CONDITIONS

The majority of truck accidents occurred during daylight conditions with over 80 percent of truck accidents occurring under these conditions. A slightly higher percentage of single-vehicle truck accidents occurred in dark conditions when compared to multi-vehicle truck accidents. About 18 percent of single-vehicle truck accidents occurred in dark conditions compared to 14 percent of multi-vehicle truck accidents. This indicates the possibility of driver fatigue during dark conditions that may contribute to a higher proportion of single-vehicle truck crashes during these conditions.

Table 10 shows the percent of truck crashes in dark conditions by roadway system and vehicle configuration. Single-unit 2-axle trucks have a higher proportion of accidents on State highway and Toll roadways in dark conditions when compared to all single-unit 2-axle truck accidents. Tractor-trailers also have a higher proportion of accidents on State highway roadways and municipal roadways in dark conditions. Tractor/Semi-trailer vehicles have a higher proportion of accidents on Toll roadways during dark conditions. These findings suggest that policies towards roadway lighting on State highway roadways should be investigated as the data shows higher percentage of truck accidents on these roadways under dark roadway conditions.

3.6 ROAD CHARACTERISTICS

The majority of truck accidents occur on straight and level portions of roadway, with 72 percent of truck accidents occurring under these conditions. A slighter higher proportion of single-vehicle truck crashes occurred on curve and grade sections of roadway than multiple vehicle truck crashes. This is consistent with conditions where the truck driver may lose control of the vehicle as a result of the roadway geometrics.

The highest percentage of truck accidents occurred on roadway sections with a posted speed limit of 25mph. This posted speed limit accounted for 26 percent of truck accidents and involved a large percentage of single unit 2-axle trucks and truck trailers. This finding supports the restriction of large trucks to National Network roadways when the truck trip does not originate in New Jersey or have destinations within the State. The next highest percent of truck crashes occurred on roadway segments with a posted speed of 55 mph. These crashes involved a large percentage of tractor/Semi-trailers.

3.7 ACCIDENT EVENTS

Accident events for truck crashes were determined by reviewing the Sequence of Events fields of the accident report. The reporting officer can select up to four events that characterize the events that occurred during the crash. These accident events can be divided into three categories: Non-Collision Events, Collision with Fixed Objects Events and Collision with Non-Fixed Objects Events. Tables 11, 12 and 13 show the percent of accident events involving truck crashes falling within each of the three categories, respectively. About 3 percent of all truck crash events involve non-collision events. "Ran Off Road" crashes are identified as being involved with over forty-percent of truck crash events. This crash event, however, is typically a secondary event that may have occurred with another primary event that more directly contributes to the crash. The primary type of non-collision event is therefore "Overturn (Rollover)" with about seventeen percent of truck crash events involved in non-collision events falling in this category.

The majority of truck crash events involve a collision with a non-fixed object. These types of crash events represent 87 percent of all truck crash events with the primary non-fixed object "Moving Vehicles in Transport". Of the remaining type of collision events with non-fixed objects, crash events involving a collision with a parked motor vehicle is the next highest type of collision with a non-fixed object. This type of crash event represents 11 percent of truck crash events with a non-fixed object.

Truck crash events involving a fixed object represent six percent of all truck crash events and include several types of objects. The highest proportion of truck crash event with a known fixed object is a crash involving a curb (14 percent), a utility pole (9.4%), and a light standard (8.9%).

Table 11: Truck Crash Events Involving Non-Collision Events

Non Collision Events	1998-1999	
	Total	Percent
Overturn (Rollover)	685	17.4
Fire/Explosion	85	2.2
Immersion	125	3.2
Jackknife	353	8.9
Ran Off Road	1634	41.4
Downhill Runaway	71	1.8
Cargo Loss or Shift	392	9.9
Separation of Units	124	3.1
Other Non Collision	478	12.1

Table 12: Truck Crash Event Involving Non-Fixed Objects

Non-Fixed Object	1998-1999	
	Total	Percent
Pedalcycle	123	0.2
Pedestrian	224	0.3
Railway train	32	0.0
Animal	114	0.2
MV in Transport	62073	86.6
MV in Transport, Other Roadway	272	0.4
Parked MV	7784	10.9
Other Object (Non Fixed)	1071	1.5

Table 13: Truck Crash Event Involving Fixed Objects

Fixed Object	1998-1999		Fixed Object	1998-1999	
	Total	Percent		Total	Percent
Impact Attenuator	68	0.8	Other Post	242	2.8
Bridge/Pier/Abutment	588	6.8	Culvert	22	0.3
Bridge Parapet End	35	0.4	Curb	1243	14.3
Bridge Rail	136	1.6	Ditch	70	0.8
Guide Rail	634	7.3	Embankment	109	1.3
Median Barrier	452	5.2	Fence	232	2.7
Traffic Sign Post	486	5.6	Tree	512	5.9
Overhead Sign Support	200	2.3	Other Fixed Object	1875	21.6
Light Standard	775	8.9	Unknown	172	2.0
Utility Pole	819	9.4			

Table 14. Truck Rollovers for 2000 by Roadway System

Roadway System	Total Trucks Involved	Single Vehicle Involvement	Involvement Ratio	Single Vehicle Rollovers	Rollover Ratio
Interstate	1869	257	13.75	29	11.28
State Highway	5721	798	13.95	52	6.52
State/Interst. Auth.	1927	266	13.8	24	9.02
County	4301	951	22.11	34	3.58
Municipality	5615	1142	20.34	25	2.19

Table 15. Truck Rollovers for 2000 by Truck Configuration

Truck Configuration	Total Trucks Involved	Single Vehicle Involvement	Involvement Ratio	Single Vehicle Rollovers	Rollover Ratio
Single Unit Truck (2 Axle)	7307	1257	17.2	44	3.5
Single Unit Truck (3+Axle)	2044	328	16.05	20	6.1
Truck/Trailer	5182	1168	22.54	53	4.54
Truck/Tractor	663	125	18.85	5	4.0
Tractor/Semi-Trailer	5470	1221	22.32	49	4.01
Heavy Truck (Other)	1238	210	16.96	7	3.33

3.8 TRUCK ROLLOVERS CRASHES

Truck Overturns (Rollovers) have been recognized as a primary type of non-collision event with seventeen percent of truck crashes involved in non-collision events falling in this type of crash. Table 14 shows the number of truck rollovers by roadway system. Truck rollovers occur primarily on non-Interstate roadways including State highways (29%), County (22%) and municipal roadways (29%). For single-vehicle truck rollovers, the largest number of these types of truck rollovers also occurred on municipal roadways (33%), County roadways (28%) and State highways (23%). Tables 15 shows truck rollovers by truck configuration. Single-unit 2-axle trucks have the highest single vehicle involvement, followed by truck/trailers and tractor/semi-trailers.

3.9 TRUCK DRIVER CHARACTERISTICS

The highest percentage of truck accidents involve truck drivers falling in the age group between 31-35 years old, followed by age group of 36-40. Their higher percentage involvement may imply that there are higher numbers of truck drivers of these age groups. Table 16 shows the distribution of ages of truck drivers involved in accidents.

Table 16: Truck Driver's Age

Age of Truck Drivers	1998-1999	
	Total	Percent
21-25	3205	8.8
26-30	5419	14.9
31-35	6205	17.0
36-40	5969	16.4
41-45	5038	13.8
46-50	3843	10.5
51-55	3107	8.5
56-60	2220	6.1
61-65	1077	3.0
66-70	403	1.1

3.10 TEMPORAL DISTRIBUTION OF ACCIDENTS

Figure 2 shows the distribution of truck accidents by time of day. Most of these accidents occur beginning about 7 AM and then trail off by about 6 PM. The highest proportion of truck accidents occur during the AM peak hour, between 8 AM and 9 AM.

Figure 3 shows the percent of truck crashes my month. Truck crashes are fairly evenly distributed throughout the year, with the highest percent of truck crashes occurring during the months of October and December. Some peaking of truck accidents can be observed during the summer and late Fall/early winter months. The lowest percent of truck accidents appear to occur during the middle and late winter months.

3.11 ACCIDENT LOCATIONS

The top roadways with the highest truck accident frequency in New Jersey are shown in Table 17. The locations include four Interstate roadways, four state routes and a US route. US Route 1 and the I-95 portion of the New Jersey Turnpike have the two highest truck accident frequencies, as these routes also have some of the heaviest vehicular and truck volumes in the state. The accident rates of the routes also show US1 and I-95 as two of the higher accident rate locations.

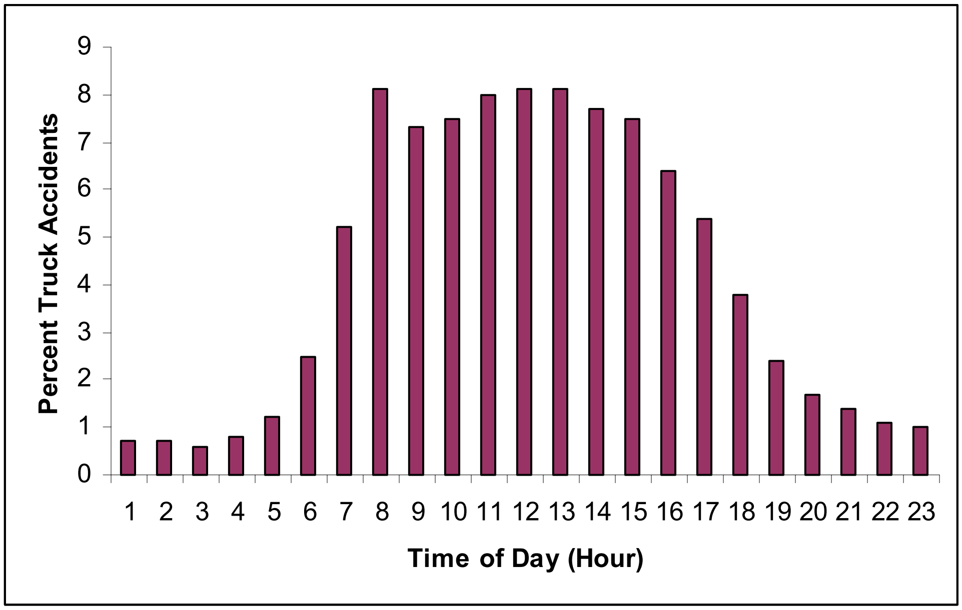


Figure 2. Percent of Truck Accidents by Time of Day (1998-1999)

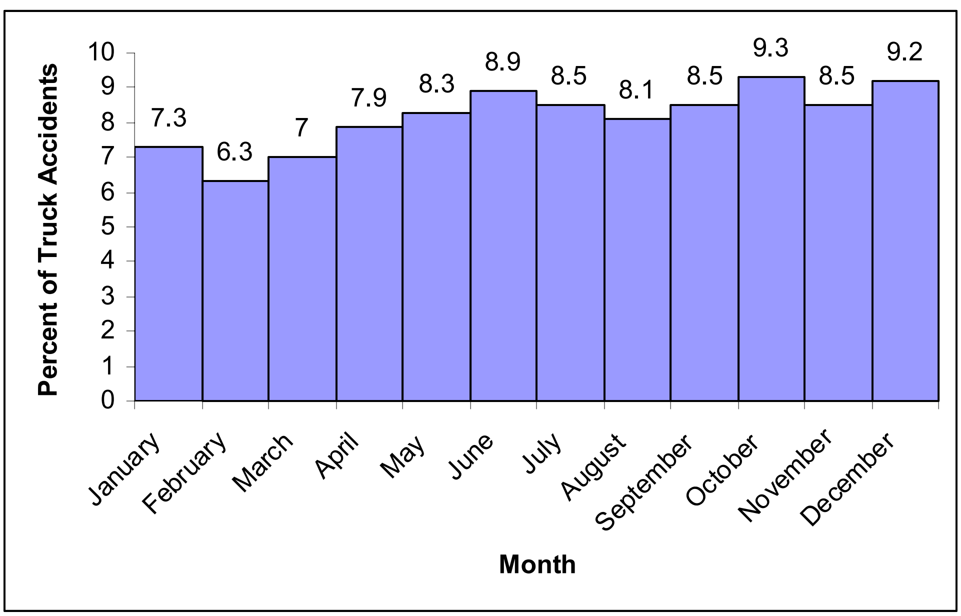


Figure 3. Percent of Truck Crashes by Month (1998 -1999)

3.11.1 500 and 600 Roadway Series

Tables 18 and 19 show the top 20 locations for truck crashes on 500 and 600 series roadways, respectively. Five-hundred roadway series roadways are primarily county roadways and 600 series roadways are primarily municipal roadways. Route 501, JFK Boulevard and Route 503, have the highest truck accident frequency on 500 or county roadways. Route 681 in Hudson County and Route 602 in Middlesex County had the highest truck accident frequency on 600 or municipal roadways.

