



CTS 08-03

*Improving Rural Transportation Safety Series: Report #2*  
A Summary for Policymakers

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# **Five-County Minnesota Case Study:**

## Rural Roadway Fatal Crash Characteristics and Select Safety Improvement Programs

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16. Abstract (Limit: 250 words) This second in a series of CERS research reports summarizes the characteristics of the fatal rural roadway crashes within five Minnesota counties and describes some of the safety improvement programs or campaigns being used in this five-county area. Past research has shown that some of the many characteristics of fatal rural roadway crashes include younger drivers, alcohol involvement, lack of seat belt use, and speeding. The crash data summarized in this report were generally obtained from the Minnesota Department of Transportation and Minnesota Department of Public Safety.  Several recommendations have been proposed as a result of this case study project that focus on improving rural roadway safety data and analyses. Evaluations of safety improvement programs/campaigns are also proposed. Recommendations include: <ul style="list-style-type: none"> <li>• Examine more rural roadway crash factors and combinations of factors for additional clarification.</li> <li>• Improve the metrics used to describe or define rural roadways in the United States.</li> <li>• Use the primary characteristics of rural roadway crashes as the basis for safety improvement measures and programs implemented in rural areas.</li> <li>• Include measures and strategies that improve driver decision-making as one of the focus or emphasis areas of a comprehensive safety program.</li> <li>• Fund projects that continue to help upgrade and apply GIS tools to plot and evaluate safety data with respect to driver behavior and roadway conditions.</li> <li>• Scientifically evaluate the impacts of the safety improvement programs described in this report.</li> </ul>			
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**Report #2 in the Series: Improving Rural Transportation Safety**

**Five-County Minnesota Case Study:  
Rural Roadway Fatal Crash Characteristics and  
Select Safety Improvement Programs**

**Final Report**

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## EXECUTIVE SUMMARY

Approximately 56 percent of the roadway crash fatalities in the United States occur along rural roadways, but only 23 percent of the population resides within areas defined as rural. Almost 70 percent of the crash fatalities in Minnesota are in rural areas. The treatment of rural roadway safety concerns, however, which occur over a large number of roadway miles, requires an efficient and effective implementation of safety improvement measures/programs. These activities need to be targeted at the driver behaviors and/or roadway infrastructure that data indicate may contribute to rural roadway crashes.

The case study documented in this report focused on summarizing the characteristics of the fatal rural roadway crashes within five Minnesota counties. In addition, some of the safety improvement programs or campaigns that are being used in this five-county area were also described. Past research has shown that some of the typical characteristics of fatal rural roadway crashes include younger drivers, alcohol involvement, lack of seat belt use, and speeding. This report summarizes these characteristics and others to describe the rural fatal crashes in the case-study area. The crash data summarized in this report were generally obtained from the Minnesota Department of Transportation and Minnesota Department of Public Safety (DPS). More than 28,800 crash reports forms were considered, but only 1.2 percent of the crashes included fatalities. It was also concluded by the project team that almost all of the crashes in the five-county case study area could be defined as rural (i.e., a population of less than 5,000). The potential impact on the results due to the one community in the cases study with a population just over 5,000 was ignored. All of the summary data described in this document, therefore, are applicable to crashes occurring along rural roadways. Some of the crash data summary results included the following:

- Less than 3 percent of the case study area population was male and 20 to 24 years old. This group of drivers, however, was involved in about 12 percent of rural fatal crashes.
- Almost 60 percent of the fatal crashes in the case study area were run-off-the-road incidents and head-on collisions.
- A significant percentage of the crash fatalities in the case study area appear to occur during the weekends and the weekday afternoon peak travel period. August also had the highest number of fatal crashes of any month in the case study area.
- Approximately 57 percent of the fatal crashes in the case study area occurred along Interstates, United States highways, and Minnesota state highways. These roadways only represented about 11 percent of the roadway miles in the case study area.
- The two contributing factors that were noted the most in reports for fatal crashes within the case study area were speed choice (i.e., illegal or unsafe) and driver inattention or distraction.
- In the rural case study area about 54 percent of the motor-vehicle fatalities that occurred were unbelted occupants. About 35 percent of the motor vehicle crash fatalities in the

case study area were alcohol-related (i.e., a BAC of 0.01 or greater or the officer's perception of alcohol involvement is noted on the crash report).

- A number of safety improvement measures and programs are being used in the case study area. Two of these programs include staggered sentences for DUI offenders and an anti-teenage drinking and driving message competition. The "Toward Zero Deaths" campaign has been applied statewide in Minnesota. In addition, a number of counties have started to complete comprehensive reviews of their roadway safety data.

Several recommendations have been proposed as a result of this case study project that focus on improving rural roadway safety data and analyses. Evaluations of safety improvement programs/campaigns are also proposed. These recommendations include the following:

- It is recommended that more rural roadway crash factors and combinations of factors be examined for additional clarification. The behavioral and infrastructure-related factors and trade-offs that need to be addressed for these crashes should be analyzed. This rural roadway crash data analysis could be applied statewide.
- It is recommended that the metrics used to describe or define rural roadways in the United States be improved. A set of new metrics that account for other rural/urban roadway characteristics (e.g., land use) may be of value. A better definition of roadway type (e.g., urban or rural) should improve the ability to identify more applicable safety improvement measures.
- It is recommended that the safety improvement measures and programs implemented in rural areas respond to the primary characteristics of rural roadway crashes. In some cases, particular crash characteristics (e.g., driving under the influence) are more significant in rural than urban areas. A summary of data for all crash severities may not always discover this difference.
- Many of the characteristics or contributing factors of rural roadway crash fatalities are connected to driver behavior and/or choices (e.g., seat belt or alcohol use, speed, etc.). It is recommended that one of the focus or emphasis areas of a comprehensive safety program should include measures and strategies that improves driver decision-making. Drivers within particular demographics may also be of particular interest (e.g., teenagers).
- It is recommended that projects be funded that continue to help upgrade and apply GIS tools to plot and evaluate safety data with respect to driver behavior and roadway conditions. Assistance with the application of these technologies with data along local and rural roadways is critical.
- It is recommended that the impacts of the safety improvement programs described in this report be scientifically evaluated. Research is needed to determine the effectiveness of programs such as Toward Zero Deaths and NightCAP. Only one of the programs described in this document (i.e., staggered sentencing) has been evaluated in any manner.

