Technical Report Documentation Page

1. Report No. SWUTC/12/476660-00052-1	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle A Comparison of Crashes and Fatalities in Texas by Age Group: Selected Cities in Texas		5. Report Date October 2012 6. Performing Organization Code
7. Author(s) Gwen Goodwin, Jamaal Schoby, and Shain Eversley		8. Performing Organization Report No. Report 476660-00052-1
9. Performing Organization Name and Address Center for Transportation Training and Research Texas Southern University 3100 Cleburne Houston, Texas 77004		10. Work Unit No. (TRAIS) 11. Contract or Grant No. DTRT07-G-0006
12. Sponsoring Agency Name and Address Southwest Region University Transportation Center Texas A&M Transportation Institute Texas A&M University System College Station, Texas 77843-3135		13. Type of Report and Period Covered Final Report 14. Sponsoring Agency Code
15. Supplementary Notes Supported by a grant from the U.S. Department of Transportation University Transportation Centers Program.		

16. Abstract In recent decades, great strides have been made to lower the number of accidents that occur on Texas roadways through graduated drivers licensing programs, messages against texting and driving, and discouraging drunk driving. Statistics show that young, novice drivers between 16 and 24 years old account for the highest rate of crashes, and senior drivers (65 and older) have the highest rate of fatalities when involved in a crash. In 2008, in Texas, 571 teens died in car crashes. From 2003 to 2008 over 2,751seniors lost their lives in automobile accidents. Building on work done on a previous study of senior fatalities, this study will examine crash data from 2006 and 2009 from the cities of Houston, Sugar Land, and Pearland, Texas to determine if the number of crashes per age group is increasing or decreasing. This study will also determine if fatalities are increasing or decreasing between these two age groups.

17. Key Words Seniors Accidents, Teen Accidents, Comparing Crashes of Teens and Seniors, Young Drivers, Senior Drivers		18. Distribution Statement No restrictions. This document is available to the public through NTIS: National Technical Information Service 5285 Port Royal Road Springfield, Virginia 22161	
19. Security Classify (of this report) Unclassified	20. Security Classify (of this page) Unclassified	21. No. of Pages 48	22. Price

Form DOT F 1700.7 (8-72) **Reproduction of completed page authorized**

A Comparison of Crashes and Fatalities in Texas by Age Group: Selected Cities in Texas

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Research Report SWUTC/12/476660-00052-1

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October 2012

ABSTRACT

In recent decades, great strides have been made to lower the number of accidents that occur on Texas roadways through graduated drivers licensing programs, messages against texting and driving, and discouraging drunk driving. Statistics show that young, novice drivers between 16 and 24 years old account for the highest rate of crashes, and senior drivers (65 and older) have the highest rate of fatalities when involved in a crash. In 2008, in Texas, 571 teens died in car crashes. From the years 2003 to 2008, more than 2,751seniors lost their lives in automobile accidents. Building on work done on a previous study of senior fatalities, this study will examine crash data from 2006 and 2009 from the cities of Houston, Sugar Land, and Pearland, Texas to determine if the number of crashes per age group is increasing or decreasing. This study will also determine if fatalities are increasing or decreasing between these two age groups.

EXECUTIVE SUMMARY

Traffic accidents, resulting in injury and fatality, are a global problem impacting all aspects of society where motor vehicle crashes are the leading causes of death. In 2009, more than five million motor vehicle crashes occurred in the United States. Less than 1% ended in a fatality, 33% injury related, and 67% resulted in property damage only (NHTSA, 2011). The greatest percentage of accidents occurred between midnight and 3 a.m. on Saturdays and Sundays, in which there were an average 1,000 fatal crashes per night. Young novice and senior drivers make up the bulk of crashes, in which operator error is the main reason for crashes between the two age groups. Teenage driver crashes are primarily a result of inexperience, while senior driver crashes result from loss of motor skills (NCIPC, 2011). In recent decades, a variety of approaches aimed to reduce motor vehicle crashes were imposed on these age groups. Educational programs, laws and sanctions, and licensing programs have been developed for novice drivers.

In 2009, Texas was the leading state in crashes, and the second leading state in vehicle miles traveled behind California (U.S. Census Bureau, 2010; and Bureau of Transportation Statistics, 2010). Building upon a study on senior crash rates, this explanatory research examined the rate of motor vehicle crashes in Houston, and two adjacent suburban cities, Pearland and Sugar Land. A longitudinal study analyzed crash data based on age, gender, crash severity, type, and day and time of week. The study assessed if fatalities are increasing or decreasing between these two age groups. Through the data mining process, the applicable variables were extracted from the three cities.

Two types of analysis were conducted. First, a statistical analysis was conducted in SPSS, in which the six variables were categorized. The variables were coded in SPSS, and executed in the model, categorical values and continuous variables. The second analysis was a descriptive analysis. GIS was used to manipulate and visually display population and crashes. A series of maps displaying crashes by age group were produced. In Houston, three maps were produced for the two years: 1) new drivers (ages 15-19), 2) young drivers (ages 20-24), and 3) senior drivers (ages 65 and older.).

Results from the study suggest crash rates among the three age groups were comparable to national crash figures. Collectively, crash rates declined in the three cities. The findings suggest programs that have been imposed during the past decade may be aiding in the decreasing crash rates among young, novice drivers under the age of 25 years old. In addition, similar policies such as two-year driver examination renewals for senior drivers may be aiding mitigating their crashes. Noteworthy findings include the following:

- At the city level, Pearland was the only city in which crash rates increased. Crashes in the city increased 11% between the years 2006 and 2009.

- Crashes by injury decreased in all cities, in which, Houston experienced the greatest decrease in crash rates. Crashes resulting in no injuries accounted for the bulk of incidents. Fatalities decreased in Houston and Pearland, while increasing significantly in Sugar Land.

- Young drivers accounted for the majority of the crashes; the greatest among the three age groups. While young drivers accounted for the most crashes, new drivers experienced the

greatest decrease in accidents. Senior drivers make up the largest age group, and accounted for the fewest amounts of crashes.

- Crash rates among young male drivers were significantly higher than new drivers. Young male drivers accounted for 25% of the crashes, while new drivers only accounted for 32% of the crashes. Moreover, crash rates among new male drivers decreased the greatest. Senior male and female drivers experienced the biggest percentage gap in crash rates.

- About 32% of the crashes occurred on Friday and Saturday. While most research shows a significant spike in weekend crashes, this research did not analyze if alcohol was a factor to crashes. Interestingly, crashes increased significantly on the weekends in Pearland, and decreased in Sugar Land. Crash rates decreased in Houston and Sugar Land on the weekdays, while remaining constant in Pearland. In Houston, crash rates decreased each day of the week, and crash rates were fluctuated in the suburban cities.

- The majority of the crashes occurred during the midday. Houston experienced a decrease in crashes during all time periods. Sugar Land experienced crashes between morning and evening peak periods, with relatively no change during the late night period. Crashes during the evening peak period increased in Pearland. Crashes by time of day fluctuated in the suburban cities. Peak period crashes decreased during the morning peak periods, and increased during the early morning period.

- The majority of the crashes occurred along U.S. 59 and HWY 6. Worth noting is younger driver accidents near schools. The number of crashes decreased in Sugarland for senior drivers.

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ACKNOWLEDGEMENTS

This study was supported by a grant from the U.S. Department of Transportation, University Transportation Centers Program to the Southwest Region University Transportation Center.

ABBREVATIONS

American Driver and Traffic Safety Education Association	ADTSEA
National Center for Injury Prevention and Control	NCIPC
National Council Information Policy Center	NCIPC
National Highway Traffic Safety Administration	NHTSA

1 INTRODUCTION

Background

Traffic accidents resulting in injury and fatality are a global problem impacting all aspects of society. Since the invention of the automobile, crashes mainly resulting in human error have been a plaguing problem. Today, motor vehicle crashes are the leading causes of death among persons aged one to 44 years old (NCIPC, 2011). In 2009, more than five million crashes occurred in the United States (NHTSA, 2011). Figure 1 displays that less than one percent was fatalities, 33% injury related, and 67% resulted in property damage only. The most accidents occurred between midnight and 3 a.m. on Saturday and Sunday, in which there were average 1,000 fatal crashes per night. Of the fatal crashes, 66% involved alcohol-impaired driving, in which a blood alcohol concentration (BAC) was greater than 0.08 grams per deciliter (g/dL).

The twentieth century was a revolutionary time period in America, in which significant developments were made in the automobile industry. Scientific and technological advancements led to decreased mortality rates, and the development of an extensive transportation network, respectively (Feenberg, 2005). Morality, fertility, migration, and immigration contributed to increased population and uneven spatial distribution in urbanized areas (Easterlin, 2000). This phenomenon contributed to urbanization, leading to rapid population growth and development in regions, in particular outlying suburban areas. Medical advancements led to decreased mortality, and increased life expectancy rates. Subsequent to the postwar era, fertility rates increased as soldiers returned in what is known as 'Baby Boomers' contributing rapid growth rates. During the same period, the automobile industry aggressively promoted and manufactured cars to keep up with the rapidly growing population.

The Federal-Aid Highway Act of 1956 contributed to an extensive highway network, linking central cities to undeveloped suburban areas. The expansion of the highway system and mass automobile production encouraged inhabitants to drive, increasing vehicle miles traveled (VMT). In particular, the population increased in Southern states where land was in abundance. Between 1950 and 2000, population in Southern states increased 24% compared to 1900 to 1950 (Lang & Rengert, 2001). As the highway network expanded, development became more disseminated and VMT increased significantly. Regions became automobile dependent, and people became more vulnerable to crashes.

During the early years of the automobile and interstate system, there were minimal motor vehicle regulations to diminish injury and fatalities resulting from crashes. There were safety regulations to alleviate motor vehicle injury and death, however education and awareness was missing. During the latter half of the 20th century, increased safety standards and enhanced vehicle technology mitigated crashes, in particular fatalities resulting from the crashes. In 1959, Congress passed legislation requiring the automobile industry to comply with standards to decrease injury and death from motor vehicle crashes (Sheldon, 1955). During this time period, the demand for private automobiles was skyrocketing, and manufactories were concerned with production rates as opposed to education and safety. Seatbelts were the first safety measure to reduce injury and save lives in automobile accidents. Although the safety measure was in place, neither drivers nor passengers were required to utilize it. As a supplement to seat belts, air bags were introduced in 1971 to add an extra measure to decrease fatalities. Airbags for drivers were mandated for all 1984 automobile models, and in 1999 became required for passengers. In 1984, New York State passed the first U.S. legislation mandating the use of seat belts in motor vehicles. In 2009, seat belt airbags were introduced as well as antilock brakes for front wheel steering.