3.11.2 Interchange Ramps

Table 20 shows the top locations for truck crashes at interchange ramps. Three routes identified with the highest number of truck crashes at interchanges include I-78, I-95 and Route 17. Further discussion of ramp locations with high truck crashes are provided in the case study analysis.

3.11.3 Intersections

Over 35 percent of truck crashes occurred at intersections. Table 21 shows the top intersections where truck crashes occurred at intersections in New Jersey. Of the top locations, 6 of the locations are along Route 1, with the intersection of Route 1 and Tonnelle Avenue Circle and the intersection of Route 1&9T and Charlotte Avenue Circle with the highest frequency. The majority of truck crashes at intersections occurred as the truck was making a right(28%), going straight ahead (22%), making a left-turn (20%) or slowing or stopping (19%).

3.12 TRUCK-PEDESTRIAN CRASHES

Truck crashes with pedestrians is of increasing concerning. These types of crashes represent about two percent of all truck crashes in the state. As shown in Table 22, the highest proportion of truck crashes with pedestrians occurred on municipal or local roadways, with 38 percent of truck crashes at intersections occurring on these types of roadways. State highways had the next highest percent of truck crashes at intersections, with 24 percent of truck crashes with pedestrians occurring on these roadways.

In the majority of truck-pedestrian crashes, the pedestrian maneuver was "Crossing/Entering Road at Intersection" with about 75 percent of truck-pedestrian crashes involving this pedestrian maneuver. Table 23 shows the remaining pedestrian maneuvers involved in truck-pedestrian crashes. Most of truck-pedestrian crashes occur under conditions of "No Control Present" with 48 percent of truck-pedestrian crashes falling in this category. Traffic signal control is present in 23 percent of truck-

Table 17. Top 10 Truck Accident Roadways By Crash Concentration

	Route Number	1999 Accident Frequency	Total Length (Miles)	Accident per Mile	Truck AADT	Accident per MVM
1	**US 1**	1124	64.9	17.31	4840	8.84
2	**I 95**	976	77.96	12.52	-	-
3	**NJ 21**	133	12.46	10.67	6795	5.27
4	**NJ 3**	102	10.84	9.41	10200	2.44
5	**NJ 17**	228	26.81	8.5	16498	1.43
6	**I 280**	150	17.85	8.4	9939	1.95
7	**I 78**	524	67.83	7.72	16440	4.5
8	**NJ 82**	33	4.93	6.69	999	18.18
9	**NJ 4**	71	10.89	6.51	7994	2.14
10	**I 80**	430	68.54	6.27	25965	0.73

Table 18. Top 20 Locations of Truck Crashes on 500 Series Roadways By Crash Concentration

	Route	Acc/Mile	1999 Accident Frequency	Route Length
1	506	6.05	65	10.74
2	529	4.92	52	10.57
3	503	3.89	69	17.72
4	501	3.02	160	53.06
5	508	2.66	43	16.14
6	507	2.29	65	28.34
7	509	2.21	57	25.78
8	531	2.20	30	13.61
9	577	2.11	21	9.96
10	514	2.07	89	42.95
11	549	1.91	34	17.82
12	541	1.80	43	23.84
13	510	1.59	47	29.58
14	585	1.25	12	9.57
15	505	1.11	23	20.64
16	537	1.10	75	67.91
17	551	1.01	35	34.57
18	525	0.89	15	16.88
19	516	0.88	17	19.27
20	502	0.84	20	23.79

Table 19. Top 20 Locations of Truck Crashes on 600 Series Roadways By Crash Frequency

	Route Number	1999 Accident Frequency	Route Length (Miles)	Accident Rate (Acc/Mile)	County
1	681	60	4.78	12.55	Hudson
2	602	39	-	-	Middlesex
3	656	37	-	-	Middlesex
4	601	33	6.61	4.99	Passaic
5	653	26	3.02	8.61	Hudson
6	617	23	-	-	Union
7	622	22	6.3	3.49	Mercer
8	610	22	-	-	Union
9	657	20	-	-	Middlesex
10	603	19	3.72	5.11	Essex
11	699	19	-	-	Hudson
12	649	18	5.31	3.39	Essex
13	602	18	-	-	Essex
14	646	18	4.03	4.47	Passaic
15	630	18	-	-	Union
16	640	17	2.26	7.52	Passaic
17	647	16	-	-	Passaic
18	676	15	1.05	14.29	Camden
19	603	15	-	-	Middlesex
20	615	15	-	-	Middlesex

Table 20. Top Four Locations for Truck Accidents at Interchange Ramps

	Route Number	Milepost	1999 Accident Frequency
1	78	58.58	22
2	95	67.48	11
3	95	50.18	8
4	17	12.35	7

Table 21. Truck Crashes at Intersections

Route	Mile Post Mile	1999 Number of Accidents	Cross Street
1	54.56	42	Tonnelle Avenue (Circle)
1&9 T	3.61	22	Charlotte Avenue (Circle)
1	45.44	20	North Avenue
439	0.62	17	RT 1 (Bayway Cirlce)
1	24.63	14	RT 130
70	8.31	14	RT 73 (Marlton Circle)
1	44.29	10	Jersey Street
1	31.46	9	Prince Street

Table 22. Road System of Truck-Pedestrian Crashes

Road System	1998-1999	
	Total	Percent
Interstate	34	4.8%
State Highway	169	23.7%
Toll Road	15	2.1%
State Park or Institution	2	0.3%
County	121	17.0%
Co. Auth. Park or Institution	1	0.1%
Municipal	273	38.3%
Private Property	96	13.5%
US Government Property	1	0.1%

Table 23. Pedestrian Maneuver of Truck-Pedestrian Crashes

Pedestrian Maneuver	1998-1999	
	Total	Percent
Crossing/Entering Road at Intersection	539	74.9%
Crossing/Entering Road Not at Intersection	52	7.2%
Walking on Road with Traffic	22	3.1%
Walking on Road Against Traffic	15	2.1%
Playing in Road	6	0.8%
Standing in Road	23	3.2%
Getting On/Off Vehicles	33	4.6%
Pushing or Working on Vehicle	14	1.9%
Other Working on Vehicle	16	2.2%

pedestrian crashes. The findings suggest that focus should be placed on improving safety at intersection for pedestrians.

Chapter IV

FATAL TRUCK CRASH ANALYSIS

4.0 OVERVIEW

In addition to studying all truck crashes in New Jersey, fatal truck crashes were also studied to identify characteristics of these types of crashes. The research also examined differences between fatal truck crashes and all vehicular fatal crashes in the state.

Fatal crashes in New Jersey involving trucks account for about 11 percent of fatal crashes. Table 24 shows the number of fatal crashes during the period between 1994 and 2001. During this period, an average of 76 fatal crashes involving a truck per year occurred in the State of New Jersey. Data for this research were obtained from the National Highway Traffic Safety Administration's (NHTSA's) Fatality Analysis Reporting System (FARS) database.

Table 24. Fatal Truck Crashes in New Jersey for 1994 - 2001

Year	Total Fatal Crashes	Fatal Truck Crashes	Percent of all Fatal Crashes
1994	691	74	10.7%
1995	719	90	12.5%
1996	754	79	10.5%
1997	700	80	11.4%
1998	671	66	9.8%
1999	664	56	8.4%
2000	659	90	13.6%
2001	685	70	10.2%

4.1 INVOLVED VEHICLES

The majority of fatal truck crashes involve another vehicle, with only 20 percent of fatal truck crashes involving one vehicle compared to 56 percent of all fatal crashes involving one vehicle. Table 25 shows the number of involved vehicles for fatal truck crashes and for all fatal crashes in New Jersey. Sixty-two percent of fatal truck crashes involve 2 vehicles and 15 percent involve three vehicles. These percentages are significantly different to the percent of all fatal accidents involving two and three vehicles.

Table 25. Number of Involved Vehicles (1997- 2000)

Number of Vehicles Involved	Fatal Truck		All Vehicle Fatal	
	Total	Percent	Total	Percent
5 vehicles	3	1.55%	7	0.34%
4 vehicles	2	1.03%	17	0.84%
3 vehicles	29	14.95%	120	5.90%
2 vehicles	121	62.37%	743	36.51%
1 vehicle	39	20.10%	1148	56.41%

4.2 MANNER OF COLLISION

As shown below in Table 26, the collision type with the highest percent of fatal truck crashes is angle collisions with 31 percent of fatal truck crashes. The highest percent of all fatal crashes is, however, single-vehicle collisions. This shows that fatal truck crashes are more likely to be involved with another vehicles with 27 percent of fatal truck crashes single-vehicle collisions. Over nineteen percent of fatal truck crashes are rear end crashes compared to almost six percent of all fatal crashes. This difference is primarily due to the inability of trucks to slow or stop because of its massive load.

4.3 LIGHT CONDITIONS

Over 65 percent of the fatal truck crashes occurred during daylight conditions compared to 51 percent of all fatal accidents in New Jersey as shown below in Table 27. This indicates that fewer fatal truck crashes occur during dark conditions than compared to all fatal crashes and dark conditions may not be as critical a contributing factor in truck fatal crashes. There were statistical significant differences between fatal truck crashes and all fatal vehicle crashes concerning daylight and dark but lighted driving conditions.

4.4 ROADWAY CHARACTERISTICS

A higher proportion of fatal truck crashes in New Jersey occurred on urban roadways when compared to rural roadways as shown in Table 28. About 70 percent of fatal truck crashes occurred on urban roadways compared to 30 percent on rural roadways. Principal roadways, consisting of the Interstates and other freeways and expressways, account for 38 percent of fatal truck crashes, while other secondary roadways account for 62 percent of truck crashes. This suggests the need to address truck safety on secondary roadways.

Table 26. Fatal Crashes in NJ by Manner of Collision (1997-2000)

Manner of Collision	Fatal Truck		All Vehicles Fatal	
	Total	Percent	Total	Percent
Single-Vehicle Collision	53	26.9%	1228	60.3 %
Rear-End	41	20.8%	118	5.8 %
Head-On	35	17.8%	268	13.2 %
Angle	61	31.0%	384	18.9 %
Sideswipe, same direction	7	3.6%	38	1.9 %
Total	197	100.0%	2036	100.0%

Table 27. Light Conditions (1997-2000)

Light Conditions	Fatal Truck		All Vehicles Fatal	
	Total	Percent	Total	Percent
Daylight	127	64.8%	1059	50.5%
Dark	18	9.2%	234	11.2%
Dark but Lighted	43	21.9%	637	30.4%
Dawn	3	1.5%	45	2.1%
Dusk	5	2.6%	120	5.7%
	196	100.0%	2095	100.0%

A comparison of the functional classification of roadways on which fatal truck crashes occurred compared to where all fatal crashes occurred showed significant differences in three types of roadways: rural principal arterial, rural local roadways, and urban principal interstate arterials. A higher percent of fatal truck crashes occurred on urban and rural principal arterials than compared to the percent of all fatal crashes on these type roadways. Rural local roadways had a lower percent of fatal truck crashes than compared to the percent of all fatal crashes on this roadway type. This is consistent with the lower vehicle miles travel of trucks on these roadways.