## 1. INTRODUCTION

In Minnesota approximately 70 percent of *all* motor vehicle crashes occur on *urban* roadways but about the same percentage of *fatal* crashes occur on rural roadways (1). In addition, only about 27 percent of Minnesota's population resides in rural areas (2). These types of statistics, however, are not unique to Minnesota. Nationwide, 56 percent of the roadway crash fatalities in 2006 were along rural roadways, but only about 23 percent of the population resided in areas that were defined as rural by the United States Census Bureau (3). Some of various factors that may contribute to this imbalance include the higher speeds, lower safety belt use, and sometimes less-than-desirable design characteristics (e.g., unpaved shoulders) that occur along rural roadways. Overall, the rare and random nature of rural motor vehicle crashes, which occur over a large geographic area, also makes the identification and efficient treatment of problematic intersections or roadway sections inherently difficult. It has been shown that about 54 to 63 percent of fatal crashes with at least one contributing factor related to driver characteristics, behaviors, or choices (i.e., speeding, drinking, and seat belt use) occur in rural areas (3). Safety improvement measures or programs that address these characteristics, behaviors, or choices should have a desirable result.

The case study data summary described in this report focused on the primary descriptive characteristics of the fatal motor vehicle crashes in five rural Minnesota counties. In general, the who, what, when, where, and why of these crashes were investigated with a focus on the factors that past research has shown are often critical in a fatal incident (e.g., driver age). The objective of this project was to provide an overview of these fatal crash characteristics in five Minnesota counties and compare them, in some cases, to the characteristics of crashes of all severities within the same area and/or similar fatal crashes statewide and/or nationally. Safety improvement programs that are already in place and used within the cases study area are also discussed. Overall, the results presented in this report are a snapshot of rural roadway safety in a five-county area of Minnesota and should provide policymakers with a better understanding of the issue and how it might be improved.

## 2. CRASH SUMMARY BACKGROUND

There are a number of sources that include national and/or statewide summary data describing the basic characteristics of fatal crashes and/or their potential countermeasures (e.g., National Highway Traffic Safety Administration (NHTSA) and the Federal Highway Administration (FHWA)). Many of these data summaries, however, are general in nature and do not specifically evaluate the characteristics of crashes in rural areas or of varying crash severities. In fact, nationally, comprehensive crash data is generally only available for fatal incidents. For example, various NHTSA summaries of 2006 data indicated the following about fatal crashes in the United States (4, 5, 6, 7, 8):

- 5,973,000 crashes that resulted in 2,575,000 injuries, and 42,642 fatalities occurred (4)
- 15 to 20 year old drivers represented 6.4 percent of the licensed drivers, but were involved in 12.9 percent of fatal crashes (5)
- 81 percent of vehicle occupants used safety belts (6)
- 32 percent of the fatal crashes involved alcohol impairment (i.e., a blood alcohol concentration (BAC)  $\geq 0.08$ ) (7)
- 31 percent of fatal crashes had speed as a contributing factor (8)

In recent years NHTSA has also begun to annually summarize some of the characteristics for rural and urban locations (3). In addition, it published a report that compared and contrasted the characteristics of urban and rural fatal crash data from 1994 to 2003 (9). Some summary information from NHTSA for the fatal rural crashes occurring within the United States in 2006 includes the following (3, 10):

- 56 percent of all crash fatalities occurred along rural roadways (3)
- 78 percent of vehicle occupants in rural areas used safety belts (3)
- 57 percent of the people that died in rural crashes were unrestrained (3)
- 58 percent of passenger car fatalities related to impaired driving were in rural areas (10)
- 57 percent of drivers in fatal crashes that were speeding were in rural areas (3)

In general these data support the fact that some of the primary characteristics of fatal crashes are driver age, seat belt use, speeding, and the combination of drinking and driving. These characteristics and others are summarized for crashes in five Minnesota counties within this report.

Roadway safety data summaries or evaluations are also completed in each state, but the distinction between rural and urban crashes is not always made. This type of summary is often done to complete annual “crash facts” reports and/or to help create the Strategic Highway Safety Plans now required in each state. In Minnesota, for example, summary data for different types of crashes have been done for seven mostly rural Department of Transportation districts in Greater Minnesota (mostly rural) and the mostly urban Minneapolis/St. Paul metropolitan district. Crash summaries have also been done for each Minnesota county and support. These include among others: critical emphasis areas related to seat belt use, drinking and drivers, young drivers, lane departures, and intersections (11, 12). These types of summaries are useful in the identification of engineering, education, enforcement, and emergency response measures that could be used to

address the safety issues described. These summaries can also be used for the potential calibration of Safety Performance Functions (SPFs) (i.e., predictive crash models) within a particular state. A recently completed analysis of rural roadway safety in Texas was done for both these reasons (13).

### 3. DATA SUMMARIZED

#### Databases Used

The information used for the summaries in this document was obtained from three different sources. First, the crash characteristic data were collected from the Minnesota Department of Transportation (Mn/DOT). Some of the crash information included in this database was location, type, age of driver, and time of day. Overall, data from a total of 23,863 crashes that occurred between 1996 and 2005 from five Minnesota counties (defined below) were used.

Approximately 1.2 percent ( $n = 287$ ) of these crashes resulted in a fatality and about 34 percent resulted in some type of injury (from incapacitating to possible). The remaining 64.8 percent of the crashes resulted in property damage only. The information in this database is from the Minnesota crash report forms completed by law enforcement personnel and maintained by the Minnesota Department of Public Safety (DPS). The locational accuracy of the crashes on this form is to the nearest mile marker and this information was used to plot them (with Environmental Systems Research Institute, Inc. (ESRI) geographic information system software) along the transportation system of the five counties of interest (See Figure 4 later in this report). The Minnesota crash report does not directly distinguish between rural and urban crash locations, but it does include the jurisdiction within which the crash occurred. This information, the FHWA (and Mn/DOT) and the United States Census Bureau's definitions of urban and rural areas (see the next section of this report) were used in this case study evaluation to categorize crashes.

Another database used in this case study summary included population age information and the source was the United States Census Bureau (14). These county-level population age estimates were those completed by the United States Census Bureau in 2000. Data from the 2000 Census were used, despite the availability of 2005 data, in an effort to find average ages of the population for the years of crash data: 1996 – 2005. Finally, the third source of information was the Minnesota DPS. Documents were obtained from the DPS that summarized crash data related to safety belt and driver alcohol usage by county for 2004 to 2006 and 2001 to 2006, respectively (15, 16-19).