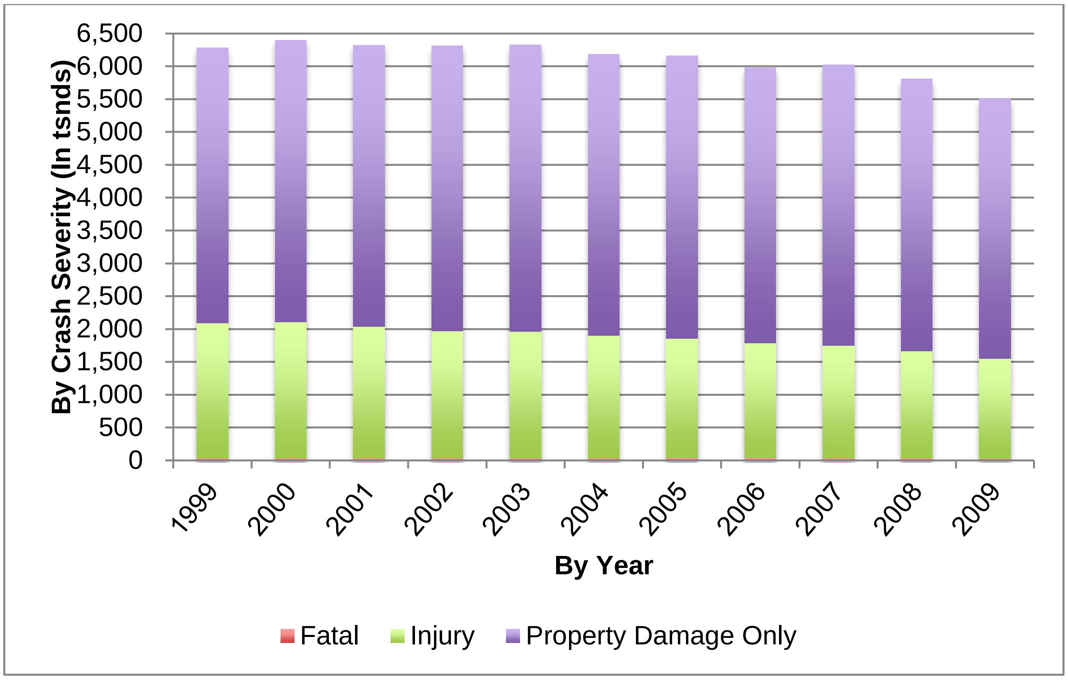

Figure 1. U.S. Motor Vehicle Crashes: 1999 to 2009
Source: National Highway Traffic Safety Administration

<u>Who Crashes</u>

Young adult and senior drivers account for 24% and 27% of accidents, respectively (NCIPC, 2011). Operator error is considered the main reason for crashes among these two age groups. Young adult crashes are result of inexperience, while senior crashes result from loss of motor skills. In recent decades, a variety of approaches aimed to reduce motor vehicle crashes were imposed on these age groups. Educational programs, laws and sanctions, and licensing programs have been developed for young, novice drivers. US driver education studies, examining young adult drivers that participated in educational programs, conclude the programs are ineffective (Jones, 1993; Mayhew & Simpson, 1996; Vernick et. al., 1999); Williams & Ferguson, 2004; and Wynee-Jones & Hurst, 1985).

Traditional young adult driver education provides basic driving skills and safety as a technique to reduce high crash rates. Driver education programs are composed of 30 hours of classroom instruction, and up to ten hours of in-vehicle training. The programs do not require drivers to have significant on-road training experience, which would expose them to various scenarios. While this type of training teaches basic technique, novice drivers are still involved in crashes due to lack of experience and risky driving.

More effective measures of reducing fatalities resulted from legislation and regulations. Laws with sanctions to restrict teenage drinking and driving proved to reduce crashes. In the U.S., all states have a minimum drinking age of 21 years old and impose zero tolerance laws. In states where motorist can be ticketed for not wearing a seat belt, there have been further reductions in teen fatality crashes. In 2000, the American Driver and Traffic Safety Education Association (ADTSEA) developed an extensive driver education program that included standards and curriculum aimed to increase driver awareness and reduce crashes. The program mandates states to develop strenuous driver education that ensures inexperienced drivers are more capable of dealing with various driving situations.

Licensing programs have been considered the most effective measure in reducing young driver crashes and fatalities. The Graduated Driver Licensing (GDL) system was introduced as a technique to allow young drivers to enhance their skills over time (Foss & Goodwin, 2003). The National Highway Traffic Safety Administration (NHTSA) recommends that states impose a three-stage GDL process to include learner's permits, restricted licenses, and provisional licenses. This three-step process gradually introduces drivers to situations to improve their experience before becoming a single-vehicle operator. States with GDL programs experienced lower nighttime fatal crashes compared to states without teenage restrictive programs (Foss, Marshall, & Masten, 2011). Since implementing the program, Nova Scotia, Canada reported a 29% reduction in crashes involving 16-year-old drivers (Mayhew et. al., 2003); a report in Ontario, Canada reported a 31% reduction in crashes for drivers 15 to 19 years old (Mayhew et. al., 2002).

Life expectancy and population growth rates have been steadily increasing, which has led to more senior drivers on the roadways. Accident rates among drivers above 65 years old exceed all age groups, with the exception of teenagers. The primary reason senior drivers are involved in accidents is due to loss of motor skills. In an effort to reduce senior crashes, some states have imposed advancing age population requirements. In Texas, the Texas Legislature became proactive in passing laws to protect these vulnerable drivers. Such laws establish additional driving guidelines and skills needed for seniors to safely operate a motor vehicle. Katie's Law, enacted in September 2007, created a mandatory vision screening of persons 79 years old or over requesting renewal for a motor vehicle license. This law also requires drivers 85 years old and older to renew their licenses every two years in person and take a vision screening examination.

Purpose of Study

In 2009, Texas was the leading state in the number of crashes, and the second leading state in VMT behind California (U.S. Census Bureau, 2010; and Bureau of Transportation Statistics, 2010). As the Texas Department of Transportation (TxDOT) continues roadway expansion to meet the demand of disseminated population growth and development, VMT will increase in automobile dependent regions. According to the Houston-Galveston Area Council (2011), more than three million inhabitants are anticipated to descend upon the Houston region during the next 30 years. The influx of people will add more vehicles to already crowded roadways, increasing people's susceptibility to crashes. As policy leaders and planners emphasize developing sustainable communities to reduce automobile dependency, countermeasures to reduce crashes and save lives should also be taken into consideration. This study examined crash data from 2006 and 2009 to determine if the number of crashes for seniors (65+), new drivers (15-19), and young drivers (20-24) is increasing or decreasing. To obtain an adequate number of crashes, Houston (urban city) and Sugar Land and Pearland, Texas (two of the area's fastest growing suburban cities) were selected.

2 LITERATURE REVIEW

An abundance of research exists on factors contributing to motor vehicle crashes. In recent years, numerous studies have been conducted on young adult and senior drivers to assess whether programs and policies are focused to decrease crash rates, in particular fatalities. This literature review discusses previous research that focuses on age, gender, crash severity, type, and day and time of week.

Young Drivers

Motor vehicle crashes are the leading cause of death for persons between 16 and 19 years old, in which a substantial proportion is alcohol related (NCIPC, 2010). The NCIPC estimates that more than 450,000 teenagers are involved in automobile crashes. Of these teenage crashes, 27,500 of those teenagers require hospitalization, and 5,500 result in death. Crashes by young adult drivers were clearly differentiating by characteristics such as lighting conditions, road surface and type of collision (Hasselberg, Kullgren, Laflamme, & Vaez, 2006). The pattern based risk levels vary considerably according to automobile safety level and driver's age at time of injury and socio-economic status. Young adult male drivers and persons with low educational attainment were represented within all the crash patterns.

Various reasons contribute to young, novice drivers being at risk for automobile crashes, however, inexperience is the leading contributing factor. Adolescents lack the experience needed to safely perform many of the complex tasks involved with driving (Albert, P., et. al., 2011). These tasks include detecting hazards, actually controlling the vehicle, and doing both of those tasks at high speeds. While possessing a learner's permit, teenage drivers must be accompanied by an experienced driver and not put into high-risk situations. Research suggests the probability for crashes increases after a full license is granted to teenagers, and their driving is unsupervised (Braitman, K.A., et. al., 2010). A study of teenage drivers in Nova Scotia, Canada revealed that accidents were the highest during the first month of driving without supervision. During the next five months, crash rates were 70 crashes per 10,000 drivers. As their driving experience increased, the crash rates among teenagers decreased to 50 per 10,000 drivers .

Young adults are more prone to nighttime crashes. The CIVPPC (2006) studied 16 and 17 year old drivers and found they have the highest crash rate of any age group. In an effort to reduce nighttime crashes, states have implemented programs that impose curfews on drivers 21 years old and younger. In 1997, the Graduated Licensing Program (GLP) was introduced as a mechanism to reduce crash rates among young drivers. Feaganes, Foss and Rodgman (2001) analyzed North Carolina State's GLP program for new drivers during a three-year time span. Measuring the rate of motor vehicle crashes, the authors' research found the program did not significantly reduce young driver crash rates. While the GLP program has proven successfully in many states, Hartos, Leaf, Preusser, and Simon-Morton (2005) argue that parents play a pivotal role in further educating and monitoring novice drivers. The authors found that many parents impose modest restrictions on their teenage children when they become licensed; these parental restrictions were negatively associated with risky driving among young drivers. Instilling this knowledge, the researchers attempted to prove whether or not well-designed and persuasive communications directed at salient issues and focused on specific and acceptable courses of action would alter perceptions, attitudes, and behavior of teens.

Recent policy innovation in this area has shown that graduated drivers licenses reduced crash rates among teenagers and is now the primary policy approach to reducing the rates of crashes when young drivers are behind the wheel. Because the graduated licensing programs are passive, little is known about the extent to which young drivers comply with the restrictions. The intervention parents and teenagers reported stricter limits on teen driving compared with the comparison group at 12 months; a simple behavior change positively increased the number of restrictions that parents placed on their children, ultimately lowering the number of high risk activities experienced by the teens.

Alam and Spainhour (2009) suggest GLP are not always effective in reducing young driver accidents. A study of fatal crashes in Florida for drivers under 25 years old that were deemed at fault found that non-human factors were the primary causes in only 6% of the crashes where young people were at fault but secondary factors accounted for as much as 25% of those crashes. The most common non-human factors were fatigue related issues and inexperience. Young, novice drivers were found at fault 62% of the time; they were overrepresented in forward impact with control loss and left roadside departure crashes. This suggests teenage drivers were at fault in the crashes due to high speed and abrupt steering decisions. The most disturbing fact that this article presented was that 91% of the young at fault drivers were actually in compliance with the state's graduated license program.

Elliott, et al. (2008) attempted to understand the exposures that teenagers have to driving as well as to explore their perspectives. A survey of 68 high school students, determined that Black and Hispanic adolescents viewed substance use while driving as less hazardous than did White adolescents, but witnessed it more frequently. The survey results showed that drinking while driving was the highest ranked hazard; however, only 12% of the teens surveyed reported exposure. The next four highest ranked areas that surveyed teens reported witnessing were text messaging, racing, impairment due to marijuana, and road rage. Additionally, 60% of the respondents viewed inexperience as a significant hazard, although only 15% reported seeing it often. This was followed by cell phone usage being counted as a hazard by 28% of the teens and 10% viewing peer passengers as hazardous.

While it is clear that distractions take a teenager's focus off the road, all of those distractions are not viewed by the surveyed teens as hazardous. The teens generally understood the danger of intoxicated driving, but some subsets of the targeted population do not recognize this as a hazard as others do. Although being inexperienced is one of the key factors that when mixed with other conditions causes crashes, adolescents do not quite understand what makes someone an inexperienced driver. The authors suggest further research on teenage drivers to include how doctors, families, and communities can be more effective in setting, promoting, and monitoring safety standards as needed.

Graduated License Programs

Graduated license programs (GLPs) and various other methods for regulating the driving privileges of both younger and senior drivers are in place all over the United States. Graduated licensing was first introduced in New Zealand in 1987. Nine years later, Florida was the first state to adopt a GLP and, today, all but two states have some sort of a GLP. While some may dispute the validity of their effectiveness based on the difficulty of actually measuring safety, there are variables that can be numerically evaluated in association with these types of programs. Many of the states, that have the privilege of regulated driving, frequently publish statistics that show the effectiveness of their respective programs. In an attempt to improve the crash rates for the Texas population of drivers that are most at risk of being involved in automobile accidents, it might be worth exploring the successes that other jurisdictions have experienced. After exploring the programs, successes, and failures of other states, there may be elements or even entire programs that the state of Texas can adopt in order to improve its crash rates for the affected population.