Table 28. Fatal Truck Crashes by Roadway Functional Classification (1997-2000)

Functional Classification	Fatal Truck		All Vehicle Fatal	
	Total	Percent	Total	Percent
Rural Principal Arterial-Interstate	9	4.2%	32	1.6%
Rural Principal Arterial, Other	28	13.2%	164	8.1%
Rural Minor Arterial	13	6.1%	85	4.2%
Rural Major Collector	9	4.2%	143	7.0%
Rural Minor Collector	3	1.4%	31	1.5%
Rural Local Road or Street	2	0.9%	79	3.9%
Unknown Rural	0	0.0%	2	0.1%
Total Rural Roadways	**64**	**30.2%**	**536**	**26.4%**
Urban Principal Arterial-Interstate	30	14.2%	126	6.2%
Urban Principal Arterial-Other	15	7.1%	161	7.9%
Urban Principal Arterial - Other	51	24.1%	484	23.8%
Urban Minor Arterial	29	13.7%	398	19.6%
Urban Collector	7	3.3%	141	6.9%
Urban Local Road or Street	16	7.5%	183	9.0%
Unknown Urban	0	0.0%	3	0.1%
Total Urban Roadways	**148**	**69.8%**	**1496**	**73.5%**

Table 29. Most Harmful Event for Fatal Truck Crashes (1997-2000)

Most Harmful Event	Fatal Truck		All Vehicle Fatal	
	Total	Percent	Total	Percent
Collision with Fixed Object	20	8.4 %	661	32.5 %
Collision with Non-Fixed Object	209	87.8 %	1311	64.4 %
Non-Collision Event	8	3.4 %	57	2.8 %

The profile and alignment of the roadways did not result in significant changes in the percent of fatal truck crashes when compared to all fatal crashes. The majority of fatal truck crashes occur on level roadways and on straight sections. A majority of all fatal truck crashes occurred on two-lane roadways, with sixty-four percent of fatal crashes occurred on roadways with two travel lanes, twenty-three percent on roadways with three travel lanes and 11 percent on roadways with four travel lanes. There is, however, a significantly lower percent of fatal truck crashes on two-lane roadways than compared to all fatal crashes.

Table 30. Fatal Accident Locations (1997-2000)

Route Type	Count	Percentage
Interstates	40	37.38%
US	44	41.12%
SR	10	9.35%
RT	9	8.41%
CR	4	3.74%

Fatal truck crashes primarily occurred on roadways with a speed limit greater than or equal to 50 mph. Fatal truck crashes at speed limits of 25, 30, 55, and 65, were shown to be significantly different that fatal crashes for all vehicles. Speed limit postings at 55 and 65 mph showed higher truck crashes and were significantly different from all vehicular crashes.

4.5 CONTRIBUTING FACTORS

The most harmful events attributed to fatal crashes are summarized on crash reports as collision with fixed object, collision with objects not fixed, and non-collision events. As shown in Table 29, the majority of fatal truck crashes involve a collision with a non-fixed object and most of these objects are another motor vehicle. Eighty-eight percent of fatal truck crashes involve collisions with non-fixed objects with 77 percent of fatal truck crashes involving a crash with another motor vehicle and 14 percent involving a crash with a pedestrian. A smaller percent of fatal truck crashes involve a collision with a fixed object than compared to all fatal crashes. Eight percent of fatal truck crashes are due to collisions with fixed-objects, compared to 32 percent for all fatal crashes.

4.6 VIOLATION CHARGES

Nine percent of fatal truck crashes were attributed to the driver's inattentiveness, carelessness, and improper driving style. While the second highest charges, at 4 percent, was due to failing to yield or equipment violation. Fatal truck crashes in this category followed very close to the entire vehicle population.

4.7 ACCIDENT LOCATIONS

As shown in Table 30, a majority of fatal truck crashes occur on US and Interstate roadways. These roadways account for almost 79 percent of all fatal truck crashes in New Jersey.

Chapter V

TRUCK CRASH CASE STUDIES

5.0 OVERVIEW

Truck crash case studies were performed for high truck accident locations in New Jersey. The objective of the studies was to investigate accident characteristics and roadway geometrics to determine possible contributing factors, as well as, mitigation technologies and approaches for improving safety at these locations. The locations for performing the field studies were identified by first visiting each of the locations included in the top 10 truck crash routes provided in Table 17 in Chapter III, the top intersections in Table 21, and the top ramp interchanges in Table 20. The locations considered are shown in Table 31 and include the top highest accident frequency locations at Route 1 and Route 95. Two locations are studied on Route 1, including two intersections, three locations are also studied on Route 95, the New Jersey Turnpike, including two ramp interchanges. Five additional ramp interchange locations were included as case studies.

5.1 CASE STUDIES

The case studies are organized by first providing a description of the crash location, the geometric conditions found at the location, accident analysis for crashes at the study location, and finally possible solutions are identified for treating accidents.

Table 31. Case Study Locations

Case Study	Location	Milepost	Municipality	County
1	RT 1 and North Avenue	45.44	Elizabeth	Union
2	RT 1 and Tonnelle Circle	54.56	Jersey City	Hudson
3	RT 95 at Exit 16E	67.48	Secaucus	Hudson
4	RT 95 at Exit 12	50.0 - 51.0	Carteret	Middlesex
5	RT 95	42.0 - 43.0	Edison	Middlesex
6	RT 3	6.0 - 7.0	Rutherford	Bergen
7	RT 82 (Morris Avenue)	0.0 - 5.0	Union	Union
8	RT 4 at RT 17	3.0 - 4.0	Paramus	Bergen
9	I-280 at RT 21 (Int. #15)	14.0 - 15.0	Newark	Essex
10	I-287 at RT 10 (Int. #39)	39.0 - 40.0	Hanover	Morris
11	I-78 at RT 95	57.0 - 59.0	Newark	Essex
12	I-80/RT46 (Interchange #47)	46.0 - 47.0	Parsippany	Morris

5.2.1 Case 1: Intersection of Route 1 and CR 624 (North Avenue) (Milepost 45.44)

Location

The study location is situated in Elizabeth City, Union County on Route1 at the intersection with CR 624 (North Avenue). The intersection is located at milepost 45.44 on Route 1. The intersection area is within close proximity to Newark International Airport and Port Newark and Elizabeth seaport. Both the airport and the seaport are major hubs for freight movement, attracting large numbers of trucks. To the east of the intersection are residential areas, which increases the conflict between passenger cars and trucks originating from the airport and seaport.

Geometric Configuration

The geometric configuration of Route 1 changes at the intersection with difference in roadway alignment and profile south and north of the intersection. South of the intersection, the roadway has three lanes in each direction with a paved median and the posted speed limit is 40 mph. North of the intersection, an inner and outer roadway is provided. Both the inner and outer roadways have four lanes for both directions. The conflicts at the intersection are primarily due to this change in roadway configuration that occurs before and after the intersection. Multiple merge areas, and a lack of positive pavement markings, create some confusion as several merges occur within a short distance. In addition, on the southbound approach the intersection is located at the end of a downgrade, which combined with heavy truck volumes, contributes to truck crashes at this location. The east approach to North Avenue has two lanes, one in each direction. Vehicles on North Avenue, turning onto Route 1, also have problems with limited area for queuing in the intersection.

Accident Analysis

This intersection is ranked by the State as number 4, in the top 100 intersections with the highest crash frequency and severity. In 1998 and 1999, there were 46 truck accidents at the intersection. Sixty-three percent of the accidents involved either northbound vehicles or southbound vehicles at the intersection with the majority of vehicles involved in accidents at the location traveling in the southbound direction. Half of truck accidents at the intersections involved same direction side-swipe collisions and 20 percent are rear-end accidents. The large percentage of same direction side-swipe accidents suggests problems with lane changing, which is consistent with the frequent number of merges occurring within the intersection area. The pre-accident vehicle action includes many maneuvers, however, the largest percent of accidents involve two vehicles going straight. This maneuver represents 13 percent of truck crashes at the intersection. An additional 22 percent of truck crashes involve a vehicle making either a right or a left turn. Many of the above same direction sideswipe truck crashes are occurring at the Route 1 northbound ramp terminus at North Avenue are due to trucks making a wide right-turn.

This intersection is scheduled to be reconstruction and is currently in the Final Scope Development phase of the scoping process. The long-term intersection reconstruction project is schedule to begin in March 2005. Several intersection upgrades have been recommended in the interim and are expected to be implemented in 2003.

5.2.2 Case 2: Intersection of Route 1 and Tonnelle Circle (Milepost 54.56)

Location

Tonnelle Circle is located in Jersey City, Hudson County, along Route 1 at milepost 54.5. This circle connects Route 1&9 with Route 139. As the circle provides access to the Holland Tunnel, both the vehicular and truck volumes using the circle and intersection are very high.

Geometric Configuration

The geometric configuration in an around the Tonnelle circle is very complicated. Some of the approaches are signalized and some are controlled using traffic islands and pavement markings. At this location, Route 1 runs East-West and consists of two lanes in each direction with a center median. The lane and shoulder widths are narrow, which results in large trucks encroaching into adjacent lanes during turning maneuvers.

Accident Analysis

This intersection is ranked by the State as number 23 on the top 100 list of intersections with the highest accidents. In 1998 and 1999, there were 89 truck accidents at the intersection. Forty-six percent of the accidents involved southbound vehicles at the intersection and 29 percent of the vehicles were headed north. Sixty-five percent of truck accidents at the intersections involved same direction side-swipe collisions and 19 percent are rear-end accidents. The large percentage of same direction side-swipe accidents suggests problems with lane changing. The pre-accident vehicle action includes many maneuvers, however, the largest percent of accidents involve two vehicles going straight. This maneuver represents 31 percent of truck crashes at the intersection.

Signal timing changes have been recommended and are being implemented, including the use of additional or extended all-red intervals within the signal timing plan. Some minor geometric and signal upgrade work will be performed. The long-term plans are to eliminate the circle under a circle elimination project.

5.2.3 Case 3: Route 95 (NJ Turnpike) –Exit 16E (Milepost 67.48)

Location

The location under study is on Route 95, NJ Turnpike, (Milepost 67.48) in Secaucus Township, Hudson County. The specific problem area is in the approach toll plaza lanes to the north and southbound direction of the New Jersey Turnpike at Exit 16E. The toll plaza is used by vehicles accessing the Lincoln Tunnel and has heavy vehicular and truck volumes.

Geometric Configuration

The roadway profile at this location has a crest-curve with multiple merge and diverging lanes into the toll plaza area.

Accident Analysis

In 1998 and 1999, there were 115 truck accidents at the ramp exit. Sixty-two percent of truck accidents at this location involved same direction side-swipe collisions and 18 percent are rear-end accidents. Thirty-four percent of truck accidents at this location involved a merging vehicle, and 25 percent involved a vehicle changing lanes prior to the accident. About 30 percent of pre-accident vehicle actions, however, involved vehicles going straight.

Additional signing may be the most feasible solution at this location. Further studies to ensure that the existing signs are properly placed may also be warranted. Technological solutions may also exist in terms of variable message signs with warnings of the approaching roadway conditions. This solution, however, would require that the location be first treated using standard signing.

5.2.4 Case 4: Route 95 (NJ Turnpike) – Exit 12 (Milepost 50.0 - 51.0)

Location

The study location is in Carteret Borough, Middlesex County between the milepost 50.0 and 51.0. The specific problem area is on the northbound approach of the New Jersey Turnpike approaching Exit 12.

Geometric Configuration

The NJ Turnpike at this location has four northbound lanes and a single exit lane. One of the problems associated with this location is limited sight-distance approaching the exit ramp. The exit is slightly hidden from approaching vehicles due to a short crest curve which has the effect of hiding the exit ramp. As a result, vehicles headed to the exit may misjudge the distance to the exit. When vehicles are queued at the exit ramp, approaching vehicles have an even shorter distance before they can merge into the exit lane.

Accident Analysis

In 1998 and 1999, there were 81 truck accidents at this location. Forty-six percent of truck accidents at the location involved same direction side-swipe collisions and 27 percent are rear-end accidents. Twenty percent of these accidents involve vehicles slowing or stopped in traffic and 18 percent involve vehicles changing lanes or merging. Thirty-seven percent of truck accidents, however, involve vehicles going straight.

At present, the drivers can only see the exit sign, but cannot see the pavement marking that separates the off ramp with the main line and cannot determine how many lanes go to the exit. An immediate solution would be to place a warning sign showing the number of lanes going to exit near the overpass bridge.

5.2.5 Case 5: Route 95 (NJ Turnpike) - Exit 10 (Milepost 42.0 - 43.0)

Location

The location under study is on Route 95, NJ Turnpike, (Milepost 42.0 - 43.0) in Edison Township, Middlesex County approaching the toll plaza at Exit 10. Accidents in this location suggest that the specific problem area is in the toll plaza lanes and ramp to the toll plaza for both the north and southbound direction of the New Jersey Turnpike.