#### “Rural” and “Urban” Definitions

One of the challenges encountered in a literature review of crash summaries from the past was confirming what definition the researchers use for “rural” and “urban”. FHWA defines a rural roadway as “...[a]ny highway, road, or street that is not an urban highway” (20, 21). An urban highway for this definition is “...any road or street within the boundaries of an urban area that includes and is adjacent to a municipality or urban place with a population of 5,000 or more (20, 21).” These rural and urban boundaries are set by the state departments of transportation and then approved by the FHWA (20, 21). These are the boundaries, for example, that are used to define the rural and urban roadway functional classes in the FHWA Fatality Analysis Reporting System (FARS) (20, 21). This definition is also used to define the Minnesota fatalities in FARS as urban or rural. It was also used to show that the five counties considered in this case study were essentially entirely rural in nature (see the next section of this document for that discussion).

The United States Census Bureau has a different definition of “rural” and “urban.” It defines rural populations as those occurring in areas that are not urban (22). There are then two types of urban space defined by the United States Census Bureau. They include the cluster that is a

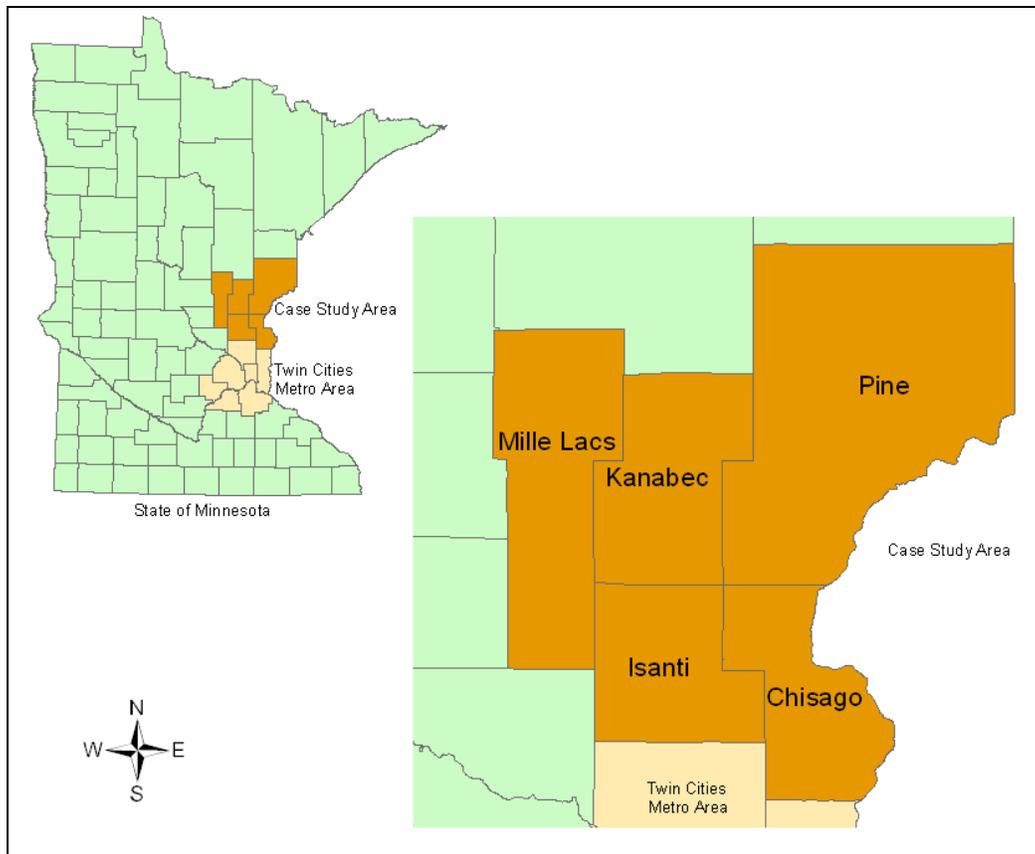
“...densely settled territory that has at least 2,500 people but fewer than 50,000...”, and an urbanized area (22). An urbanized area is defined as those spaces with “...a general population density of at least 1,000 people per square mile of land area...” that has a total population of at least 50,000 people (22). The population data used in this case study summary was defined in this manner. The United States Census Bureau definition attempts to take land use density into account.

Neither of the definitions above takes into account the continuum of land uses that may impact crashes in those areas that are not considered fully urban or rural (e.g., suburban). According to the FHWA definition, these types of roadways would sometimes be urban and sometimes rural. In addition, neither definition considers current roadway design. In some cases, there may be roadways with what are typically considered rural roadway characteristics that are defined as urban and vice versa. In addition, the difference in the definitions also makes the comparison of rural crashes (based on the FHWA definition) and rural population estimates (based on the United States Census Bureau definition) a general approximation of the significance of the rural safety issue.

#### 4. CASE STUDY AREA DESCRIPTION

The research team completing this summary decided early in the project schedule that for efficiency purposes its focus should be on crashes within counties of the East Central Region of Minnesota. These counties are almost entirely rural (per the FHWA definition above), comprise an economic development cluster within the state (facilitating data acquisition), and are also relatively close in proximity to the University of Minnesota. The close proximity of these counties to the researchers allowed site visits to crash locations to be completed easily.

The East Central Region of Minnesota is immediately north of Minneapolis and St. Paul (the Twin Cities) and includes the case study counties of Chisago, Isanti, Kanabec, Mille Lacs, and Pine (See Figure 1). The eastern side of the region is the St. Croix River and Minnesota's boundary with Wisconsin. Interstate 35 is located in this region and follows a north-south alignment through the area (connecting the Twin Cities with Duluth). Numerous lakes are found throughout the northern part of the study area and also to its east, west, and north. This region is on the fringe of the Twin Cities metropolitan area, but still includes prime recreational land and continues to be home to many rural communities, farmers, and American Indian reservations.



**FIGURE 1. Map of the Study Area Counties (Map Source: MetroGIS ([www.metrogis.org](http://www.metrogis.org)))**

The population, demographics, and income vary within the case study area. Overall, between 1990 and 2005, the population in this five-county area grew at a rate of 2.9 percent. This rate is more than double that of the 1.1 percent statewide. The populations for the counties closest to the Twin Cities have grown even faster. The population of Isanti County grew by 3.0 percent between 1990 and 2005, and the Chisago County population grew by 4.9 percent (14). The median household income in Isanti and Chisago Counties also exceeded the state median household income of \$47,000 by approximately 4.3 and 10.6 percent in 2000, and their unemployment rates were 3.2 and 2.5 percent in 2005, respectively. The unemployment rate in Minnesota during that year was 2.9 percent. In 2000 more than 96 percent of the population in the five-county area population was white, and the largest percentage of non-whites was in Mille Lacs and Pine counties (14). These counties both have American Indian reservations (14). They also have, in addition to Kanabec County, median household incomes that are 13.6 to 18.2 percent lower than the 2000 statewide median income. Their unemployment rates of 3.5 percent (Mille Lacs County) and 4.2 percent (Kanabec and Pine Counties) in 2005 were also higher than the statewide rate (14).