Florida is one of the states whose regulations were explored in the literature review portion of this document. In 1998, one year after Florida's Comprehensive Graduated Drivers Licensing law took effect, the state noticed a 21% decrease in the number of automobile related teen-aged fatalities. Lawmakers in Florida attributed this decrease to the implementation of the Graduated Driver's License program. Although one year of fatality reductions certainly doesn't constitute a trend, the initial observation was positive and suggests that Florida's program, and subsequently programs similar to it, would have similar and lasting fatality reductions (Braitman, Fields, Hellinga, McCartt, & Teoh, 2010).

Among some of the other states that have GLPs is California. As with Florida, California also enacted their graduated license program in 1997, although it didn't take effect until July 1998. Similarly, one year after California's program took effect; they also realized a 21% decrease in the numbers of teen-agers involved in automobile accidents. In California, the GLP was not applicable to driver's age18 and older. Another astonishing fact that became present after the law went into effect, however, was that the crash rates among drivers older than 18 years were 5% higher than those drivers under the graduated license umbrella.

Outside of the United States, studies have been completed that analyze the effectiveness of restricted driver programs for older drivers. One such study conducted in British Columbia, Canada was highlighted in the article "Do Restricted Driver's Licenses Lower Crash Risk Among Older Drivers? A Survival Analysis of Insurance Data from British Columbia" (Caragan, 2009). In this study, an analysis of crash claims for drivers over the age of 66 was paired against a graduated de-licensing program for those drivers. The de-licensing program included restrictions on speed and time of day that driving was allowed for the affected population. These factors were measured over a period of eight years lasting from 1999 to 2006. This study found that the risk cause of a crash was 87% lower for restricted drivers compared with unrestricted drivers after controlling for age and gender. The article stressed that further studies are needed to determine which drivers are most likely to benefit from restricted licenses. The initial findings, however, suggest that driving restrictions may be effective for prolonging the crash-free driving of some aging drivers.

Between 2002 and 2007, road deaths of 16- to 19-year-old drivers declined by 32% in Texas. Texas currently has a peer program in place where teens teach other youths about dangers on the road. The drop in the death rate of Texas teenagers due to auto crashes can likely be attributed to both the GLP and the peer program. Having already experienced a drop in deaths due to the GLP, Texas should continue to see declines with this program for teens. Furthermore, a similar program for senior drivers, much like the program in place in British Columbia, Canada has the potential to improve the death rates of senior drivers for Texas. It appears as though the crash rates of drivers in Texas are most problematic for teen-aged and Senior-aged drivers. Proving successful in other jurisdictions by a decrease in death rates for these age groups, implementing similar programs in Texas has the potential to make Texas one of the safest states for driving.

Senior Drivers

Researchers note the large American population or ‘Baby Boomers’ approaching their senior years. Evidence suggests that older drivers have more difficulty performing key driving actions due to declining physical and mental abilities. Research suggests older drivers are involved in fewer crashes than middle-aged drivers aged 25 to 64 years old, however, those in the crashes resulted in death (Rosenbloom, 2009). While crashes are the cause of a small percentage of deaths among older drivers, who represent 13% of the population, they represent 18% of US motor vehicle deaths. When compared with middle-aged drivers, older drivers experience more deaths per 100,000, than any other section of the population except drivers under the age of 25.

Despite having more driving experience, seniors encounter problems when they encounter changes in their built environment. Cumbersome driving situations prove challenging to seniors in work zones. The Federal Highway Administration’s (FHWA’s) *Guidelines and Recommendations to Accommodate Older Drivers and Pedestrians* and the *Highway Design Handbook for Older Drivers and Pedestrians* offer design features and recommendations designed to help older drivers navigate work zones. These handbooks were created in response to the staggering statistics that 22% of all crashes and over 1,000 crash fatalities happen in work zones (Heaslip et. al, 2009). To examine senior responses in work areas with variable message signs (VMS), static warning signs, and physical barriers i.e. arrow boards, taper drums, and barriers, Heaslip et al., conducted research, on a bridge replacement and lane closure along Interstate 91 in Greenfield, Massachusetts. They found, with the exception of static signs, all the measures delineated in FHWA’s design handbooks made a significant impact on the drivers. Older drivers also posted significantly lower speeds at VMS and the actual work activity areas. Senior drivers showed the lowest speeds with physical barriers (i.e., tapered road).

Another negative factor for senior drivers involves driving alone. Many researchers examined the negative impact peers/passengers have on teens and the more positive impact they have on older drivers. Padlo, et al. (2005) using data from Connecticut’s DOT in years 1997 to 2001, show 12.6% of drivers were ages 16-20 and 8% were senior drivers (p. 9). More than 60% of young drivers were alone during crashes and 29% had peers in the car. This compares to over 75% of seniors alone during crashes and 25% of crashes that had other seniors in the car with a senior driver (p. 9). As a result of these findings, the authors offered the following recommendations:

- Impose a longer Phase I for teens in the Connecticut’s GDL program
- Limit the number of passengers of any age in the car with teen drivers. The opposite is true for senior drivers’ passengers who tend to co-pilot/co-drive.
- Create similar restrictions on seniors to the ones imposed on teen drivers

Nonetheless, imposing restrictions can only work if drivers remain compliant. Nasvadi and Wister (2009) examined 151,284 senior drivers between ages 66 to 103 years old, with driving restrictions. Generally, more men than women were restricted to daytime driving and women had speed limit maximums imposed on them more so than the men. Crash rates prior to receiving the restriction show that senior drivers, who eventually received restrictions, showed a higher number of pre-restriction crash rates than seniors without any restrictions. Crash rate change shows senior drivers with restrictions had fewer crashes than those without restrictions. Survival analysis showed that “after controlling for gender and age, the odds of causing a collision were reduced by half for drivers restricted to daylight-only driving compared with unrestricted drivers. A look at crash severity and daylight only driving restriction compliances found only 18 (out of 583 crashes) occurred during night/dark hours. Researchers reported that most of these crashes involved noncompliant men. These results show encouraging evidence that restrictions work as seniors tend to be compliant with driving restrictions.

Understanding Crashes

There are a plethora of reasons why different age groups get into vehicle crashes. These reasons can vary from issues as simple as just not paying attention to the road to engineering and design flaws in the roadway. Other issues that can cause accidents among varied age groups include level of driving experience and the complexity of the vehicle being operated. There is a prevailing theme among all of the reasons that drivers get into crashes though - cars. It seems simple, but without the use of a car for daily trips, there would be no crashes to report and the whole issue of driver safety would be null.

For that reason, understanding the data that Household Travel Survey puts out is critical for understanding the propensity for crashes. For example, between 1983 and 2009, for drivers aged 16 to 20 the average daily trips per person rose 6.06%. That same percentage for drivers aged 21 to 35, 36 to 65, and over 65 increased 26%, 45%, and 78% respectively. This suggests that all age ranges of drivers are driving cars (taking trips) more often, thusly, increasing their chances of being involved in a crash. When this data are broken down further, even more interesting trends are shown. In every category, except ages 36 to 65, women had a larger increase in the average daily trips per person.

Similar trends presented themselves when an average mile of travel per person was analyzed. In the same time period of 1983 to 2009, drivers aged 16 to 20 had an increase of 33%, followed by 23%, 51%, and 100% for drivers aged 21 to 35, 36 to 65, and over 65, respectively. When this data were looked at from a gender perspective, however, men had higher percentage increases in each of the categories except for ages 16 to 20. Taking all of the data into consideration, one could assume that over the last 28 years, women began to take more trips where they served as the driver of the vehicle; however, men took longer trips than women. Does this support the theory that women self govern themselves more readily than men regarding driving? Does the increase in the miles per trip across every age group support the thought that Americans have embraced life in the suburbs, away from dense urban areas where public transit could meet their transportation needs, thus putting themselves at higher risk for crashes? These are just a few of the issues that need to be addressed when the crash rates of American drivers are analyzed. There is clearly a need for much more extensive research to be done on this subject.

3 DESIGN OF STUDY

This explanatory research examined the rate of motor vehicle crashes within select Texas cities. Building upon a previous study of senior fatalities, this study will examine crash data from 2006 and 2009 to determine if the number of crashes per age group is increasing or decreasing. This study will also determine if fatalities are increasing or decreasing between these two age groups. Data collected from the Texas Department of Transportation assessed crash rates during the years 2006 and 2009. The goal was to see how crash severity (the dependent variable) varied based on the independent variables (age, gender, day of the week, and crash time). For the purpose of this study, a sample size of Houston's population was selected. The central city, Houston, and two suburban cities, Pearland and Sugar Land crash rates were analyzed during the two study years.

Statistical Analysis

Motor vehicle crash data was collected from the Texas Department of Transportation, and through the data mining process said variables were extracted. Unprocessed data were downloaded to Microsoft Access, and the three cities were extracted. The raw data were in five separate data sets, which were joined to one file. The relevant variables were then filtered by the three cities' codes:

- 208 = Houston
- 326 = Pearland
- 413 = Sugar Land

Applicable variables within the three cities were then extracted into a Statistical Package for the Social Sciences (SPSS). The variables were coded in SPSS and executed in the model using categorical values, i.e. male or female, day of the week and then were assigned values. For example, male = 1 and female = 2. Continuous variables, e.g. age, date, and time of crash were binned to limit the number of iterations generated in SPSS and to have a more comprehensive examination of the variables' impact on the model. The crash time variable was binned into six categories. This generated a new variable "new_crash_time". The same exercise occurred for the age variable generating three categories. The crash_severity variable was re-coded to list the severity in an ordinal manner. Within the crash__severity variable, cases expressed as "99" ("not applicable/not reported") were excluded using SPSS. Other anomalies in the data include, 6,591 (in 2006) and 6,507 (in 2009) persons' gender listed as unknown. These cases were primarily in Houston. Table 1 outlines the variables coded for SPSS.

Descriptive Analysis:

Geographic Information Systems (GIS) was utilized to manipulate and visually display population and crashes. A series of maps displaying crashes by age group were produced. In Houston, three maps were produced for the two years: 1) new drivers, 2) young drivers, and 3) senior drivers. For the two suburban cities, all age groups were displayed on one map per year and colored to differentiate between the categories.

Table 1. Variable Categories

Variable	Category	Code
Gender	Male Female	1 2
Age	New Drivers: 15 to 19 years old Young Drivers: 20 to 24 years old Senior Drivers: 65 & above	1 2 3
Crash severity	No injury Possible Injury Non-Incapacitated Incapacitating Fatality	1 2 3 4 5
Day of week	Sunday Monday Tuesday Wednesday Thursday Friday Saturday	1 2 3 4 5 6 7
Time of day	Early Morning: 12:00am to 5:59am Morning Peak: 6:00am to 8:59pm Midday: 9:00am to 2:59pm Evening Peak: 3:00pm to 5:59pm Evening: 6:00pm to 7:59pm Late Night: 8:00pm to 11:59pm	1 2 3 4 5 6

4 RESULTS AND DISCUSSION

Collectively, motor vehicle crashes in Houston, Pearland, and Sugar Land declined during the three-year study period. In 2009, there were 10,941 crashes compared to 13,430 crashes in 2006, down 19% (Table 2). Segregated by the city level, Houston accounted for 94% of the crashes, and also experienced a 19% decrease in crash rates. In 2009, there were 10,186 crashes compared to 12,597 crashes in 2006. The two suburban cities combined accounted for 6% of the crashes, with differentiating crash statistics. While Houston accounted for the most crashes, Sugar Land reported the largest decrease in crashes at 22%. Unlike Houston and Sugar Land, crash rates in Pearland increased 11%, with 343 crashed in 2009.