Geometric Configuration

This section of the turnpike is divided with three lanes in each direction. The speed limit of the mainline roadway is 65 mph and all lanes are 12 feet with 12 feet shoulders in both directions. Two-lane ramps lead to the toll plaza with a downgrade alignment on the ramps.

Accident Analysis

In 1998 and 1999, there were 115 truck accidents in toll plaza, and ramp areas for both the northbound and southbound approaches. Fifty-one percent of truck accidents at the location involved same direction side-swipe collisions and 20 percent are rear-end accidents. Nineteen percent of these accidents involve vehicles slowing or stopped in traffic and 26 percent involve vehicles changing lanes or merging. Thirty-one percent of truck accidents, however, involve vehicles going straight.

During the field visit, it was felt that installing a sign stating "Slow Down" at an appropriate location to warn drivers on the mainline and exiting vehicles of the upcoming merge, may be effective in reducing the potential for accidents at this location.

5.2.6 Case 6: Route 3 (Milepost 6.0 -7.0)

Location

The study location is situated in Rutherford, Bergen County. This location on Route 3 includes the interchange with Route 17 and is used by vehicles accessing the Meadowlands Sports Complex and Arena.

Geometric Configuration

The roadway has three lanes in each direction with a speed limit of 55 mph.

Accident Analysis

In 1998 and 1999, there were 27 truck accidents within milepost 6.0 and 7.0 of Route 3 in both the eastbound and westbound directions. Fifty-seven percent of vehicles involved in truck accidents at this location were traveling in the westbound direction and 27 percent were traveling in the eastbound direction. Forty-eight percent of truck accidents at the location involved same direction side-swipe collisions and 19 percent are rear-end accidents. Twenty-four percent of these accidents involve vehicles changing lanes or merging and sixty-one percent involve vehicles going straight. About 30 percent of truck accidents in this location occurred under wet road conditions, suggesting the need for further studies to determine the skid resistance of the pavment and visibility of the markings.

One approach for reducing accidents on Route 3 may be through the use of overhead signing with lane arrows to allow drivers to stay within lanes at the interchange.

5.2.7 Case 7: Route 82 - Morris Avenue (Milepost 0.0 - 5.0)

Location

The study location is situated in Union, Union County. The roadway is designated as an Urban Principal Arterial. Route 82, Morris Avenue, extends for 5.0 miles extending from I-78, crossing the Garden State Parkway, and ending at Route 27. The roadway acts as a bypass for I-78 vehicles.

Geometric Configuration

Route 82 has several signalized and unsignalized intersections with several driveways providing access to the roadway. The route is undivided with four lanes provided for the eastbound and westbound directions with a speed limit varying between 30 and 35 mph.

Accident Analysis

In 1998 and 1999, there were 51 truck accidents on Route 82 in both the eastbound and westbound directions. Forty-two percent of vehicles involved in truck accidents at this location were traveling in the eastbound direction and 33 percent were traveling in the westbound direction. Thirty-seven percent of truck accidents at the location involved same direction side-swipe collisions, 14 percent involved angle collisions, and 12 percent involved rear-end collisions. Thirty-four percent of truck accidents involved vehicles going straight and 28 percent involved vehicles making either a left or right-turn. About 14 percent of truck crashes at this location occurred under light conditions that were dark with street lights on and 16 percent occurred under wet weather conditions.

5.2.8 Case 8: Route 4 (Milepost 3.0 -4.0)

Location

The study location is situated in Paramus, Bergen County. This location on Route 4 includes a major interchange with Route 17. The Garden State Parkway Mall is also located in the southwest quadrant of the interchange. This interchange was under construction during the period when the accident data were collected for this analysis. The location, however, is still included in our field analysis.

Geometric Configuration

Route 4 is an urban principal arterial with a speed limit of 40 mph. The number of lanes at this location varies from three to four lanes along the mainline approach. The interchange is very complicated with multiple lane entry and exits. Route 17 is also an urban principal arterial with a speed limit of 50 mph and 6 lanes for both directions at the interchange location.

Accident Analysis

Based on 1998 and 1999 accident data, this intersection is ranked by the State as number 2, in the top 100 intersections with the highest accidents. In 1998 and 1999, there were 29 truck accidents within milepost 3.0 and 4.0 of Route 4 in both the eastbound and westbound directions. Forty-three percent of vehicles involved in truck accidents at this location were traveling in the westbound direction and 33 percent were traveling in the eastbound direction. Forty-eight percent of truck accidents at the location involved same direction side-swipe collisions and 41 percent are rear-end accidents. The large percentage of rear-end accidents is consistent with accidents in congested locations such as surrounding the interchange. Twenty percent of these accidents involve vehicles slowing or stopping and 24 percent involve vehicles changing lanes or merging. Fifty percent of the accidents involve vehicles going straight.

In 1998 and 1999, there were 67 truck accidents within milepost 12.0 and 13.0 of Route 17 in both the northbound and southbound directions. Fifty-three percent of vehicles involved in truck accidents at this location were traveling in the southbound direction and 31 percent were traveling in the northbound direction. Sixty-one percent of truck accidents at the location involved same direction side-swipe collisions and 28 percent are rear-end accidents. Vehicles involved in truck accidents at this location are primarily going straight prior to the accident, with 48 percent of accidents involving vehicles going straight. Another 15 percent of truck crashes involved vehicles slowing or stopped in traffic, and 26 percent involved vehicles changing lanes or merging. About 18 percent of truck crashes at this location occurred under light conditions that was dark with street lights on and 19 percent occurred under wet weather conditions

The construction at the interchange has been completed. The State plans to monitor this location to ensure that all safety problems are addressed.

5.2.9 Case 9: I-280 at RT 21 (Interchange # 15)

Location

The interchange of I-280 and Route 21 is situated in Newark, Essex County. The roadways connected by the interchange are some of the highest volume roadways in the city of Newark, with a high percentage of truck volumes. The heavy volumes using the interchange is also due to the ability to access the New Jersey Turnpike from Route 21 using this interchange. Route 21 also provides access to Route 1, Newark International Airport and to Ports Newark and Elizabeth.

Geometric Configuration

I-280 at the interchange has six lanes serving both the eastbound and westbound directions. There are two closely spaced on-ramps in the eastbound direction and two closely spaced off-ramps in the westbound direction. Just east of the interchange is the Stickel Memorial Bridge crossing the Passaic River. The short distances between the ramps, particularly the on-ramps in the eastbound direction, result in drivers on and off I-280 having to make significant speed changes and perform merge or diverge operation in a short distances. Merging for entering vehicles at the interchange is made even more difficult because of the lack of acceleration lanes on I-280. As a result of no acceleration lanes, vehicles entering I-280 from Route 21 must make a complete stop before entering the roadway. Furthermore, the upstream on-ramp from Broad Street lies 0.1 mile within the interchange, while the downstream off-ramp to the City of Harrison is near (about 0.13 miles) to the interchange. The volumes within this area are heavy, resulting in a poorly operating weaving section with limited sight distance for vehicles entering and exiting at this location.

Geometric conditions for vehicles exiting from I-280 to Route 21 also contribute to the accidents at this location. Sight distance for vehicles making a right from I-280 to Route 21 is limited due the presence of a bridge support. Vehicles have been seen to enter the left lane when merging into the right lane onto Route 21.

Route 21 is designated as an urban principal arterial with a speed limit of 35 mph. There are 2 lanes in each direction from milepost 2.0 to 2.5 and 3 lanes in each direction from milepost 2.5 to 3.0. The roadway is undivided with nine signalized intersections within the study area.

Accident Analysis

In 1998 and 1999, there were 62 truck accidents within milepost 14.0 and 15.0 of I-280 in both the eastbound and westbound directions. Fifty-two percent of vehicles involved in truck accidents at this location were traveling in the eastbound direction and 32 percent were traveling in the eastbound direction. Thirty-nine percent of truck accidents at the location involved same direction side-swipe collisions and 34 percent are rear-end accidents. Vehicles involved in truck accidents at this location are primarily going straight prior to the accident, with 48 percent of accidents involving vehicles going straight. Another 15 percent of truck crashes involved vehicles slowing or stopped in traffic, and 21 percent involved vehicles changing lanes or merging. Seven of the truck accidents at this location involve vehicles running off the road. A significant percent of truck crashes at this location occurred under light conditions that were dark with street lights on and about 23 percent occurred under wet weather conditions.

On Route 21 in 1998 and 1999, there were 72 truck accidents within milepost 3.0 and 4.0 in both the northbound and southbound directions. Forty-four percent of vehicles involved in truck accidents at this location were traveling in the northbound direction and 40 percent were traveling in the southbound direction. Thirty-nine percent of truck accidents at the location involved same direction side-swipe collisions and 38 percent are rear-end accidents. Sixteen percent of these accidents involve vehicles slowing or stopping and 51 percent involve vehicles going straight. A significant number of truck crashes in this location involve wet weather conditions with 21 percent of truck crashes involved in these conditions.

The truck accidents at this location are primarily due to geometric conditions that place two on-ramps in the eastbound direction and two off-ramps in the westbound direction very close to each other. These conditions make for difficultly in merging on to I-280. Outside of reconstruction of the interchange, technologies should be investigated for assisting drivers with merging onto I-280.

5.2.10 Case 10: I-287 at RT 10 (Interchange #39)

<u>Location</u>

The interchange of I-287 and Route 10 is situated in Hanover, Morris County. The interchange may be used by I-287 vehicles destined to I-280, but using Route 10 as a bypass.

<u>Geometric Configuration</u>

The interchange is a diamond interchange with loop ramps in some quadrants of the interchange. The radius of the ramp connecting eastbound Route 10 with I-287 northbound is small, requiring drivers to reduce their speeds and then merge with high-speed vehicles of I-287. On the ramp connecting westbound Route 10 to southbound I-287, vehicles must merge with high-speed vehicles on I-287.

Accident Analysis

In 1998 and 1999, there were 51 truck accidents within milepost 39.0 and 40.0 of I-287 in both the northbound and southbound directions. Forty-eight percent of vehicles involved in truck accidents at this location were traveling in the southbound direction and 40 percent were traveling in the northbound direction. Forty-five percent of truck accidents at the location involved same direction side-swipe collisions and 26 percent are rear-end accidents. Vehicles involved in truck accidents at this location are primarily going straight prior to the accident, with 46 percent of accidents involving vehicles going straight. Another 16 percent of truck crashes involved vehicles slowing or stopped in traffic, and 26 percent involved vehicles changing lanes or merging. Thirteen percent of truck accidents were attributed to improper lane changing. About ten percent of truck crashes at this location occurred under light conditions that were dawn or dusk and 18 percent occurred under wet weather conditions.

5.2.11 Case 11: I-78 at RT 95 (Milepost 57.0 - 59.0)

Location

The interchange of I-78 and RT 95, New Jersey Turnpike, is situated in Newark, Essex County. I-78 at this location becomes the NJ Turnpike Extension with a toll plaza located within the study section. The roadways connected by the interchange are some of the highest volume roadways in the city of Newark, with a high percentage of truck volumes. The interchange has a large number of vehicles, including trucks, providing access to Newark International Airport, Ports Newark and Elizabeth and to the Holland Tunnel in Jersey City.

Geometric Conditions

I-78 at this location has between 4 and 6 lanes in both directions with a posted speed limit of 65 mph. The interchange is located adjacent to two other high volume interchanges of I-78 with Route 1/9 and I-78 with Route 21. The location of a toll plaza within the study area causes some additional changes within the lane configuration of I-78.

Accident Analysis

In 1998 and 1999, there were 250 truck accidents within the two-mile segment of milepost 57.0 and 59.0 on I-78 in both the eastbound and westbound directions. Thirty-three percent of vehicles involved in truck accidents at this location were traveling in the eastbound direction and 30 percent were traveling in the westbound direction. Half of truck accidents at the location involved same direction side-swipe collisions and 20 percent are rear-end accidents. Vehicles involved in truck accidents at this location are primarily going straight prior to the accident, with 36 percent of accidents involving vehicles going straight. Another 14 percent of truck crashes involved vehicles slowing or stopped in traffic, and 30 percent involved vehicles changing lanes or merging. About 17 percent of truck crashes at this location occurred under light conditions that were dark with street lights on and 12 percent occurred under wet weather conditions.