Only one jurisdiction within the case study area in Figure 1 exceeded a population of 5,000 (i.e., might be considered urban) in 2000 (14). Cambridge, Minnesota (located in southern Isanti County), had a population of 5,520 in the 2000 census (14). Based on the previously discussed FHWA and MN/DOT definition of urban and rural areas, therefore, only the crashes in Cambridge would be considered “urban” within the entire five-county area. However, for the purposes of this research, this small “urban” area was ignored and all the crashes in the five-county area were assumed to be along rural roadways. It is not believed that the conclusions of this study would change if the Cambridge crashes had been excluded from the analyses.

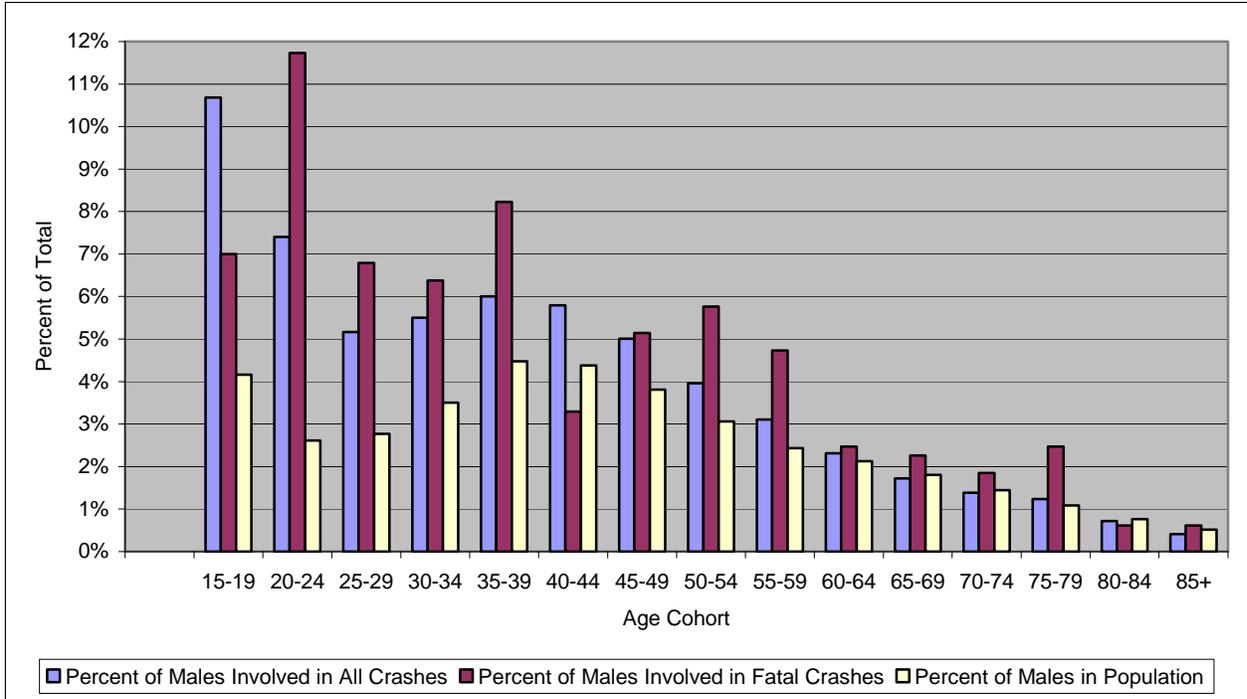
## 5. SELECT FATAL CRASH CHARACTERISTICS

Several select crash characteristics were summarized as part of this project. These characteristics were selected for review based on an evaluation of past research results and because they provided a comprehensive summary of some primary factors related to the fatal crashes that occurred in the rural case study area (See Figure 1). Overall, a total of 23,863 crashes occurred in the case study area between 1996 and 2005, but only 1.2 percent of those crashes resulted in fatalities. The fatal crash characteristic summaries in this document helped answer the following questions:

- Who is the typical driver in fatal crashes?
- What are the most typical fatal crash types?
- When do fatal crashes typically occur?
- Where within the case study area did fatal crashes typically occur?
- Why do fatal crashes seem to occur (i.e., the primary contributing factors to fatal crashes)?

### Vehicle Drivers

The statewide annual crash summary produced by the Minnesota DPS has consistently shown that young drivers and males are involved in fatal crashes at a rate that is greater than expected (23, 24, 25). In fact, in 2006, 15-to-24-year-old people were 16 percent of the licensed drivers but involved in 28 percent of the crashes in Minnesota (25). In addition, 55 percent of the drivers in all crashes and 72 percent of those resulting in a fatality were male (25). Similar over-representation patterns were also found in the data summarized for this project. Figure 2 shows the age distribution of the male population in the five-county case study area in 2000. It also shows the age distribution of male drivers involved with all rural crashes in the case study area between 1996 and 2005 and the fatal crashes. In both cases young males appear to be over-represented. In fact, some of the biggest differences between the population distribution and the percentages of crash involvement occur for males between 15 and 29 years old. For example, less than 3 percent of the case study area population in 2000 was 20 to 24 years old and male, but this group of drivers was involved in more than 7 percent of all the rural crashes in the region and nearly 12 percent of the rural fatal crashes. It should be noted, however, that the distribution of the overall 2000 population by age is only an approximation of the percentage of drivers that might be involved in the case study area crashes from 1996 to 2005.