Table 2. Crashes by Study Area City

City	2006	2009	Percent Change
Houston	12,597	10,186	**-19%**
Pearland	308	343	**11%**
Sugar Land	507	393	**-22%**
TOTAL	**13,430**	**10,941**	**-19%**

Crashes by Severity

On average, 62% of the crashes resulted in no injuries (Figure 2 and 3). Persons with possible injuries and incapacitating injuries both decreased 34%. In 2009, there were 2,644 possible injuries compared to 4,023 injuries in 2006. Similarly, there were 188 incapacitating crashes in 2009 compared to 287 crashes in 2006. While fatalities accounted for less than 1% of the crashes, the crash rate decreased 6% during the two study periods. Incapacitating crash rates decreased in all three cities, while crash types fluctuated in the other cities. Houston experienced the greatest percent change in crashes resulting in incapacitation. Fatalities decreased in Houston and Pearland, while increasing significantly in Sugar Land.

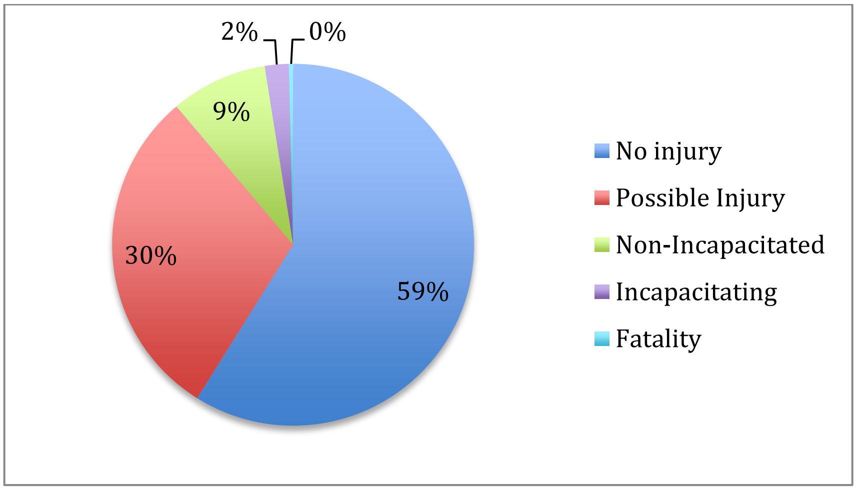

Figure 2. Crash Severity, 2006

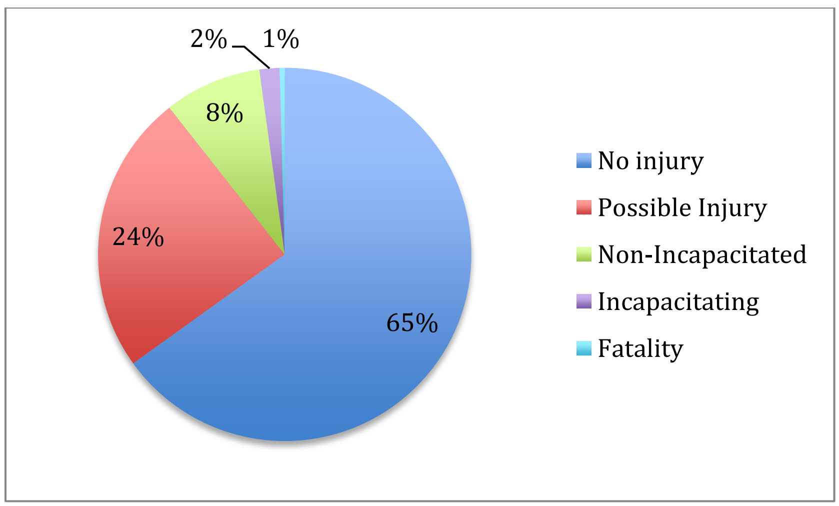

Figure 3. Crash Severity, 2009

Houston experienced the most decreases in crash rates. In 2009, there were 176 incapacitating injuries compared to 272 in 2006, down 35%. Moreover, severity by injuries decreased in all categories in Houston, in which possible injury and incapacitating injury decreased the most. While fatalities account for the less severity, they decreased the least in percent change. In Pearland and Sugar Land, crashes that resulted in non-injury accounted for approximately 70% of the crashes (Table 3).

Table 3. Crashes by City: Severity

City	2006				
	No Injury	Possible Injury	Non-Incapacitated	Incapacitated	Fatality
Houston	7,318	3,882	1,094	272	49
Pearland	231	47	21	8	1
Sugar Land	360	94	45	7	1
Total	**7,909**	**4,023**	**1,160**	**287**	**51**
	2009				
City	No Injury	Possible Injury	Non-Incapacitated	Incapacitated	Fatality
Houston	6,561	2,514	840	176	46
Pearland	236	66	34	6	0
Sugar Land	278	64	43	6	2
Total	**7,075**	**2,644**	**917**	**188**	**48**
	Percent Change				
City	No Injury	Possible Injury	Non-Incapacitated	Incapacitated	Fatality
Houston	-10%	-35%	-23%	-35%	-6%
Pearland	2%	40%	62%	-25%	-100%
Sugar Land	-23%	-32%	-4%	-14%	100%
Average	**-10%**	**-9%**	**-11%**	**-25%**	**-2%**

Crashes by Age Group & Gender

For the purpose of this study, crashes among three age groups were analyzed. New drivers were classified between 15 and 19 years old, young drivers between 20 and 24 years old, and senior drivers 65 years old and older. Figure 4 shows, during the two study years, young drivers accounted for 54% of the crashes, the greatest among the three age groups. While young drivers accounted for the most crashes, new drivers experienced the greatest decrease in accidents. In 2009, there were 3,160 new driver crashes compared to 4,204 crashes in 2006, down 25%. Senior drivers make up the largest age group, and accounted for the fewest amounts of crashes. On average, senior drivers accounted for 16% of the crashes.

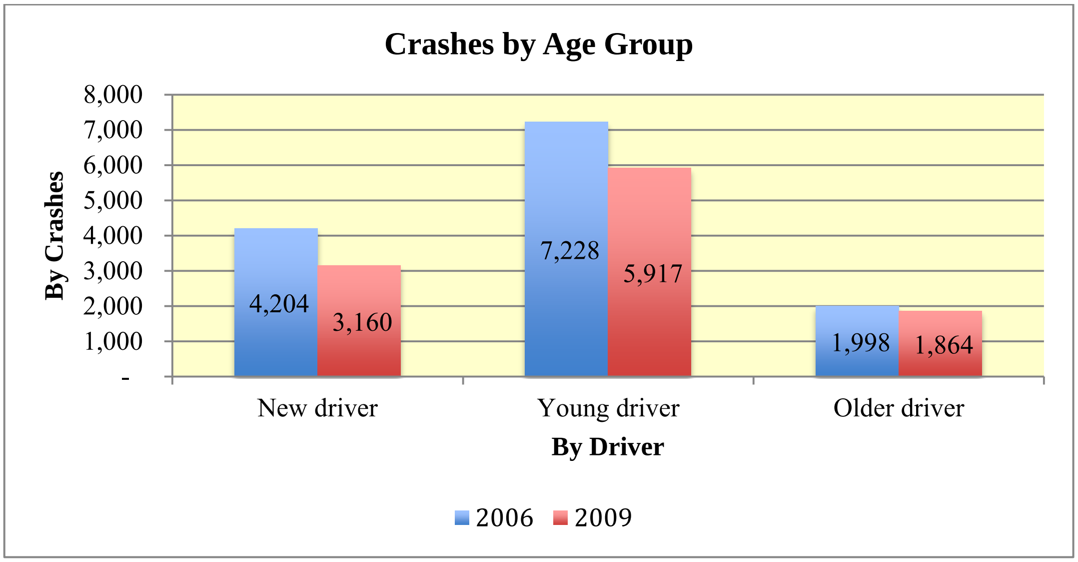

Figure 4. Crashes by Age Group 2006 versus 2009

Research suggests male drivers under the age of 25 years old are most susceptible to motor vehicle crashes. The results from this study show minimal difference between young, novices - male and female drivers. Drivers between the ages of 15 and 24 years old accounted for 84% of the crashes. Interestingly, crash rates among young male drivers were significantly higher than new drivers. Young male drivers accounted for 55% of the crashes, while new drivers only accounted for 32% of the crashes. Moreover, crash rates among new male drivers decreased the greatest. In 2009, there were 1,859 crashes compared to 2,526 crashes in 2006, down 26%. Senior male and female drivers experienced the big percentage gap in crash rates. Senior male crashes decreased 10%, while senior female crashes only decreased 2%. New driver crashes decreased in all three cities (Table 4). In Pearland, young driver and senior driver crashes increased 33% and 55%, respectively. Table 5 shows that in Houston, male crash rates decreased 21%. While in Sugar Land, female crash rates decreased 28%.

Table 4. Crashes by City: Age Group

4.1 City	4.2 New Driver			4.3 Young Driver			4.4 Senior Driver		
	Year 2006	Year 2009	% Change	Year 2006	Year 2009	% Change	Year 2006	Year 2009	% Change
Houston	3,796	2,858	-25%	6,922	5,606	-19%	1,897	1,741	-8%
Pearland	156	132	-15%	112	149	33%	40	62	55%
Sugar Land	252	170	-33%	194	162	-16%	61	61	0%
Total	**4,204**	**3,160**	**-24%**	**7,228**	**5,917**	**-18%**	**1,998**	**1,864**	**-7%**

Table 5. Crashes by City: Gender

City	Males			Females		
	2006	2009	**Percent Change**	2006	2009	**Percent Change**
Houston	7,506	5,947	-21%	5,091	4,239	-17%
Pearland	171	187	9%	137	156	14%
Sugar Land	280	230	-18%	227	163	-28%
Total	**7,957**	**6,364**	**-29%**	**5,455**	**4,558**	**-10%**

Crashes by Day & Time

Crash rates decreased on Fridays and Saturdays, when crashes are generally highest due to alcohol impaired driving (Figure 5). While this research did not assess alcohol related crashes, there was an evident spike in crash rates on Fridays and Saturdays. Collectively, 32% of the crashes occurred on the two days, with Friday being slightly higher with 17% of the crashes. Crash rates on Monday through Thursday remained constant, accounting for roughly 14% of the crashes on each day. Sunday experienced the fewer amount of crashes, and experienced the greatest decline in crash rates. In 2009, there were 1,287 crashes compared to 1,740 crashes in 2006, a difference of 26%. In Houston, crash rates decreased each day of the week, and were dispersed in the suburban cities (Table 6). Interestingly, crashes increased significantly on the weekends in Pearland, and decreased in Sugar Land. In 2009, there were three-fourths more crashes and almost half more in Pearland on Sundays and Saturdays, respectively. On the contrary, crashes decreased in Sugar Land on the weekends. On Sunday the crash rate declined significantly, while only declining by 5% on Saturdays. As mentioned, collectively, crash rates remained constant Monday through Friday. Segregated by the city level, crash rates decreased in Houston and Sugar Land compared to the same days. In Pearland, crashes increased on Monday through Thursday.