5.2.12 Case 12: I-80/RT 46 (Interchange #47)

Location

The interchange of I-80 and RT 46, is situated in Parsippany-Troy Hills, Morris County. The interchange also serves as the beginning of I-280 which from I-80. The interchange has large volumes with a high percent of truck traffic.

Geometric Conditions

I-80 at this location has six lanes for both the eastbound and westbound directions with a 65 mph posted speed limit. Directional ramps are provided for vehicles exiting I-80 to I-280 and Route 46. I-80 at this point in the roadway also has horizontal curvature which combined with exit/entrance ramps makes for safety concerns.

Accident Analysis

In 1998 and 1999, there were 55 truck accidents on I-80 between milepost 47.0 and 48.0 in both the eastbound and westbound directions. Truck accidents at this location primarily involve vehicles traveling in the eastbound direction. Seventy-six percent of vehicles involved in truck accidents at this location were traveling in the eastbound direction and 20 percent were traveling in the westbound direction. Just over half of truck accidents at the location involved same direction side-swipe collisions with 55 percent of truck accidents involved in this type of collision. Twenty percent of the accidents involve rear-end collisions. Vehicles involved in truck accidents at this location are primarily going straight prior to the accident, with 54 percent of accidents involving vehicles going straight. Another 36 percent of truck crashes involved vehicles changing lanes or merging. Truck accidents at this location may be attributed to light conditions as 25 percent of these accidents occurred under dark conditions. These conditions included "Dark Street Lights On", "Dark Street Lights Off", and " Dark No Street Lights".

Chapter VI

TRUCK ACCIDENT INFORMATION AND MANAGEMENT SYSTEM (TAIMS)

6.0 OVERVIEW

Geographic Information Systems (GIS) can be applied for collecting, storing, processing, and displaying information about areas of the earth. In recent years, GIS has been applied to many areas in transportation. However the application of GIS in the truck accident analysis has not been explored extensively. The application of computer information technology, such as GIS, to the accident data management can greatly improve the efficiency for analyzing factors that contribute to the accidents, and hence find the mitigation measures. Since GIS has the ability of spatial referencing and graphical displays that are very helpful to visually dispose accidents, it is desirable to develop a GIS-based accident information and management system.

The GIS-based system developed in this research can visualize a large amount of data at both macroscopic level (e.g., showing the rates of high accident crash locations) and microscopic level (e.g., creating collision diagrams). It can be used to study individual crashes in relation to the roadway geometry and other safety hardware, as well as summarize all crashes within a designated segment or area of a specific roadway network or region. Because of the capability of data integration, the proposed GIS-based system may encompass more information, such as introducing geometric, traffic and accident, and demographic data into GIS, rather than just displaying the locations of accidents. Thus, the data can be managed in a uniform and structured manner, which be retrieved and manipulated more efficiently and reliably than that in manual systems.

With the purpose of managing truck accident records in an efficient way, we developed a GIS-based Truck Accident Information and Management System for New Jersey Department of Transportation (NJDOT).

6.1 OBJECTIVE AND SCOPE

The objective of this study is to develop a GIS-based Truck Accident Information and Management System (TAIMS) that can help to identify factors and accident mitigation technologies. These mitigation measures can be considered to reduce the frequency and severity of traffic crashes statewide. The purpose of the study is twofold. The first one is to construct a comprehensive GIS database to illustrate study findings in both graphical and tabular form, while the second is to analyze accident factors and the countermeasures with the application of TAIMS.

To fulfill this study, the following tasks are accomplished:

- Develop a GIS-based accident management information system for the data collection, integration, maintenance and analysis,
- Develop an interface for importing new data set for future analysis, and
- Identify significant factors that contribute to truck accidents.

6.2 POTENTIAL BENEFITS

As mentioned previously, GIS has features of visually disposing large amount data efficiently. By integrating truck accident data and other useful information like roadway geometric data into the system, the accident data can be easily accessed, while the possible factors that contribute to the accidents can be related. Moreover, inaccurate records that are generated from the data collection stage can be visually identified on the map, which would be a hard work to check this by human eyes. Another benefit of the system is to identify high crash locations by displaying the crash frequency. Truck accident information can also be used for planning purposes, such as to restrict trucks to the facilities whose physical characteristics may be potential accident causes to such type of vehicles.

6.3 EXISTING ACCIDENT MANAGEMENT INFORMATION SYSTEMS

The most common use of GIS is to visually dispose a large amount of information quickly. Examples include showing locations with high accident crashes and/or creating collisions diagrams. On the microscopic level, by creating collision diagrams, one can study the roadway geometry and safety hardware if they are the factors contributing to the crash, or pinpoint the exact location on the roadway where the crash occurred (14).

Other examples of GIS applications are to obtain the data including driver's age, time of the day, injury level, speed, alcohol use, or roadway physical characteristics. These information are integrated into the GIS as attribute data relating to each accident record. Different levels of inquiries can be performed with GIS. In error checking, for example, features coded by the police officer and speed limit can be verified by the data stored in the roadway database. Moreover, regions with high accident rates can be identified when assessing how land use affects accident rates (15).

GIS is also helpful in identifying potential crash-related factors for high crash locations. By using the functions of GIS, potential factors contributing to the crashes could be identified conveniently, compared with the traditional crash tabular data. For the planning purpose, GIS can be used to answer the "What if" questions. An example for transportation planning is the system of Using Geographic Information System for

Welfare to Work Transportation Planning and Service Delivery. This advantage of GIS provides deep understanding for the policy makers [16].

The truck accident GIS data, provided by NJDOT, include the truck accident and roadway inventory files. Truck accident data contain the basic information of the accident, such as the time, location, direction of travel, driver's name, age, etc. Roadway inventory data provide the roadway geometry and alignment, such as the route number, milepost, number of lanes, median type, shoulder, etc. Additional data considered to be integrated into the system include speed-limit inventory, pavement condition inventory, intersection/crossing inventory, and average daily traffic data.

There are several GIS-based accident data analysis software in the market, such as AIMS (Accident Information Management System), Collision Record System, Crossroads Collision Database Software, HAS Software (Highway Safety Analysis Software), Intersection Magic and Map Magic, and Snapshot. The main features of these products are summarized in Table 32.

However, none of the above systems is designed specially for analyzing truck crashes. Among the five GIS-related accident analysis software mentioned above, AIMS appears to meet most of our needs, hence we adapt many of its features into TAIMS.

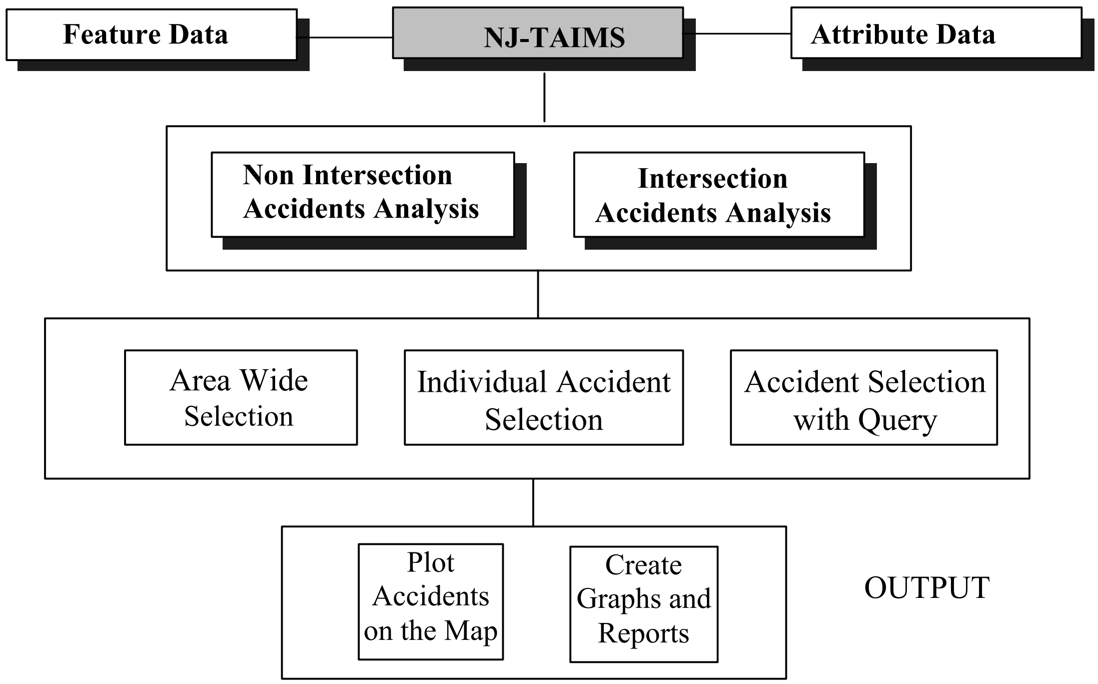
6.4 TAIMS

Among the accident management information software in the market, TAIMS is the first one with three-dimensional mapping features. TAIMS can manage large volume of data up to millions of accident records. Similar to all other GIS applications, TAIMS can display accidents on map in three dimensions, and use GIS for mapping. AMIS can analyze accident data by category (e.g., intersection and non-intersection); retrieve data in a simple way by identifying an area on map or by querying/sorting; customize accident reports and summaries by adding texts, symbols, lines and curves; display results in bar, pie, area, or line graph; and export data/results to other software. The unique features of TAIMS are described as following:

Table 32. Comparison of the GIS-based Accident Data Analysis Software

Software	Data Input/Storage	Query/Output	Analysis Features	Other Functions
Collision Record System (CRS)	Manual entry; Import data from state collision record system in the form of ASCII delimited file; Database management.	Reporting tools; Graphs.	Collision Rates; Collision diagram; High crash location.	Import data from State Collision Record system.
Crossroads Collision Database Software	Manual input; Database management.	Query and analysis of crash records; Creation of crash summaries and reports.	Query and analysis of crash records; Display of crash diagram.	Display query results in ArcView; Process location information with GPS.
Highway Safety Analysis Software (HSA)	Fast data entry from the motor vehicle accident reports or accident data description spreadsheets; Database management.	Highway safety investigation report; Accident rate; Safety benefits evaluation.	Collision diagram; Reveal accident patterns and develop road safety improvements.	Data Transfer procedure to converts the standard accident data description files into HSA.
Intersection Magic and Map Magic	Manual; Database management.	Pin maps of high accident locations; frequency reports; presentation graphics.	Analysis at the macro or micro level; High crash location; Generates automated collision diagrams.	Support for node based systems, milepost systems, intersections, and corridors.

Figure 4. Basic Modules of TAIMS



6.4.1 MODULES OF TAIMS

The basic module of TAIMS is shown in Figure 4. TAIMS is developed based on the GIS map and Database utilities. With feature Data, it can display and pin the accident on the map; utilize GIS buffering, overlaying and thematic functions. With attribute data, it can generate accident statistics and reports; utilize querying functions to perform accident analysis. TAIMS basic accident analysis abilities include intersection accident analysis and non-intersection accidents analysis, which can be performed either by selecting study area from the map, or selecting accidents from map, or selecting accidents by querying. Intersection accident analysis evaluates crashes around a user-defined intersection/spot within a given search radius. Non-intersection accident analysis evaluates crashes along a user-defined route or area. The output of TAIMS of the analysis results can be the plotting of accidents on the map, the statistics tables, graphs and reports.

6.4.2 Applications of TAIMS to Truck Accident Analysis

Use aforementioned TAIMS features for truck accident analysis, several useful accident analysis methods are generated, such as high accident location identification, scenario analysis, spot/intersection analysis, strip analysis, cluster analysis, corridor analysis, etc. They are discussed in details as follows:

6.4.2.1 **Identify High Crash Locations**

Use the functions provided by TAIMS, users can identify high accident locations for the State wide, for specific area, or for specific scenario. Users can identify high accident locations according to number of accidents, accident rates, or some weighted average index (such as a fatal accident weighs 3, an injury accident weighs 2, a property damage accident weighs 1).