**FIGURE 2. Percent of Males in Case Study Area Population (2000), Male Drivers in all Crashes (1996 to 2005), and Male Drivers in Fatal Crashes (1996 to 2005)**

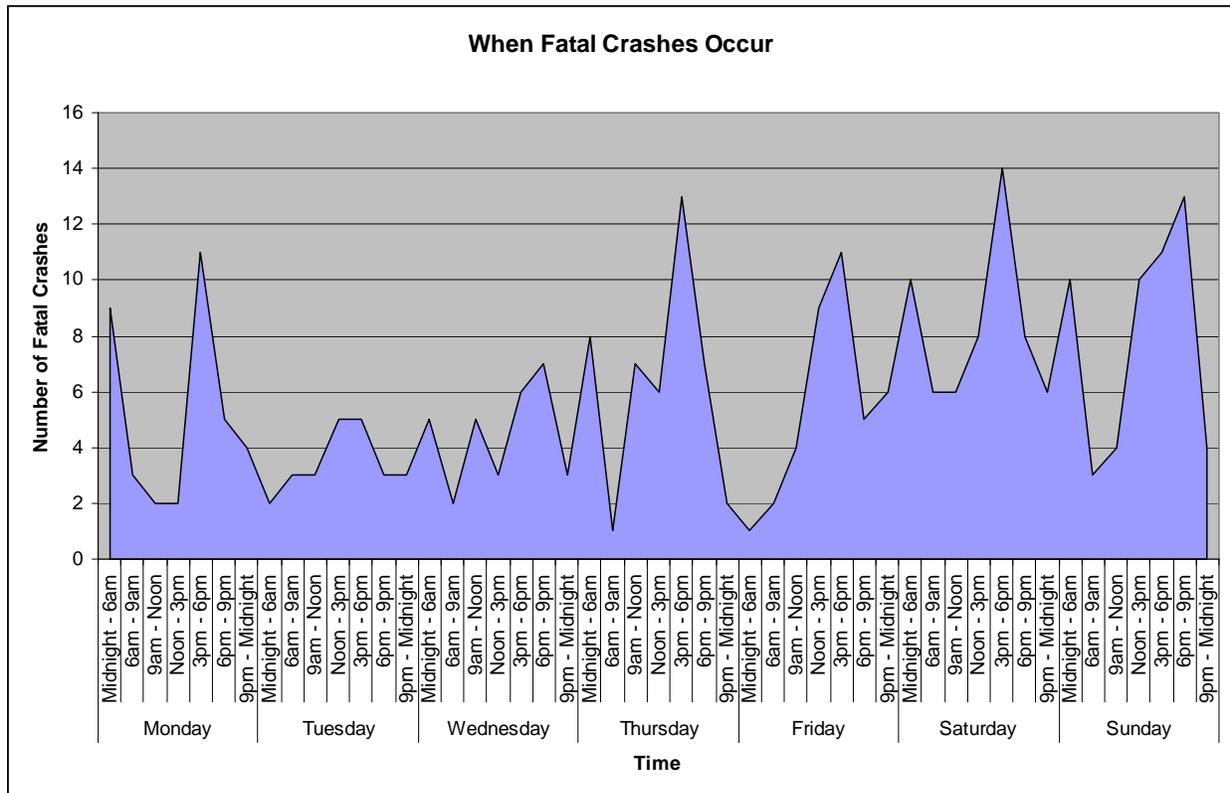
**Crash Type**

Evaluating the crash diagram codes for all crashes and fatal crashes yielded two noteworthy results for the years 1996-2005 (1). The majority of fatal crashes (37 percent) were run-off-the-road. But only 23 percent of all crashes were run-off-the-road. These types of crashes are typically single vehicle. (2) The other chief finding is that while only 4 percent of all crashes are head-on collisions, 19 percent of fatal crashes are head-on collisions. Overall, more than half of the fatal crashes in the rural case study area were run-off-the-road incidents and head-on collisions. A comparison of the statewide and case study data for these two types of crashes would appear to indicate that most run-off-the-road and head-on fatalities in Minnesota are occurring in rural areas.

**Time of Crash**

In 2006, most fatal crashes in Minnesota occurred when traffic volumes were high (e.g., 7 to 8 a.m.) (25). The weekdays with the most fatal crashes were Fridays and Saturdays (25). Figure 3 summarizes the time of day and day of week recorded for the fatal crashes occurring in the case study area (See Figure 1) from 1996 to 2005. Overall, approximately 53 percent of the fatal crashes occurred on Friday, Saturday, and Sunday. It has been suggested that increases in fatalities during the weekend, but more specifically late at night, may be related to impaired driving during these time periods (25, 26). As shown in Figure 3, the high number of fatalities that occur on “Sunday” is generally reported between midnight and 6:00 a.m.. There is also an increase in fatalities on Sundays between 3:00 p.m. and 9:00 p.m.. This increase may be related to the increases in traffic volume that are likely to occur at this time as weekend recreational

travelers return to the Twin Cities. The increases in rural fatal crashes shown for Thursday and Friday afternoons may be for the same reason, but with recreational travelers going from the Twin Cities to their northern parts of Minnesota. During the other weekdays (i.e., Monday to Thursday) rural fatal crashes in the five-county area occur most often during the afternoon/evening commute (or high volume) time periods. In fact, 26 percent of fatal crashes between Monday and Thursday occur between the hours of 3:00 p.m. and 6:00 p.m.