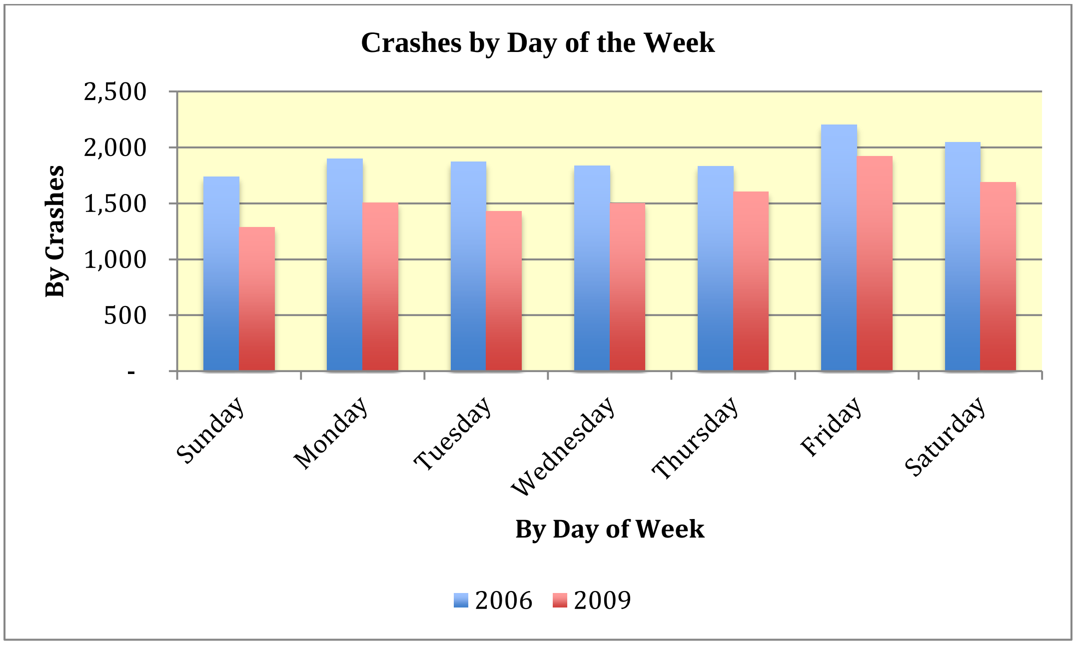

Figure 5. Crashes by Gender and Group 2006 versus 2009

The majority of the crashes occurred during the midday. Approximately 30% of the crashes occurred during the midday in all of the cities. Crashes during the peak periods were relatively lower than anticipated. Houston experienced a decrease in crashes during all time periods. Sugar Land experienced a decrease between morning peak and evening period, with relatively no change during the late night period. A person would think the highest crashes would occur during the peak periods. While crashes during the peak period accounted for 24% of the crashes, the crashes during the morning peak period decreased. Crashes during the evening peak period increased in Pearland (Table 7). Crashes by time of day fluctuated in the suburban cities. Peak period crashes decreased during the morning peak periods, and increased during the early morning period. During the morning peak and evening peak period, crashes account for 10% and 24%, respectively. Crash rates decreased the greatest during the morning peak period. In 2009, there were 1,005 crashes compared to 1,453 crashes in 2006, a variance of -31%.

Table 6. Crashes by City: Day of the Week

City	2006						
	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Houston	1,667	1,768	1,752	1,705	1,717	2,051	1,955
Pearland	17	46	42	50	59	57	37
Sugar Land	56	83	77	83	57	95	56
Total	**1,740**	**1,897**	**1,871**	**1,838**	**1,833**	**2,203**	**2,048**
	2009						
	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Houston	1,220	1,402	1,317	1,391	1,488	1,803	1,584
Pearland	30	46	46	53	61	55	52
Sugar Land	37	59	65	58	56	65	53
Total	**1,287**	**1,507**	**1,428**	**1,502**	**1,605**	**1,923**	**1,689**
	Percent Change						
	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Houston	-27%	-21%	-25%	-18%	-13%	-12%	-19%
Pearland	76%	0%	10%	6%	3%	-4%	41%
Sugar Land	-34%	-29%	-16%	-30%	-2%	-32%	-5%
Average	**5%**	**-17%**	**-10%**	**-14%**	**-4%**	**-16%**	**6%**

Table 7. Crashes by City: Time of Day

4.5 City	**Year 2006**					
Houston	Early Morning	AM Peak	Mid Day	PM Peak	Evening	Late Night
Pearland	1,506	1,354	3,704	2,960	1,843	1,163
Sugar Land	17	42	96	78	52	22
Total	**33**	**57**	**172**	**129**	**77**	**39**
	Early Morning					
	Early Morning	AM Peak	Mid Day	PM Peak	Evening	Late Night
Houston	1,211	922	3,141	2,511	1,471	948
Pearland	22	37	103	108	52	21
Sugar Land	42	46	126	82	58	39
Total	**1,275**	**1,005**	**3,370**	**2,701**	**1,581**	**1,008**
	Percent Change					
	Early Morning	AM Peak	Mid Day	PM Peak	Evening	Late Night
Houston	-20%	-32%	-15%	-15%	-20%	-18%
Pearland	29%	-12%	7%	38%	0%	-5%
Sugar Land	27%	-19%	-27%	-36%	-25%	0%
Average	**12%**	**-21%**	**-12%**	**-4%**	**-15%**	**-8%**

Mapping the crashes

Figures 6 and 7 show crashes by age groups for 2006 and 2009 in Sugar Land, Texas[1]. The number of crashes decreased in Sugarland for younger and older drivers. The majority of the crashes occurred along U.S. 59 and HWY 6. Worth noting is younger driver accidents near schools. Data from Pearland provide a different picture of crashes than in Sugar Land.

In Pearland, crashes increased for younger and older drivers. In 2006, 40 crashes were attributed to seniors and 268 were attributed to younger drivers. As seen in Figures 8 and 9, for both years, most of the crashes occurred along FM 518 and State HWY 35.

Figures 10 to 14 show crashes for new drivers, young drivers, and senior drivers for Houston from 2006 and 2009. Due to the number of crashes in this urban city, each age category and year is presented on a map. Young drivers represented 10,718 and 8,464 crashes in 2006 and 2009, respectively. While the cluster of accidents are not as clearly defined as in Sugar Land and Pearland, most crashed occurred on major freeways. Loop 610, I.H. 45, and U.S. 59 showed the heaviest clusters of accidents. Additional clusters are seen along major arterials, i.e., Westheimer Street.

[1] For mapping purposes, “new driver” and “young driver” were combined into one category called “new and young” drivers for Sugar Land and Pearland.