For example, suppose to identify high accident locations for the whole area, users can either click one or more rectangles on the map to cover the area, or use sort/query expression to select all records (a blank query expression in TAIMS selects all records). Once the accident records have been retrieved, the high accident locations can be identified according to various standards. For instance, to get high accident locations according to number of accidents, users can use TAIMS query to produce a report with 2 columns: location and number of accidents. Then use TAIMS query to arrange the "location" column in descending order with the highest number of accidents listed first. As a result, the high accident locations for the whole area are identified. Finally using TAIMS display and filtering capability, users can plot only those locations with 20 or more accidents on map.

To identify high accident locations according to accident rates, users can choose TAIMS Accident Rate option. This feature leads to identify high accident locations by weighted average index. TAIMS query includes functions to assign weights to specific fields, from which users can create a report containing locations and weighted indices, and locations can be arrange in descending order with respect to the index values.

As shown in Figure 5, TAIMS provides the function of finding the 100 worst accident locations. Users can first select “Plot 100 worst accident locations on the map” from the menu. Then a report of accident statistics is generated. The accident locations are plotted on the map, denoted by columns with different heights. The height of the column displayed is proportional to frequency of the accident around the accident location.

6.4.2.2. Scenario Analysis

For scenario analysis, such as “all accident related to pedestrian”, “all accidents resulted in injury for a given age group of drivers”, etc., the example is shown in previous section. Scenario analysis is usually used by performing composite queries on the accident database according to the users’ requirement. In scenario analysis, cross query technique is frequently used. The following example, to query the accidents happened on one-lane highway, shows how to perform cross query step by step

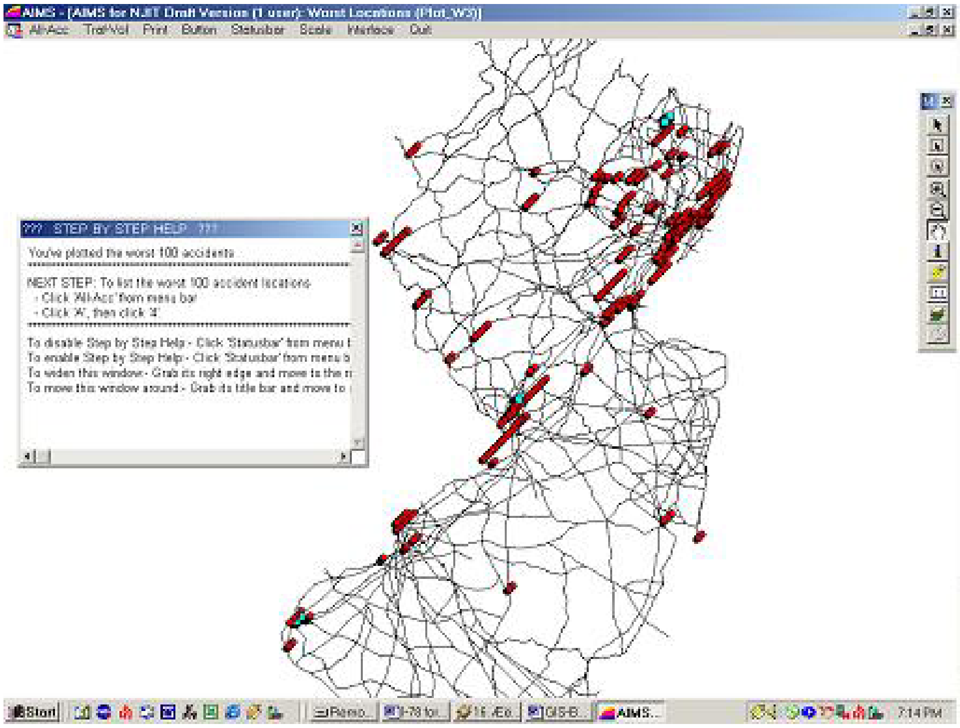


Figure 5. The 100 Worst Accident Locations

between accident data and pavement data in TAIMS, which is a little more complex than normal query.

6.4.2.3. Cluster Analysis

Cluster analysis has been used to study crashes around a given roadway feature such as an intersection or traffic signal[(17)]. Crashes within a user-defined distance of a feature are identified on the routes to be analyzed. If the number of crashes exceeds the user-defined minimum threshold, the location is identified and marked out.

Cluster analysis is usually used for spot/intersection analysis. Users can evaluate crashes at a user-defined spot or intersections within a given search radius. The system can retrieve all accident records within the specified area, plot with three-dimension symbols, produce reports, do further queries, produce statistics and graph, save the retrieved accident records in various formats for further analysis by other software.

To perform Cluster Analysis, first choose the function “Select Accidents from Map” from the menu, and then select a base point, e.g., the interchange/intersection at US 1 and NJ 29. Next step is to define a search area, for example, using the mouse to circle out an area within a radius of 0.5 miles from the interchange. Finally select the

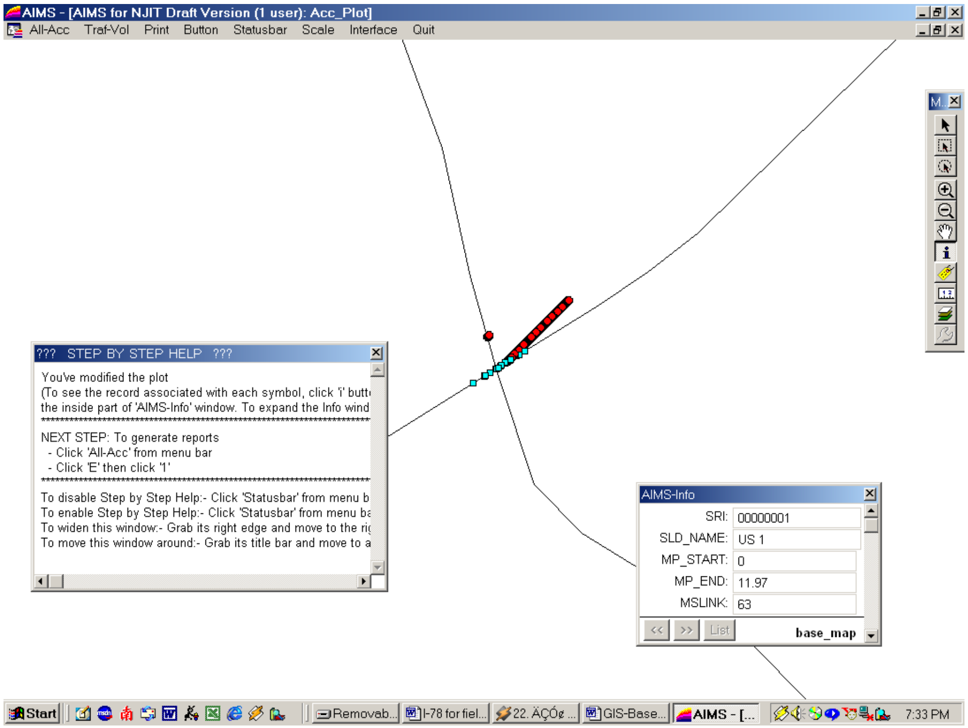


Figure 6. Cluster Study at Interchange/Intersection of US 1 and NJ 29

"Plot the Accidents on Map" and "Generate Report" functions from the menu to get the analysis results (See Figure 6).

6.4.2.4 Strip/Corridor Analysis

For strip or corridor analysis, users can first zoom in the map to a suitable scale. Then, use mouse to drag and click repeating and over-lapping circles or rectangles to cover a desired strip or corridor on the map. Once the desired strip or corridor has been selected on the map, the system will retrieve all accident records within the selected area. This method takes into account the accidents happened in the crossing roads and sideways, which is not considered in the former method.

Corridor analysis can also be performed by creating a sorting/query expression to retrieve all accident records within a user-defined distance from specify routes. Once the specified accident records are retrieved, you then can plot all accidents for the selected area on the map, produce reports, perform further queries, etc as described in cluster analysis above.

6.4.3 Case Study

The truck accident related information provided by NJDOT for the development of TAIMS include:

- Accident Records: A truck accident record contains about 130 fields of information, including County Code, Accident Location (Milepost), Posted Speed, Road Character, Road Surface Type, Surface Condition, Weather Condition, Collision type, Alcohol Test, Age, etc. There are about 22,930 and 20,450 truck accidents occurred in 1999 and 1998, respectively. These accident information are stored in spread-sheet file,

- Highway Geometry: The highway systems in New Jersey contain about 38,400 intersections of all 947 highways. Related information for truck accident analysis include Beginning/Ending Milepost (Mp_start, /Mp_end), Intersection, Pavement Type, Number of Lanes, Shoulder, Median, Cracks Roughness, etc.

- Annual traffic reports of 1998 and 1999: The annual traffic report contains Annual Average Daily Traffic (AADT) for part of NJ roadways. The percentage of trucks of the AADT is recorded at selected locations throughout the state and should not be taken as annual truck percentages for these locations.

- Demographic Information: The demographic information is taken from TIGER census files. The relationship between the truck accident rate and regional population can be retrieved for analysis.

The main fields in the truck accident file include: Accident Year, Accident Date, Accident Time, Accident Location, Route, MilePost, Direction, Distance To Cross Street, Ramp From Route Number, Ramp From Route Direction, Posted Speed, Traffic Controls, Road System, Road Character, Road Surface Type, Surface Condition, Weather, Road Median Type, Number of Axles, etc. These fields provide the information of accident facts, which are consistent with the New Jersey Police Accident Report.

Volume and geometric data were not available in the original accident database. The volume data includes data from the state's ATR stations. A limited amount of geometric data is available from the state's straight-line diagrams, which includes information on the number of lanes, pavement and shoulder widths, posted speed limit, median type and functional classification is available. The straight-line diagram also provides information on the location of various roadway features such as signalized intersections and interchanges. In the accident data file, the important information about the accident is described in the Table 33.

Other fields and meaning are described in the attachment and the New Jersey Police Accident Report.

Table 33. Description of Truck Accident Information

Field	Description
Truck Configuration	The types of trucks include: single unit truck (2 axle), singe unit truck (3+axle), truck/trailer, truck/tractor (bobtail), tractor/semi-trailer, tractor/doubles, tractor/triples, and other heavy truck.
Collision Type	The types of Collision Type include: Rear End, Same Direction - Side Swipe, Angle, Head On, Left Turn, and Struck Parked Vehicle.
Roadway Type	The types of trucks include: Interstate, State Highway, State/Interstate Authority, State Park or Inst., County Co. Auth Park or Institution, and Municipal.
Road Surface Condition	Indicates the surface of the roadway is Concrete, Blacktop, Gravel, Steel Grid, Dirt or Other.
Surface Condition	Indicates the surface is Dry, Wet, Snowy, Icy or Other.
Weather	Indicates the weather is Clear, Rain, Snow, Fog, or Other.

6.4.3.1 Truck Accident Analysis with TAIMS

Several study sites are chosen for analysis with TAIMS. These sites are among the routes mentioned in the top truck accident locations. One example showing how to adapt new accident data is described at the last of this section. A case study is conducted with TAIMS, while results are shown in Figure 7. The study site is located at the interchange of I-280 and Route 21, in the city of Newark (between the milepost of 14.0 and 15.0 of I-280) as marked on the map.

A simple query of searching accidents is performed using the basic logic operators, i.e., "=", "<>", ">", "<", "And", "Or" (See Figure 8). First choose the function "Select Accident by Query or Sorting" from the Sub-menu "All-Acc", then input the expression "Route="280"" in the Expression Edit Box of the Pop-up Dialog Box and Click "OK" button. Finally select the "Plot the Accidents on Map" from main menu; TAIMS will plot all the accidents of target year of Route 280 on the map (See Figure 7). The high accident location is identified easily by intuition.