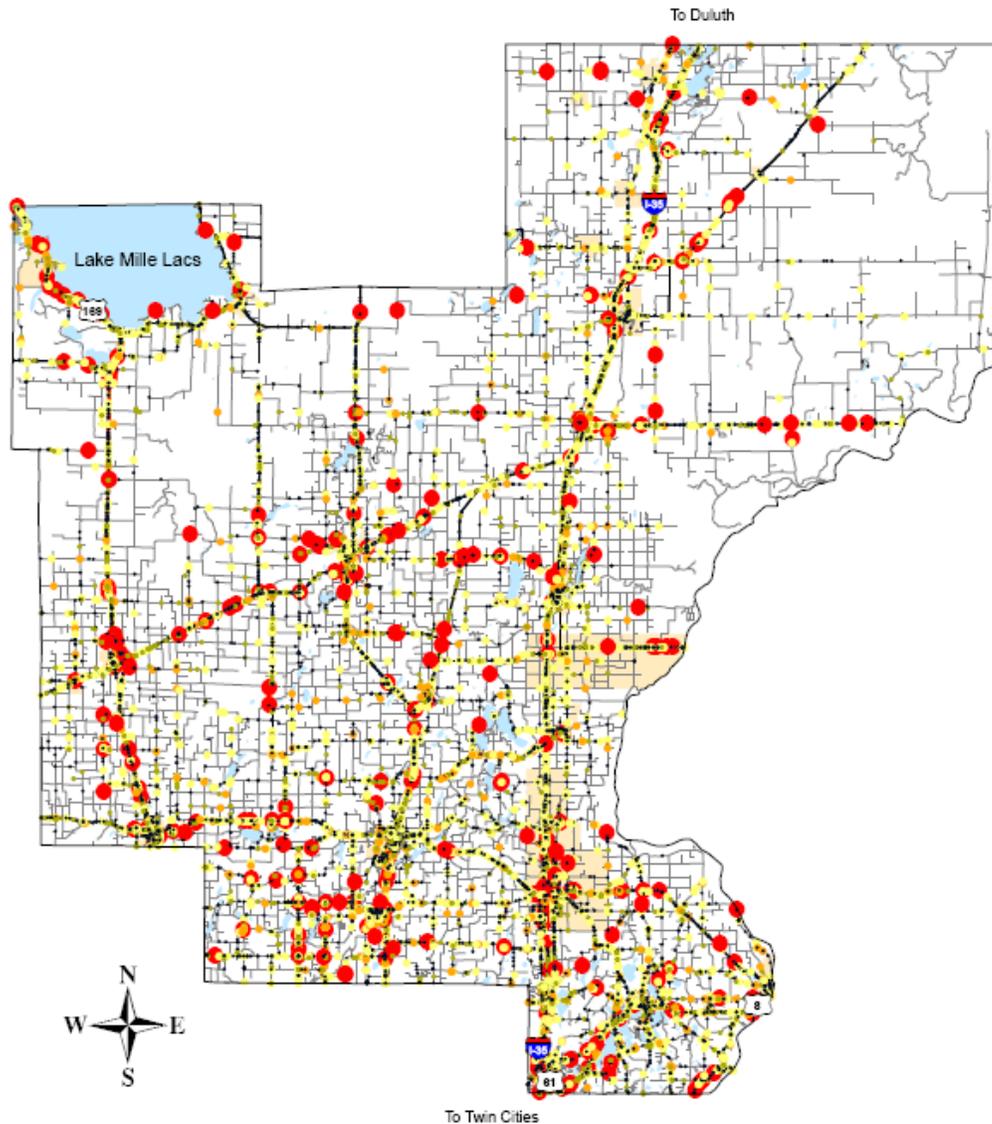


**FIGURE 3. Case Study Area Fatal Crashes by Time and Day**

From 1996 to 2005 the highest percentage (i.e., 15 percent) of the fatal crashes in the case study area occurred during August, but only 8 percent of all the crashes in the five-county area occurred during that month. In 2006, the largest number of fatal crashes in Minnesota occurred during July (25). This pattern, again, is likely due to the overall increase in relatively high speed recreational traffic volumes during the summer. Monthly crash data for the rural case study area also shows that almost four out of 10 motor vehicle incidents occurred during October, November, December, and January. Approximately 39 percent for all the crashes in the case study area occurred during this time period and 37 percent of the fatal crashes. It is possible that this pattern is at least partially influenced by the combination of traffic volume and winter weather. Similar percentages of these types of crashes also occurred during these months in 2006 throughout Minnesota (25).

### Crash Location

Statewide, in 2006, approximately 46 percent of fatal crashes and 52 percent of all crashes in rural areas (i.e., areas with less than 5,000 people) occurred on Interstates, United States highways and Minnesota state highways (25). A similar percentage of fatal urban crashes also occurred on these types of roadways in 2006, but the percentage of all the crashes was smaller (i.e., 36 percent) (25). Figure 4 shows spatial distribution of the fatal, injury, possible injury, and property damage crashes in the rural five-county case study region from 1996 to 2005.



### Key

- Red Circle – Fatality Crashes
- Orange Circle – Incapacitating and Non-Incapacitating Injury Crashes
- Yellow Circle – Possible Injury and Property Damage Crashes

**FIGURE 4. Spatial Distribution and Severity of Case Study Crashes (1996 to 2005)**  
(Map Sources: MetroGIS ([www.metrogis.org](http://www.metrogis.org)))

Overall, 57 percent of the fatal crashes in the case study area occurred along Interstate, U.S., and Minnesota state highways. This percentage is somewhat larger than occurred statewide in 2006 (see above). Interstate 35 experienced approximately 11 percent of the fatal crashes in the case study area, but only accounted for about 2.7 percent of the roadway miles. In addition, the U.S. highways in the case study area experienced approximately 14 percent of the fatal crashes, but are only about 1.9 percent of the roadway miles. The Minnesota state highways in the case study area accounted for approximately 32 percent of the fatal crashes, but only about 6.8 percent of the roadway miles. Overall, these three types of roadways accounted for approximately 57 percent of the fatal crashes from 1996 to 2005, but represented only 11.4 percent of the roadway miles. These types of roadways also have some of the highest traffic volumes in this case study area.

### **Contributing Factors**

The crash report form in the State of Minnesota allows law enforcement officers to enter 0, 1, or 2 contributing factors for each vehicle involved in a crash (25). These are factors that officers believe influenced the occurrence of the crash. Overall, approximately 61 percent of the crash reports considered for this project either did not have a contributing factor or indicated “no” or a non-specific “other” as an input. These crashes tended to be those with just property damage or no clear injuries (i.e., a possible injury input). For example, in 2006 property damage crashes accounted approximately 68 percent of the motor vehicle incidents in Minnesota (25).

Many of the contributing factors to crashes are related to human behavior or choices. These types of factors usually give provide a good understanding of why the crash may have occurred (25). In fact, 81 percent of the contributing factors noted for all the crashes in the rural five-county areas were related to human behavior, decision, or choices (e.g., seat belt use). Ten percent of all the crash reports had a contributing factor that was related to the vehicle (e.g., brake failure) and 9 percent were related to the weather.

In 2006, the three contributing factors related to human behavior that were mentioned the most in crash reports were driver inattention or attraction, failure to yield right-of-way, and illegal or unsafe speed (25). The leading contributing factors related to human behavior for all the crashes (that included reports with a designated contributing factor) in the case study area from 1996 to 2005 were similar and are listed below:

1. Driver inattention or distraction (24 percent)
2. Illegal or unsafe speed (13 percent)
3. Failure to yield right of way (13 percent)

The “top three” human behavior contributing factors, for just the fatal crashes in the case study area in the case study area included two of the above and an “other” human behavior category. These three factors are listed below along with the percentage of crash reports in which they were mentioned:

1. Illegal or unsafe speed (17 percent)
2. Driver inattention or distraction (15 percent)
3. “Other” human behavior (14 percent)

Illegal or unsafe speed and inattentive or distracted drivers were the two contributing factors noted the most for crashes in the case study area. Illegal or unsafe speed was a contributing factor in 17 percent of the fatal crashes and 13 percent of all the crashes. Inattentive or distracted driving was noted in 24 percent of all the crash reports but only 15 percent of the rural fatal crash reports. The contributing factor that is third on the list above for all the crashes in the case study area was “failure to yield right-of-way.” This factor was noted in 13 percent of the crash reports. Similarly, an “other” human behavior contributing factor was noted in 14 percent of the reports for fatal crashes.