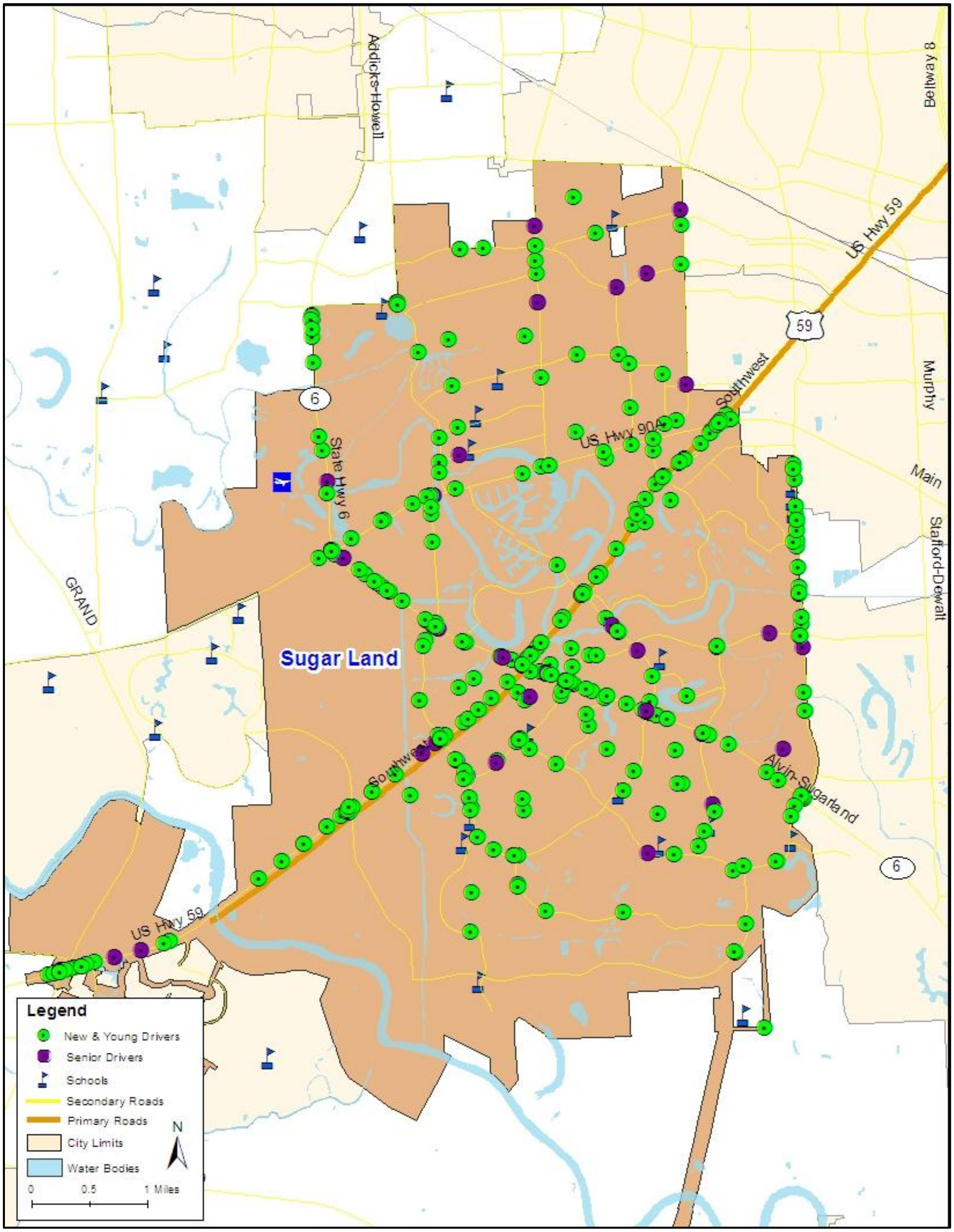

Figure 6. Sugar Land Crashes by Age Group, 2006

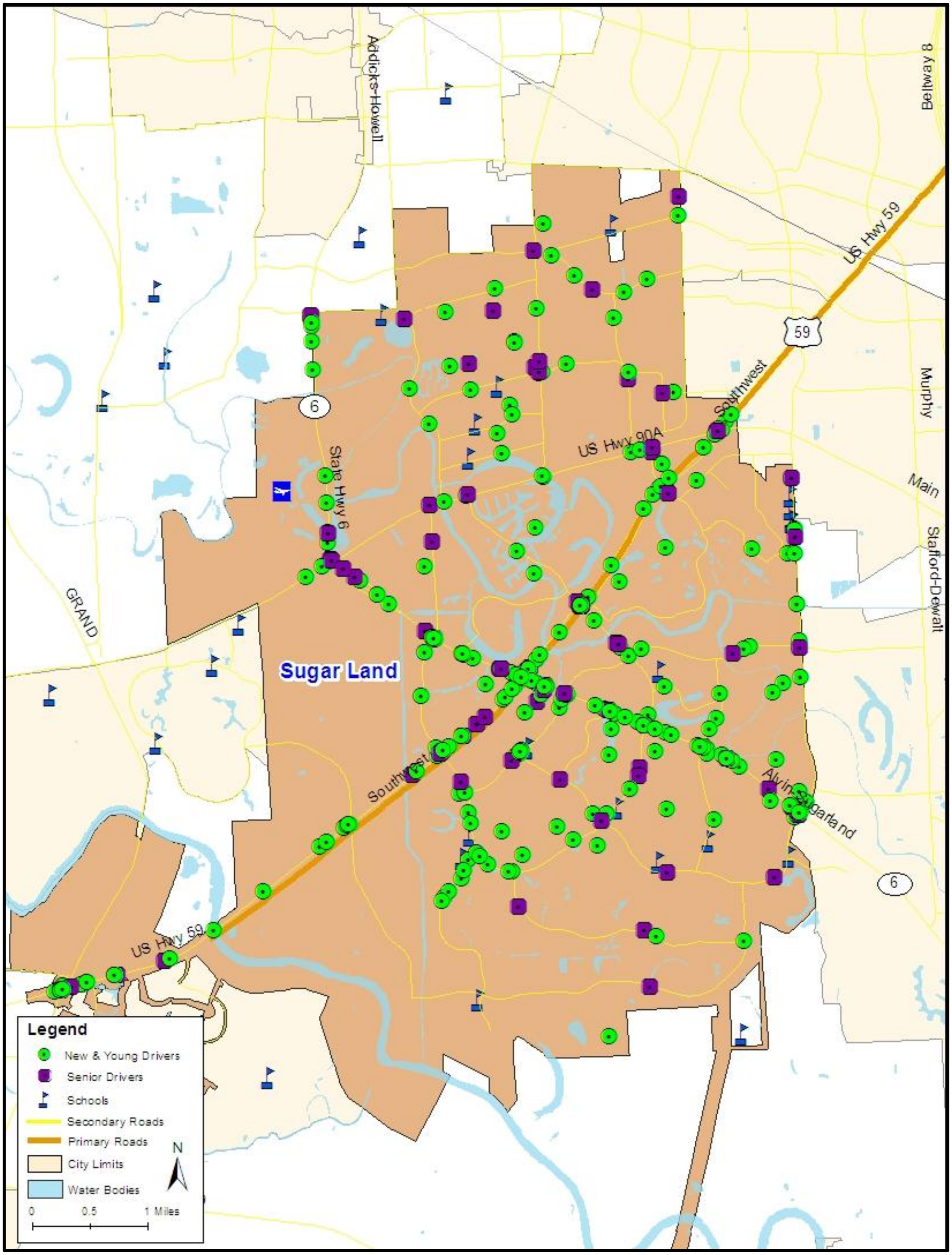

Figure 7. Sugar Land Crashes by Age Group, 2009

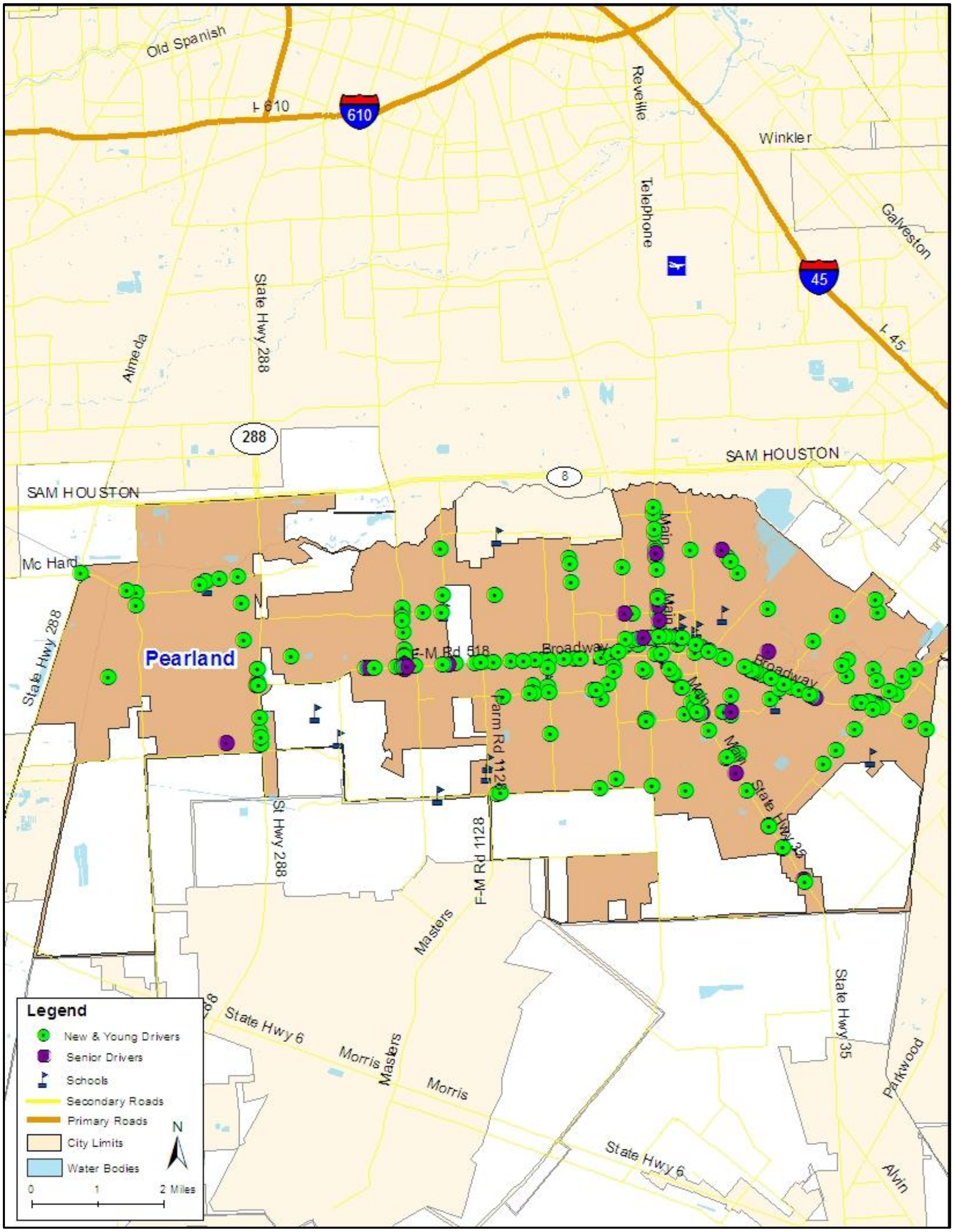

Figure 8. Pearland Crashes by Age Group, 2006

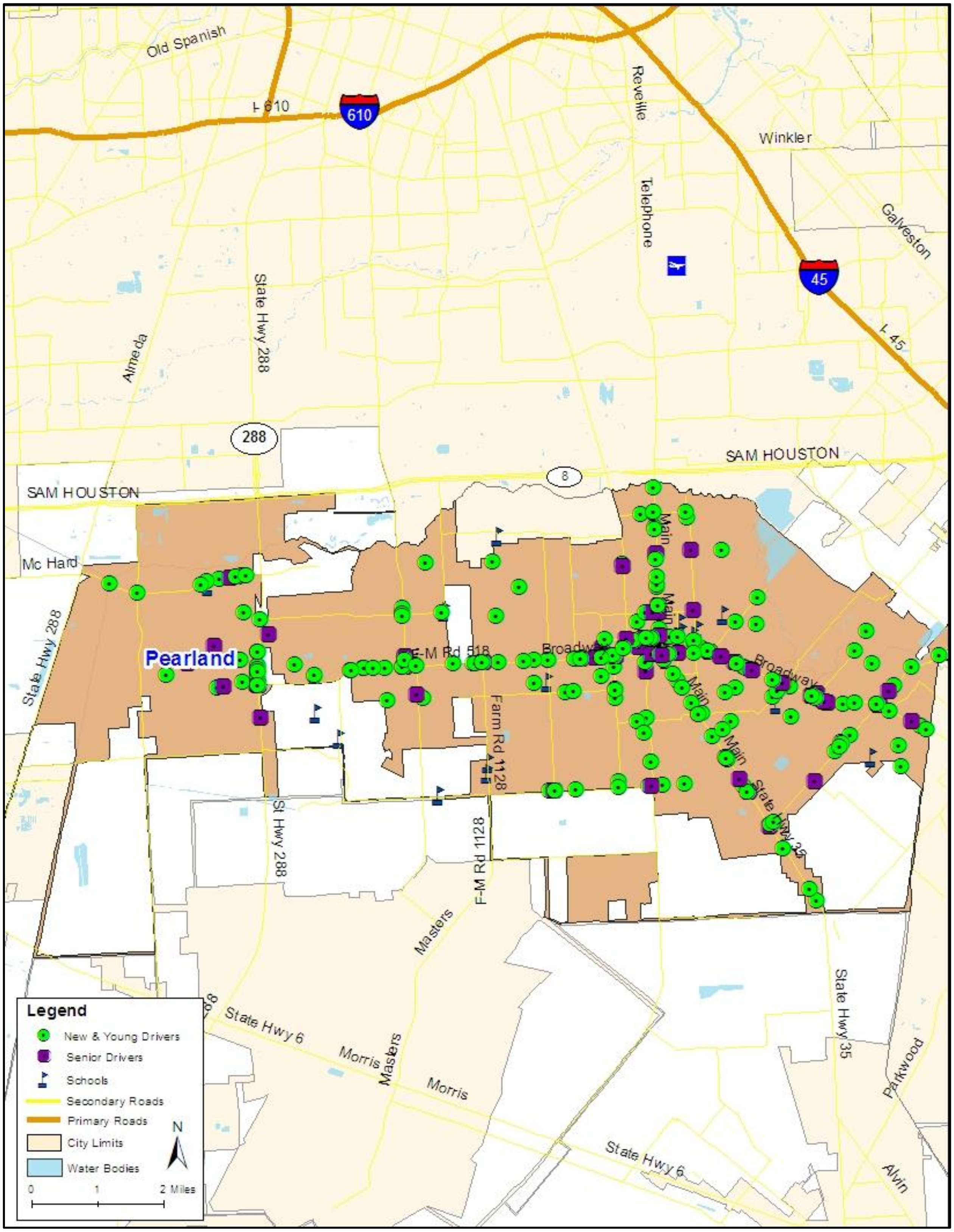

Figure 9. Pearland Crashes by Age Group, 2009

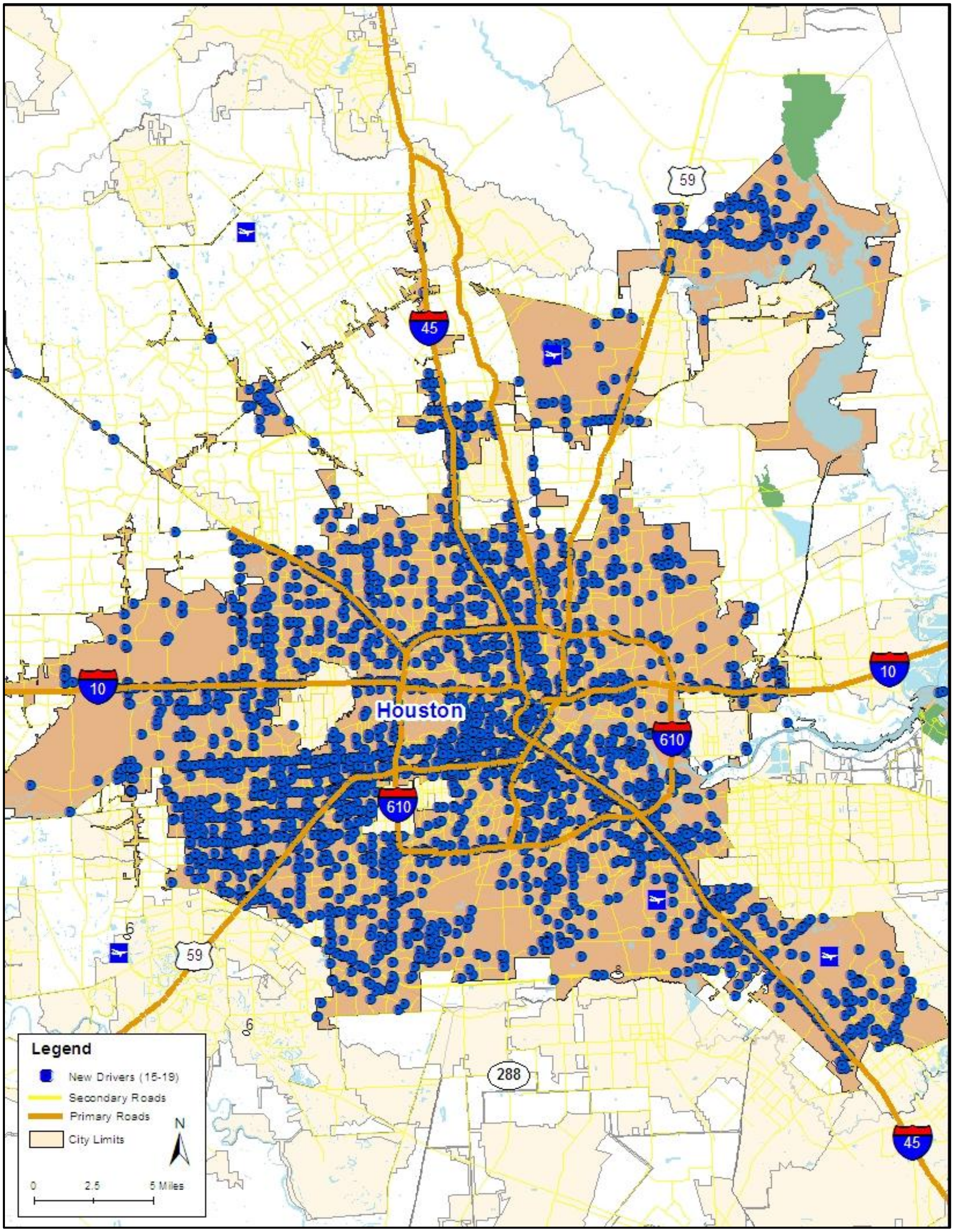

Figure 10. Houston Crashes: New Drivers, 2006

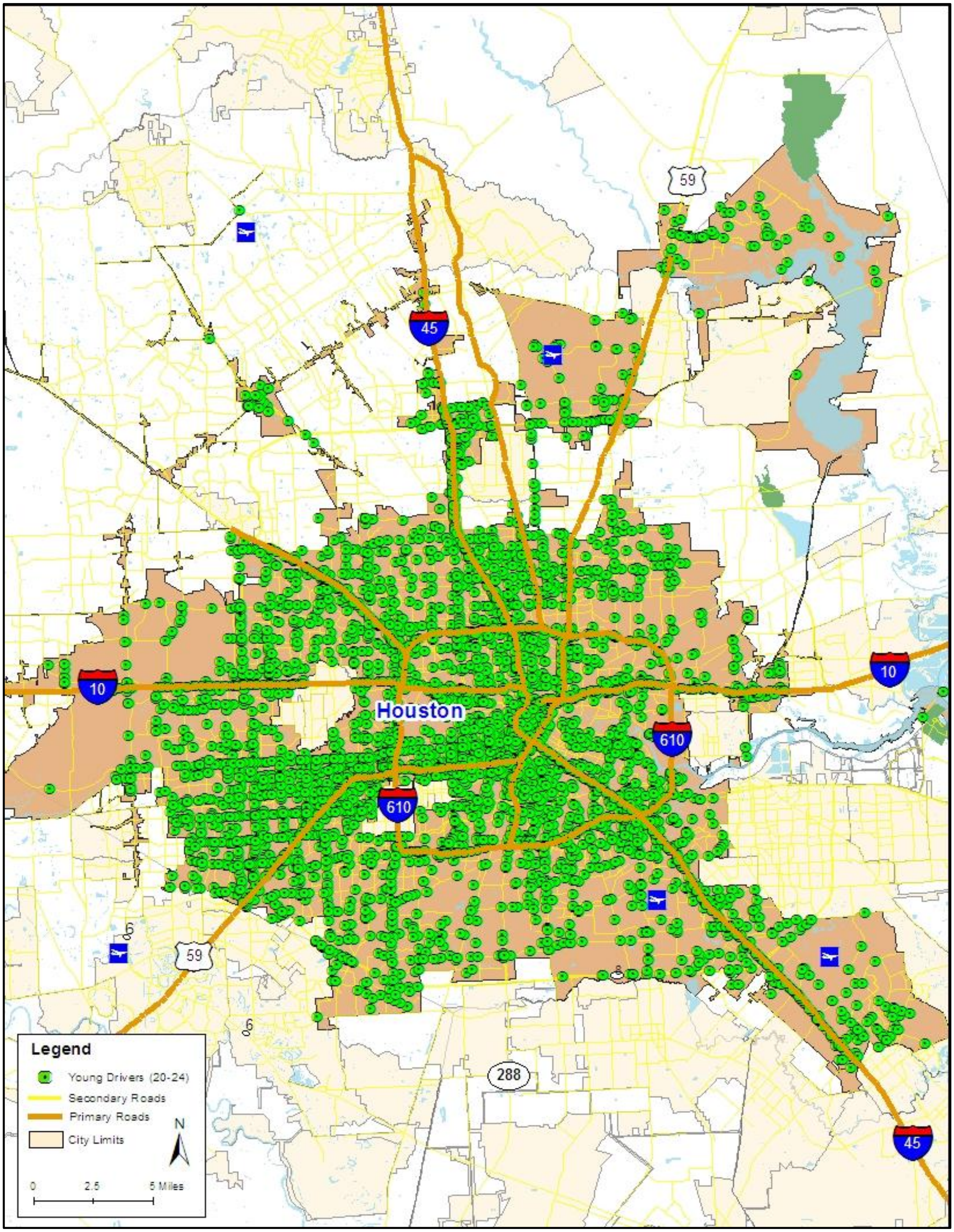

Figure 11. Houston Crashes: Young Drivers, 2006

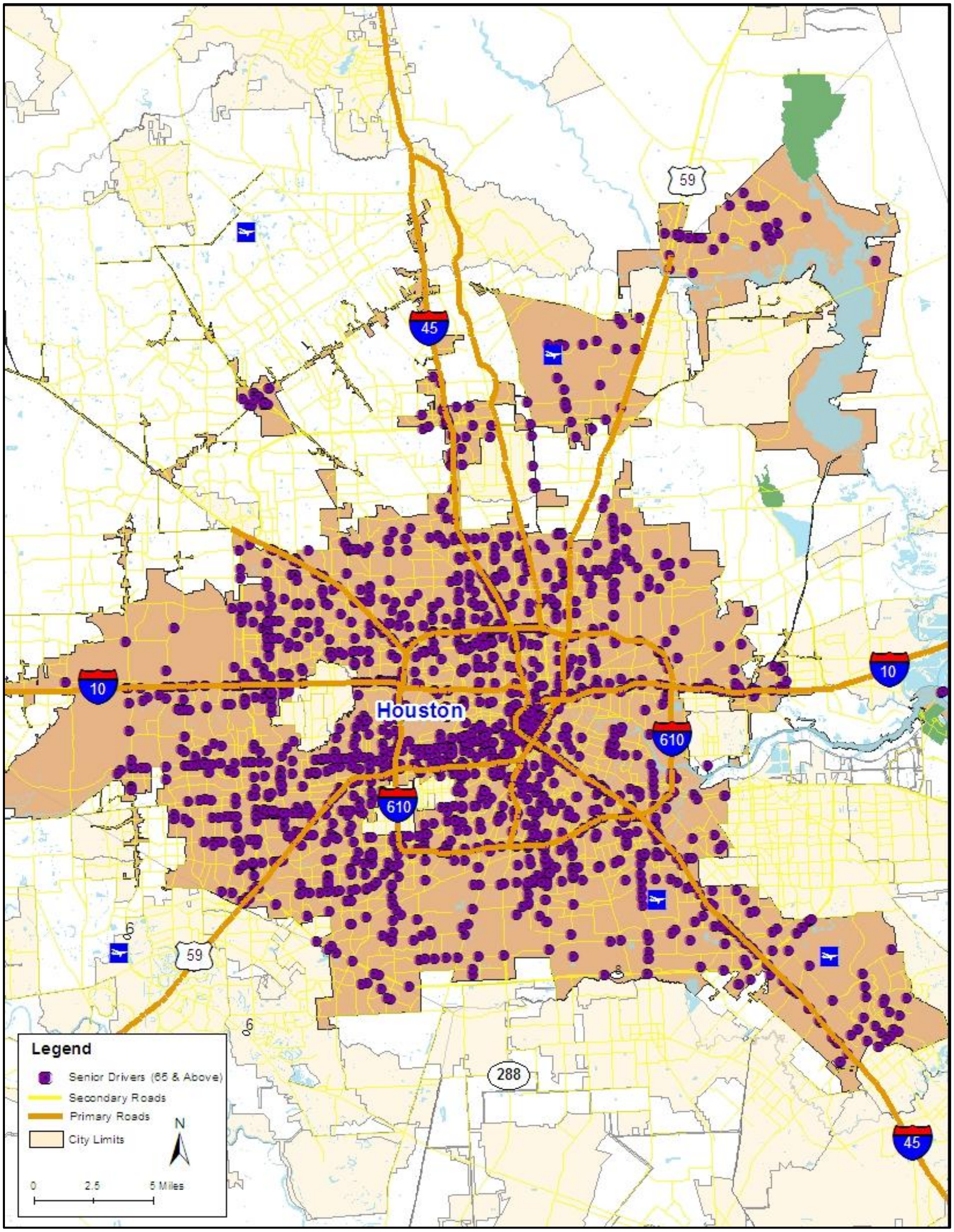

Figure 12. Houston Crashes: Senior Drivers, 2006

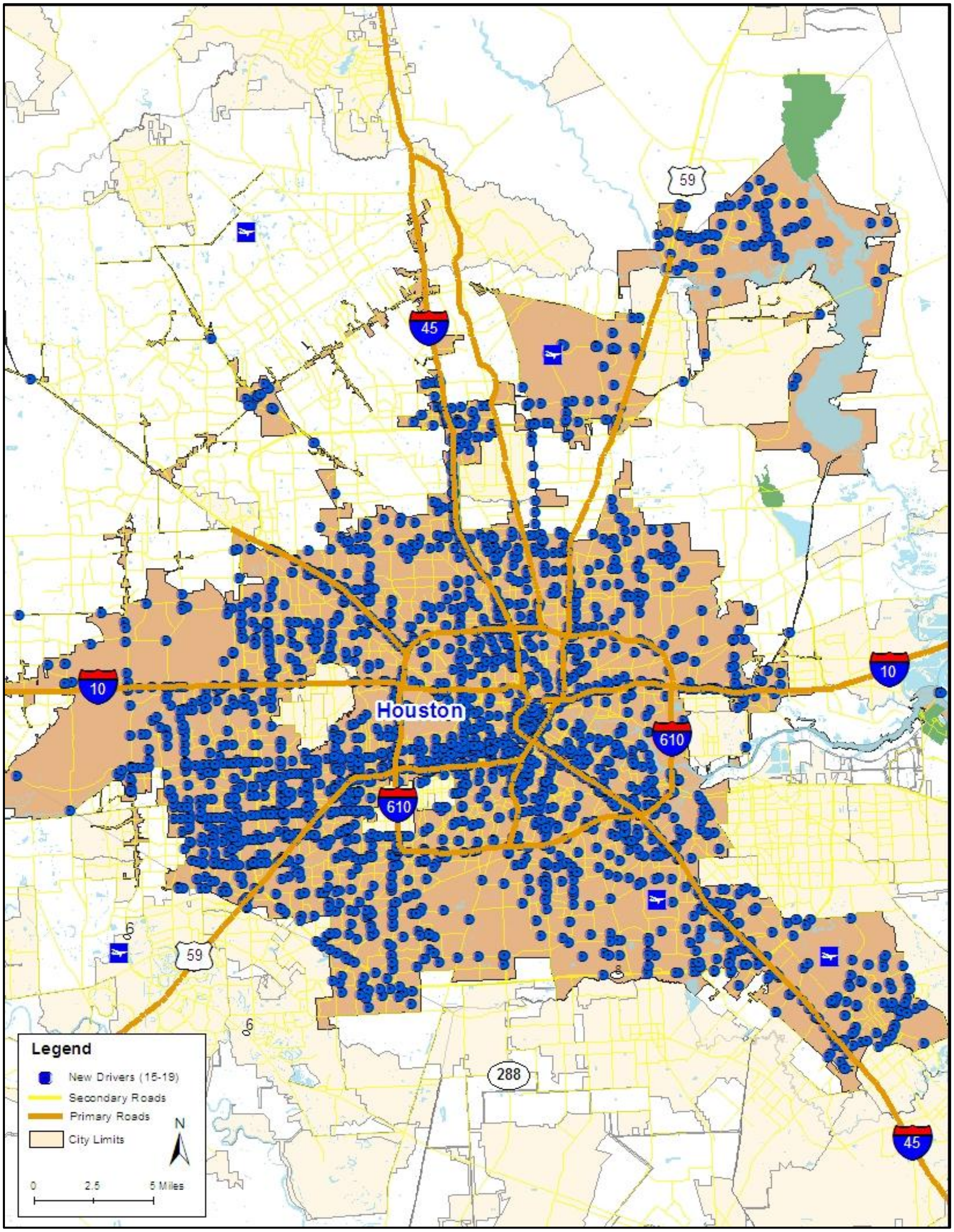

Figure 13. Houston Crashes: New Drivers, 2009

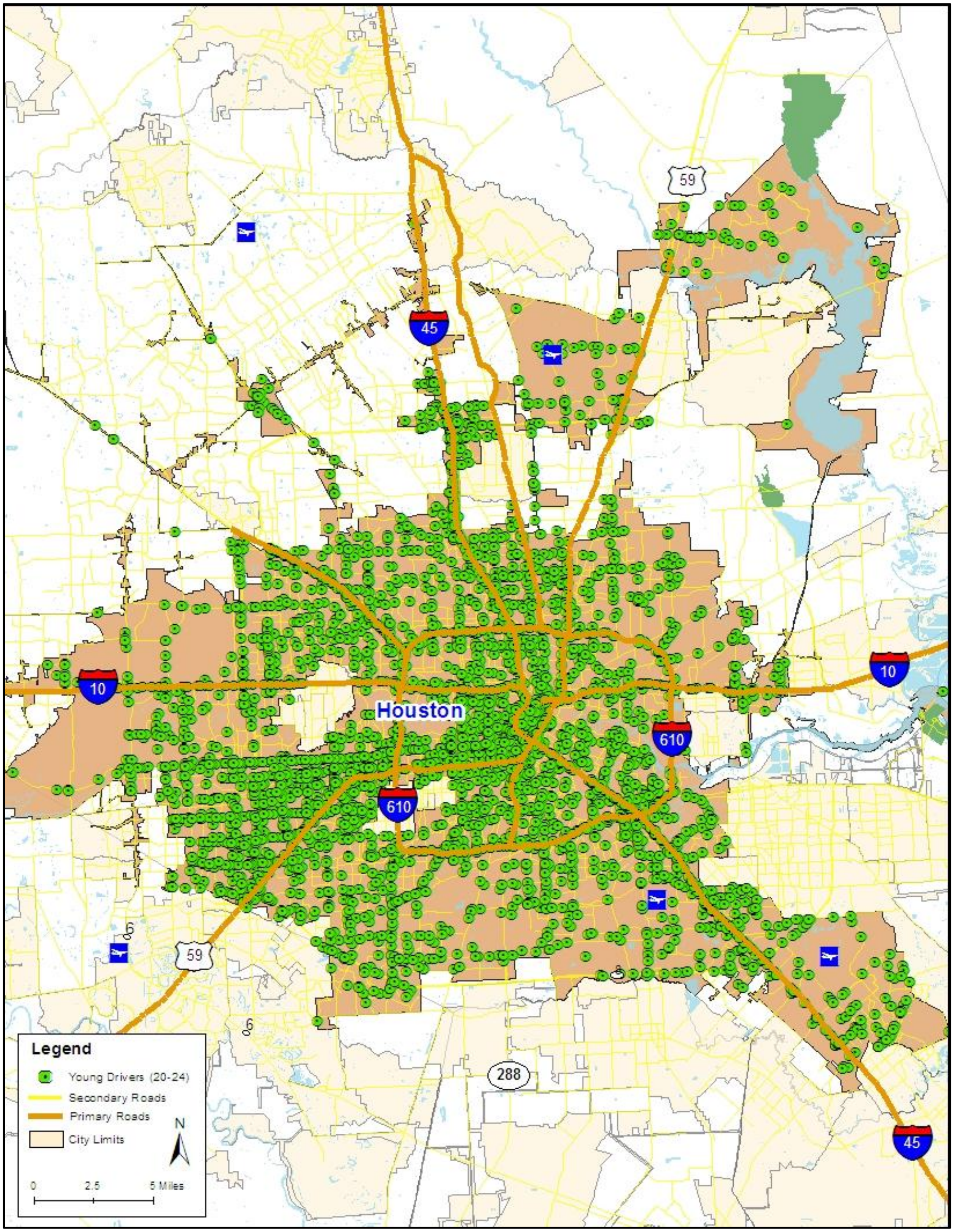

Figure 14. Houston Crashes: Young Drivers, 2009

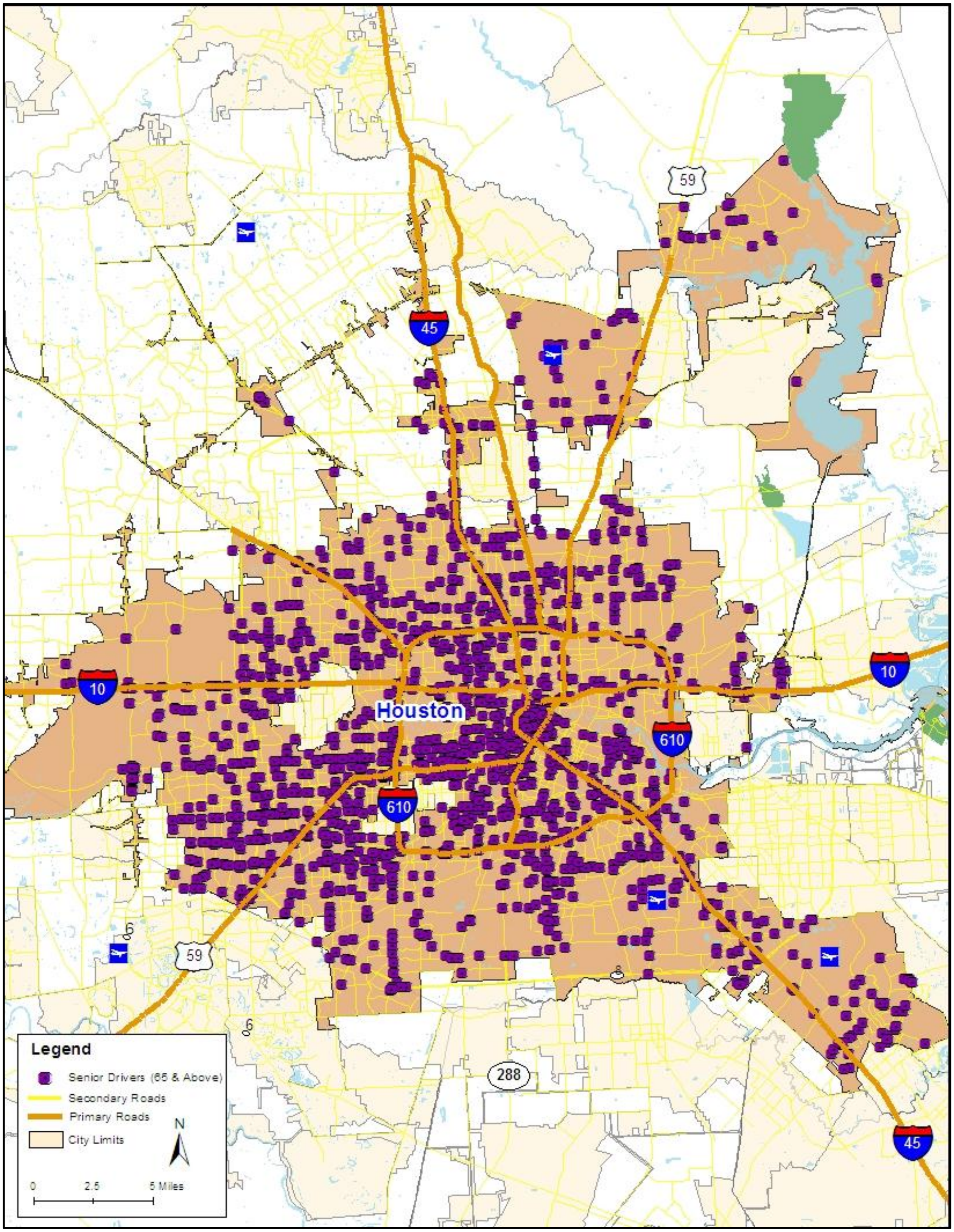

Figure 15. Houston Crashes: Senior Drivers, 2009

5 CONCLUSION

This study used Texas Department of Transportation crash data to analyze the rate of crashes among three age groups: 1) new drivers between 15 to 19 years old, 2) young drivers between 20 to 24 years old and 3) senior drivers 65 years old and above. Results from the study suggest crash rates among the three age groups were comparable to national crash figures. Collectively, crash