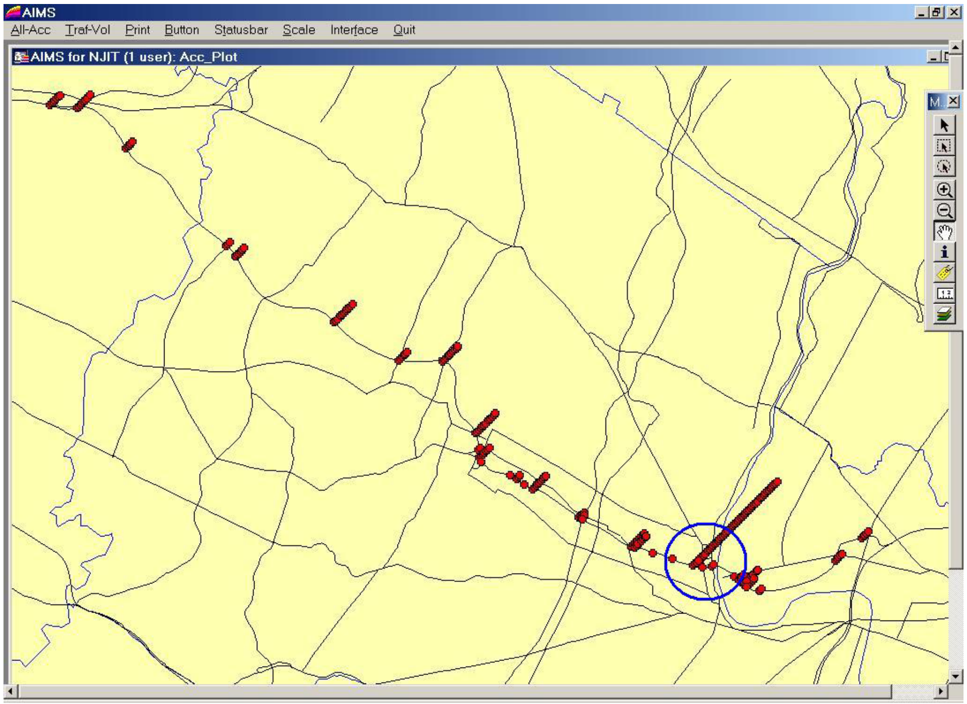


Figure 7. High Crash Location Identified by TAIMS on I-280

Further information, such as accident by type, day of the week, Milepost, etc., can be performed by TAIMS "Further Query or Sorting" function. Besides the six basic logic operations, a complex SQL sentence may contain various query functions like count, sum, etc. Count function is used frequently in SQL statement when performing queries, for instance, counting the numbers of one specific accident type, say, "Rear-end". As can be seen in Figure 8, this further query will select all the accidents with “Collision_Type=1” (means Rear-end collision). Moreover, TAIMS provides options for generating and summarizing the query results such as the report by accident type, location, or week of day. Also TAIMS can produce the histogram or pie statistics graph on the basis of the query (See Figure 9).

The accident related information around site #1 is retrieved by using the information query tools of TAIMS and listed in Table 34. Table 35 also shows the hourly volumes at the site. At this site there are 52 truck accidents happened in 1998 and 1999. According to the report generated by TAIMS, the accidents can be classified into four groups, including 22 sideswipe accidents, 17 rear-end accidents, 5 angle accidents, and 8 accidents of other types.

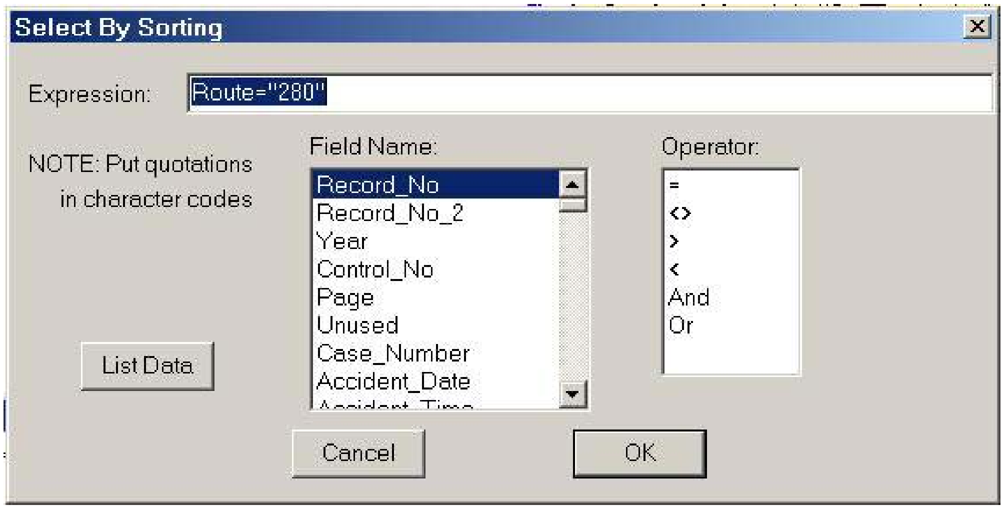


Figure 8. Simple Accident Query by Sorting

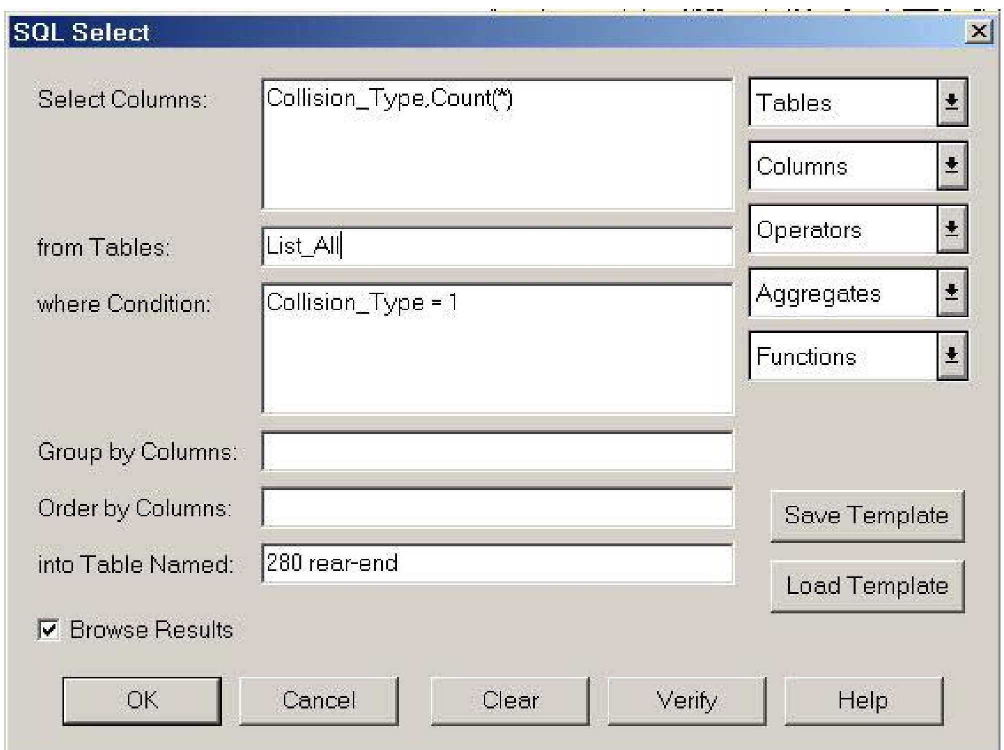


Figure 9. Perform Further Query

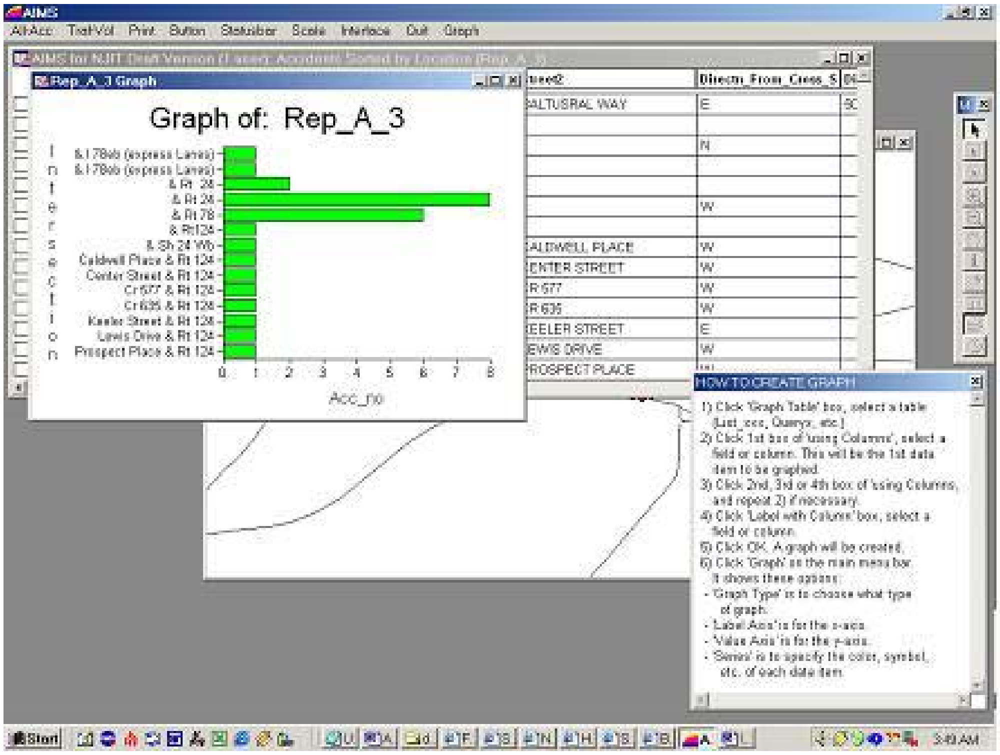


Figure 10. Histogram Graph: Accident Along Route 280 Intersections

Another problem is that the sight under the interchange for the vehicles make right turn to Route 21 is not clear (the side wall block the sight to southbound of Route 21). Vehicles on the left lane intend to merge on to the right lane for making right turn onto Route 21, which is practically hazardous (See Figure 10).

Table 34. Information of Site #1 with TAIMS

Milepost (mile)	Number of Accident		Number of lanes		Median	Shoulder	Speed limit (mph)
	Year 1998	Year 1999	EB	WB			
14.7-14.9	24	28	2	2	Yes	No	50

Table 35. Hourly Volume Report at Site #1

Milepost	Location of Count	Year	Weekday Vol. Both Directions (veh.)
14.3	Newark from NJ 21 NB to I-280 EB	2000	778
14.35	Newark from NJ 21 SB to I-280 EB	2000	4,207
14.5	Newark from I-280 WB to NJ 21 SB	2000	1,221

6.5 CONCLUSIONS

In this section, basic findings of truck accident analysis with TAIMS are generalized, and some proposed expansions to the future system are discussed. Some of these proposed expansions are so useful that they have already had their applications in other commercial software.

The proposed GIS-based Truck Accident Information and Management System (TAIMS) for identifying factors and countermeasures for truck accidents is developed and whose features have been demonstrated. Although the crash samples employed in this study include only two years (1998 and 1999) data, results have indicated that TAIMS is a potential analysis tool for truck accident analysis. Research findings in this study and future extensions are discussed below:

1. TAIMS effectively integrates electronic maps, traffic accident data, and roadway geometry data. Further development on this system can be focused on integrating other useful data, such as land use information.

2. One of the most powerful features of TAIMS is its capability of efficiently identifying high crash locations and generating accident related statistics. TAIMS provides a flexible query interface for users to specify criteria in generating outputs.

3. TAIMS is a powerful tool to identify the accident factors by checking the high accident locations relevant features or attribute data, and visually assess the problem at the current stage. Furthermore mitigation measures to prevent accidents can be assessed. Future study in this aspect may concentrate on identifying the exact accident factors with the application of other methodology, such as regression models or fuzzy logic theory [18,19].