### **Safety Belt Use**

The safety belt usage rate in 2006 by motor vehicle occupants within the rural areas of the United States has been estimated to be approximately 78 percent (27). In Minnesota, however, the overall safety belt usage rate for front seat passengers averages about 83 percent (6). However, more than half of the Minnesota population lives in the seven-county metropolitan area of the Twin Cities (25). Overall, NHTSA has estimated that the use of seat belts saved more than 15,300 lives within the United States in 2006 (28). Nationally, it has also been estimated that approximately 57 percent of passenger vehicle occupants killed in motor vehicle crashes in rural areas were unbelted (3).

The percentage of crash fatalities that were unbelted within each county of the case study area from 2004 to 2006 are shown in Table 1. This percentage ranged from 36.8 percent in Chisago County to 76.2 percent in Mille Lacs County. The percentage of unbelted fatalities in the entire rural case study area from 2004 to 2006 was 54.0 percent, and this was somewhat higher than 51.6 percent throughout Minnesota during this same time period. The case study area is primarily rural in nature and the use of seat belts in rural areas is typically less than that in urban areas. A somewhat higher percentage of unbelted fatalities than that experienced in Minnesota, therefore, was expected. In fact, Kanabec and Mille Lacs counties had a much larger percentage of unbelted fatalities than statewide and the other three counties were lower (See Table 1).

**TABLE 1. Percent Unbelted Vehicle Occupant Fatalities (2004 to 2006) (15)**

<b>County</b>	<b>Total Vehicle Occupant Fatalities</b>	<b>Total Unbelted Vehicle Occupant Fatalities</b>	<b>Percent Unbelted Vehicle Occupant Fatalities</b>
Chisago	19	7	36.8
Isanti	17	8	47.1
Kanabec	13	9	69.2
Mille Lacs	21	16	76.2
Pine	17	7	41.2
Total	87	47	54.0

### **Alcohol Use**

Alcohol use is also a component in many rural roadway crashes throughout the United States. In fact, in 2006 it is estimated that alcohol-impaired driving (i.e., at least one driver with a blood-alcohol concentration (BAC) of 0.08 or greater) accounted for approximately 32 percent of the

crash fatalities in the United States (7). In addition, approximately 58 percent of the fatalities related to alcohol-impaired driving of passenger cars were in rural areas (10). During the same year NHTSA reported that about 31 percent of the crash fatalities in Minnesota were connected to alcohol impairment and about 36 percent were alcohol-related (i.e., at least one driver with a BAC of 0.01 or greater) (7).

In Minnesota the DPS summarizes alcohol-related crash statistics by county each year. Its definition of alcohol-related crashes, however, includes incidents where a BAC of 0.01 or greater is found or the officer’s perception of alcohol involvement is noted on the crash report (19). In 2006, DPS reported that approximately 34 percent of the fatal crashes and overall roadway fatalities in Minnesota were alcohol-related (19). The percentage of alcohol-related fatalities from 2001 to 2005 within the counties of the case study area is shown in Table 2. In Minnesota during this time period the percentage of alcohol related fatalities was approximately 35.8 and percent (16, 17, 18). This same statistic was approximately 35.0 percent in the entire case study area, but ranged from approximately 21.2 to 48.5 percent in Chisago and Mille Lac counties, respectively. Table 2 also shows that the percentages in the three more northern rural counties of the case study area (i.e., Kanabec, Mille Lacs, and Pine) are higher than the two counties (i.e., Chisago and Isanti) that are somewhat closer to the Twin Cities (See Figure 1). It should be noted, however, that this percentage within a county can vary from 0 to 100 percent from one year to the next. The use of five years of data reduces the impact of that variability on the results somewhat.

**TABLE 2. Percent Alcohol-Related Crash Fatalities (2001 to 2005) (16, 17, 18)\***

<b>County</b>	<b>Total Crash Fatalities</b>	<b>Alcohol-Related Crash Fatalities</b>	<b>Percent Alcohol- Related Crash Fatalities</b>
Chisago	33	7	21.2
Isanti	36	10	27.8
Kanabec	27	11	40.7
Mille Lacs	33	16	48.5
Pine	48	18	37.5
Total	177	62	35.0

\*Alcohol-related included incidents where a BAC of 0.01 or greater is found or the officer’s perception of alcohol involvement is noted on the crash report.

## 6. SELECT SAFETY IMPROVEMENT PROGRAMS

The crash characteristics described in this document can be used to define the various measures and/or programs that might help improve roadway safety in the five-county case study area. In fact, these five counties already take advantage of several enforcement and education programs that address some of the primary characteristics of the motor vehicle crash fatalities occurring within their jurisdiction. Some of these programs are described below.

### Alcohol Use

#### *Staggered Sentences*

An innovative strategy to combat alcohol-related crashes and fatalities in Minnesota has been developed by Judge James Dehn of Minnesota's Tenth Judicial District. Judge Dehn is located in Isanti County and the Tenth Judicial District includes all the case study area counties except Mille Lacs. Judge Dehn's program targets drivers with more than one driving while under the influence (DUI) offenses, and he believes his approach is designed to empower people to make changes in their lives.

Repeat DUI offenders in Minnesota are typically sentenced to serve a *continuous* period in jail. Judge Dehn, on the other hand, often places these types of offenders on probation and allows the jail time to be served in two or more installments. The first jail time installment is served immediately following their conviction. During initial sentencing, however, Judge Dehn also provides offenders with a motion form and a set of instructions that explains how they can request forgiveness for the next installment of jail time. The second period of jail time is only forgiven, however, if offenders can demonstrate their sobriety to Judge Dehn. This sobriety can be proven with testimony or letters from probation agents, family, friends, alcoholics anonymous (AA) sponsors, co-employees, and/or employers (29). A failure to file or receive approval of a motion for this forgiveness, however, will result in the individual serving the second jail time period (30).

As part of this program remote electronic alcohol monitoring (REAM) systems are also enlisted by Judge Dehn to monitor repeat DUI driver alcohol levels. These devices are connected to the phone line and allow the offender's breath to be tested for alcohol three times per day (e.g., early morning, an hour after work, and late at night). They are often required by Judge Dehn for the 30-day period immediately following the completion of the first jail segment or at times when the offender may require additional monitoring (e.g., New Year's Eve). Should the REAM indicate that the offender had been drinking the offender is brought before the sentencing judge (29). Judge Dehn also warns all DUI offenders that have been put on probation that any new DUI arrests will result in a probation revocation and an immediate execution of all the remaining jail time (in addition to the consequences that will result from the new arrest).