rates declined in the three cities. The findings suggest programs that have been imposed during the past decade may be aiding in the decreasing crash rates among young, novice drivers under the age of 25 years old. In addition, similar policies such as two-year driver examination renewals for senior drivers may be aiding mitigating their crashes. Noteworthy findings were:

- On the city segregate level, Pearland was the only city in which crash rates increased. Crashes in the city increased 11% between the years 2006 and 2009.

- Crashes by injury decreased in all cities, in which Houston experienced the greatest decrease in crash rates. Crashes resulting in no injuries accounted for the bulk of incidents. Fatalities decreased in Houston and Pearland, while increasing significantly in Sugar Land.

- Young drivers accounted for the majority of the crashes, the greatest among the three age groups. While young drivers accounted for the most crashes, new drivers experienced the greatest decrease in accidents. Senior drivers make up the largest age group, and accounted for the fewest amounts of crashes.

- Crash rates among young male drivers were significantly higher than new drivers. Young male drivers accounted for the bulk of the crashes, while new drivers only accounted for the less crashes. Moreover, crash rates among new male drivers decreased the greatest. Senior male and female drivers experienced the largest percentage gap in crash rates.

- The majority of the crashes occurred on Fridays and Saturdays. This research did not analyze if alcohol was a factor in the crashes. In Houston, crash rates decreased each day of the week, and were dispersed in the suburban cities. Interestingly, crashes increased significantly on the weekends in Pearland, and on the contrary, crashes decreased in Sugar Land on the weekends.

- The majority of the crashes occurred during the midday. Houston experienced a decrease in crashes during all time periods. Sugar Land experienced decrease between morning peak and evening period, with relatively no change during the late night period. Crashes during the evening peak period increased in Pearland. Crashes by time of day fluctuated in the suburban cities. Peak period crashes decreased during the morning peak periods, and increased during the early morning period.

- The majority of the crashes occurred along U.S. 59 and HWY 6. Worth noting is younger driver crashes near schools. The number of crashes decreased in Sugarland for senior drivers.

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