4. Maintaining truck accident data and related information in traditional way is time consuming and often leads to data inconsistency and incompleteness, which affect the effectiveness of TAIMS greatly. Therefore, a well-built database with the capability of data standardization and validation used to maintain the information (such as AADT) collected in routine works will benefit future works

6.6 FUTURE EXTENSIONS OF TAIMS

6.6.1 The Sliding Scale Program

Sliding scale program is a technique to identify high crash rate locations along the routes. The program was developed as part of the crash referencing and analysis system by HSIS (Highway Safety Information System) projects and used in several other projects [17]. Several parameters are required to be defined to employ the technology, which include Segment Length, Extension Length, Maximum Extensions without a Crash, and Crash Rate. Segment Length refers to the length of one roadway segment within which *sliding scale program* calculate the crash rate. Extension Length is defined as the distance to slide along the route when a new segment is to be analyzed. Maximum Extensions without a Crash is the maximum number of extended lengths without a crash that *sliding scale program* will "jump" these segments to compute the crash rate from next start point. Crash Rate is defined as the threshold crash rate (per million vehicle miles, i.e., MVM) to be used to determine if a segment is a high crash rate segment. For different highway classes (e.g., Interstate, State Highway, and County, etc.), data related to truck accidents used in sliding scale program are:

- Vehicle Miles Traveled (VMT)
- Flow rate (ADT/AADT)

The program will search and estimate truck related accidents from the starting point of the route specified by users, then slides the "window" to the next position computed by the extension length. Window size is the same as the segment length. If the crash rate of any segment exceeds the minimum threshold crash rate in number of accidents per million vehicle miles (MVM) given by user, the segment was marked as the high crash segment. By comparing the critical rate with the crash rate, the searching process continues until the maximum milepost of the route is reached, and then all the high crash segments are located [20].

TAIMS used the similar concept to identify the high crash locations with high crash rates. But for the lack of AADT for most links of the route, TAIMS identifies the high crash location only by calculate the accident rate per mile, which may be not reasonable for heavy traffic route.

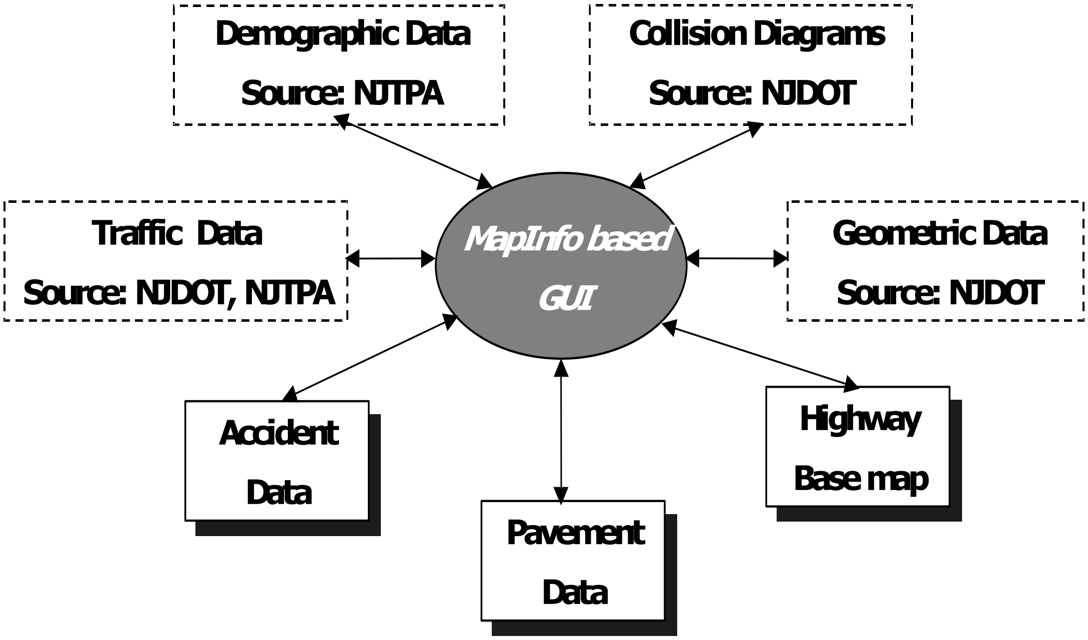


Figure 11. Adapting More Data

6.6.2 Adapting More Data

The current version of TAIMS only includes three layers and one accident data file. These three layers are highway base map layer, pavement layer, and county bound layer. Future extensions of TAIMS, as shown in Figure 11, may consider including more thematic layers, for example, the traffic count data, the roadway geometric layer, collision diagram layer and demographic layer. These data sources can be provided by New Jersey Department of Transportation (NJDOT), North Jersey Transportation Planning Authority (NJTPA) and other state agencies and commercial entities.

6.6.3 Inclusion of Statistical Analysis Modules

TAIMS does not include general statistics methodologies, such as the Regression Models, Simple Parametric Analysis etc., for analyzing the accident data. Statistical models are widely used in traffic accident studies. There are several studies regarding identifying significant factors that contribute to accidents, and accident prediction model using Poisson regression and a negative binomial model [21,22,23,24]. Since the statistics models are so useful, TAIMS should be strengthened with statistics tools to establish reliable relationship between traffic accidents and the factors involved and develop prediction model of the accident rate.

6.6.4 Multimedia Inventory of Road and Roadside Features

Incorporating multimedia data into the GIS database has come out recently in some GIS applications. One of such GIS applications is realized by Brett Rose (2000). The benefit of the technology applying to accident data inventory is obvious—it would exempt the necessity to pay a field visit provided that the spot image around the accident site are stored in the database, such as intersections photos, truck warning signs etc. Hence, reduce the expense to perform the study and the time.

With the proposed expansions, TAIMS will provide more powerful functions and will make truck accident analysis more accurate and efficient.

Chapter VII

SUMMARY AND CONCLUSIONS

7.0 OVERVIEW

The goals of this study were to identify statistically significant factors that contribute to truck accidents in New Jersey and to recommend technologies and strategies holding potential use as countermeasures for the most prevalent of these factors. To accomplish these goals, a truck-accident database was developed and the percent distribution of truck accidents determined for truck configuration, roadway system, collision pattern, light conditions, road characteristics, accident event, truck driver characteristics, and temporal distributions. Top locations where truck accidents occurred in the State were also determined. A fatal truck crash analysis was also performed to identify characteristics of these crashes compared to fatal crashes for all vehicles in the State. Truck crash case studies were performed to investigate the roadway geometrics and possible contributing factors at high truck crash locations. Finally, a Truck Accident Information and Management System (TAIMS) GIS system was developed for collecting, storing, processing and displaying the truck crash data.

7.1 TRUCK ACCIDENT SUMMARY

Truck accidents in the State of New Jersey represent about 8 percent of all accidents and about 11 percent of all fatal accidents in the State. A majority of all truck crashes and fatal truck crashes are multi-vehicle accidents, occurring during daylight conditions, and occurring on straight and level portions of roadway. There are differences in the roadways where all truck accidents occur compared to where fatal truck accidents occur. About half of all truck accidents occur on State highways and municipal roadways and about 25 percent occur on roadways with a posted speed limit of 25 mph. This supports the restriction of large trucks to National Network roadways when the truck trip does not originate in New Jersey or have destinations within the State. The majority of fatal truck crashes occur on US roadways, Interstate roadways and roadways with speed limits greater than 50 mph. In addition, a greater percent of fatal truck accidents occur on urban roadways when compared to all fatal accidents. These accidents occur with the highest frequency on urban principal arterial roadways. The presence of signalized and unsignalized intersections on some urban principal arterials may be a factor in increasing the risk of truck accidents on these roadways.

Angle collisions represent the collision type with the highest percent of fatal truck crashes. Sideswipes in the same direction are the highest percent of collision type for all truck crashes. The presence of a wet roadway surface does not indicate to be a factor in the type of collisions that occur. Under dark conditions, however, there is a higher proportion of single-vehicle truck accidents than multi-vehicle truck accidents. This indicates that driver fatigue may be a contributing factor in single-vehicle accidents under these conditions. Tractor-trailers were seen to have a higher proportion of accidents on State highways and municipal roadways in dark conditions and tractor/semi-trailer vehicles were seen to have a higher proportion of accidents on State/Interstate Authority roadways during dark conditions. The findings suggest that policies toward roadway lighting on State highway roadways should be investigated to determine its impact on truck safety. For fatal truck crashes, however, dark conditions did not appear to be a critical contributing factor as fewer fatal truck crashes occur during dark conditions than compared to all fatal crashes.

The results of the truck accident analysis indicate that there is no one factor contributing to truck accidents on New Jersey roadways. Assigning cause to these accidents cannot be achieved due to large confounding influences from the vehicle, driver, and the environment. The analysis does point to the need for continued monitoring of truck accidents and truck vehicle-miles traveled so that truck accident rates can be calculated and used to better assess the safety performance of trucks in the State.

7.2 CASE STUDY

Case studies were performed at high truck accident locations to investigate accident characteristics and to determine possible contributing factors. Field and accident analyses showed that conditions consistent to high truck accident locations include locations with high vehicular and truck volumes where frequent lane changes occur, such as at interchanges, intersections with multiple entry and exit lanes, and approaches to toll plazas. Overall, accidents at high truck accident locations involve a higher percentage of accidents on curve sections of roadways, a higher percentage occur during dark conditions, and a higher percentage involve sideswipe and rear-end type collisions when compared to all truck accidents. In some cases, accidents could be reduced through additional warning signs and positive roadway guidance. Advanced technologies should also be explored for their use to alert and warn drivers of changing roadway conditions.

These case studies provide a beginning for further detailed analyses to determine other contributing factors to accidents at the high truck accident locations. The case studies also indicate the interrelatedness between roadway operation and roadway safety. At high volume locations, there is an increase risk of accidents as traffic densities increase and roadway performance is degraded. Efforts should be made to identify the relationship between roadway operation and roadway safety. Given these relationships, operational changes may be one approach to improve safety at some of these locations.

7.3 TAIMS

The GIS-based Truck Accident Information and Management System (TAIMS) developed in this research can be used to help in identifying factors that contribute to truck accidents. By integrating truck accident data and other useful information such as roadway geometric data, possible factors that contribute to these accidents could be determined even more efficiently. One of the features of TAIMS is the ability to identify high accident locations Statewide, for a specific area, or for a specific scenario. Cluster analyses can be performed to determine detailed information about a specific location. The system can be adapted to include additional accident data as well as other thematic layers.

7.4 FURTHER RESEARCH

This research provides a first step in improving the safety performance of trucks in New Jersey. The research did not investigate the impact of the 65-mph speed limit and the truck restrictions on truck safety. Further studies, are needed to determine the combined impact of these policies on truck safety across the state.

The next step of this research may be to focus on corridors within the State where truck safety improvements are needed. The City of Houston initiated an Intelligent Transportation System (ITS) project, “Truck Safety and Monitoring”, that deployed and integrated ITS technologies in the corridors leading to and from the Port of Houston and other major destination points in the region. The project involved deploying Dynamic Message Signs (DMS) at major points of entry to the corridors leading into the Houston District. The signs provide information about congestion, construction, flooding, and other conditions. Highway Advisory Radio, kiosks providing truck operators with information on traffic conditions, incidents and construction notices were also included as part of this project.

The Federal Motor Carrier Safety Administration (FMCSA) continues to study approaches for improving truck safety on the Nation’s roadways. Efforts currently being conducted by this organization to improve the safety of commercial vehicles should be investigated for their applicability to New Jersey. A recent international conference, “International Truck and Bus Safety Research and Policy Symposium”, provided research papers and recommendations on five areas related to truck and bus safety. These areas include: driver issues, data analysis, new technology, management issues, and enforcement. Some of the strategies for improving truck safety identified at this conference included: (1) the construction of separate toll truckways on selected interstate highway corridors; (2) the use of warning signs activated by sensors that detect risky behavior; and (3) monitoring convictions by commercial motor vehicle drivers. A more thorough review of the proceedings from this conference may identify additional approaches that can be used for improving truck safety within the State.

Addressing truck safety involves explicitly considering safety in the planning, design and operations of roadways in the State. To accomplish this goal, methodologies capable of predicting the safety performance of roadways is needed. The safety performance, which is usually defined as annual accident frequency, can be determined as a function of many variables including roadway geometric conditions, traffic conditions, and intersection control conditions. Given the safety performance of existing and proposed roadways, effective decisions can be made not only on the design and operation of roadways, but also on prioritizing roadway improvement projects to improve truck safety.

These and other research efforts cannot be accomplished without a high quality, searchable accident database. This research points to the importance of the State to continue to maintain its accident database. There is some need for continued efforts to improve the database through the use of information technology and through additional training of law enforcement agents filling out the accident reports. As the database continues to be expanded and reviewed, truck accident analyses can become an on-going effort for identifying trends in truck safety and improving safety not only for trucks but for all vehicles on the State's roadways.

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