In January 2003, the Minnesota Legislature House Research Department released a preliminary evaluation of Judge Dehn's staggered sentencing program. This study revealed that the program appeared to produce a DUI recidivism rate that was about 50 percent of those statewide. The first 61 offenders who received staggered sentences were tracked for an average of more than two years and only 6 of the 61 were arrested again (30). Almost 12 re-arrests would have been

expected if the statewide average rate for DUI recidivism had occurred. The reduced jail time served by the DUI offenders under Judge Dehn's program also saves state funds. The time spent incarcerated by these 61 individuals was reduced by an average of 52 days and this amounts to an average savings of approximately \$3,620 per offender (30). The savings for the first 61 offenders through Judge Dehn's program, if the average amount of \$3,620 is applied, are slightly more than \$220,000.

#### *Letters to Licensed Drinking Establishments*

As more and more DUI charges were brought before his courtroom Judge Dehn also decided that he would ask the owners of local drinking establishments to watch whom they serve more closely. Judge Dehn now asks each convicted DUI offender where they took their last drink and if the location is a licensed drinking establishment he writes its owner a letter. The letter informs the owner and staff that a convicted DUI offender took his or her last drink at their establishment, reminds them of the laws against serving the intoxicated, and also asks them to no longer serve the particular individual identified. Judge Dehn hopes to enlist the owners and staff of these establishments as partners in his effort to reduce the number of impaired drivers in their communities (29). The effectiveness of this particular program has not been evaluated.

#### *Safe Cab Program*

The transportation planning director of the East Central Regional Development Commission, which focuses on the five county area considered in this project, has also sought other innovative methods to address what he considers a "drinking culture." Director Robert Bollenbeck has developed a Safe Cab Program by acquiring financial support from the local Budweiser™ distributor and the Iowa-Minnesota American Automobile Association. The program provides free rides home to intoxicated individuals and he believes that this will lower the number of DUI arrests (31). The effectiveness of this particular program has also not been evaluated.

#### *NightCAP Program*

The NightCAP program is not designed solely for rural areas but provides funding to address the problem of impaired driving during local events where alcohol is either sold or consumed. The funds provided by this program are used to support the implementation and advertising of concentrated enforcement efforts that focus on ticketing alcohol impaired drivers during these types of events statewide. (32). NightCAP is one of the Minnesota Safe and Sober Campaign programs run by the DPS Traffic Safety Office (32, 33, 34). The effectiveness of NightCAP and the Minnesota Safe and Sober Campaign have not been evaluated.

#### *Teen Drinking and Driving*

Judge Dehn (of the Minnesota Tenth Judicial District) also spearheads a safety improvement program that includes an annual slogan contest. Judge Dehn offers a cash award, out of his own pocket, to the three best anti-alcohol slogans for teens that are developed by area middle school students. The contest occurs just before prom and graduation and the winning slogans are placed on message signs and posters within businesses. One annual winning slogan was, "There is nothing finer than a sober minor." The effectiveness of this educational program has not been evaluated (29).

## **Toward Zero Deaths**

Toward Zero Deaths is a statewide program in Minnesota that focuses on the overall reduction of roadway deaths. A multi-agency partnership guides Toward Zero Deaths and includes agencies and groups such as Mn/DOT, Minnesota DPS, Minnesota State Patrol, FHWA, local government law enforcement, county health professionals, emergency response professionals, safety advocacy groups, and the Center for Transportation Studies at the University of Minnesota.

Towards Zero Deaths wants to raise awareness of traffic safety issues and create tools to reduce the number of deaths and injuries on the roadways in Minnesota (34).

The approach used by the Toward Zero Deaths coalition recognizes that there is a variety of roadway safety situations (and potential solutions) in Minnesota from one county to another. It emphasizes the need for customized crash reduction programs. In other words, a comprehensive application of activities that focuses on the “Four E’s” (education, enforcement, engineering, and emergency trauma care) is preferred. Some of these activities are described below:

- **Education.** These activities work to increase the roadway safety knowledge of drivers so that they can make more informed decisions and avoid hazardous practices. These types of educational activities should also, if possible, include different messages to the various driver demographics (e.g., younger and older) that may exist.
- **Enforcement.** These programs often concentrate attention on traffic control, drunk-driving, and other safety-related laws. Laws that improve driver behavior can be effective if drivers’ actions are changed because they believe the legislation will be enforced.
- **Engineering.** Engineering measures to improve safety problems can be low cost (e.g., signing and marking) but are also sometimes expensive (e.g., grade separation of conflicting flows). However, the cost effectiveness of the measures implemented are always at least partially determined by the crash reduction benefits they provide. Engineering improvements are typically examples of a tangible crash reduction investment in the public infrastructure. For example, Mille Lacs and Isanti Counties are working together within a program called “United Toward Zero Deaths.” This program has targeted the improvement of two state highways, Trunk Highway 65 and 95 (34).
- **Emergency trauma care.** Emergency response plays a critical role in determining the injury outcome of a crash. Improvements to programs that provide a higher quality of care and a faster response time should increase roadway crash survivability (i.e., reduce crash fatalities) (34). Better emergency response is especially important in rural areas.

## **Roadway Safety Audits**

Comprehensive roadway safety data reviews are being completed within several Minnesota counties. This type of review evaluates the county crash data to consider the potential safety improvements that might occur with the implementation of activities related to the “Four E’s” (see above). In some cases the focus of these reviews has also only been on traffic control and/or infrastructure improvements. In 2006, Mille Lacs County conducted a review of its safety data with an independent team of experts. These experts considered the crash data for the entire county, investigated problematic intersections and roadway corridors, and then held a meeting at which elected officials, public health representatives, law enforcement personnel, school district

representatives, and engineers were invited to participate. The outcome of this meeting emphasized that many of the safety issues appeared to be educational or behavioral in nature and a community problem that might be better addressed through a cooperative partnerships (30). Isanti and Kanabec Counties are planning to conduct similar reviews in 2008 (34).

## 7. SUMMARY FINDINGS

This study considered the characteristics of fatal motor vehicle crashes on the roadways within a primarily rural five-county Minnesota case study area. Crash involving male drivers of different ages were examined along with crash type, time, location, and contributing factors. The number or percentage of rural crash fatalities related to unbelted vehicle occupants and alcohol use were also summarized. Some of the safety improvement programs or activities being used to address these crash characteristics were also described. The findings and recommendations described below are the result of the data and safety improvement summaries completed as part of this project.

### *Summary Findings*

- Rural roadways experienced more than half the motor-vehicle crash fatalities in the United States. In Minnesota approximately 70 percent of all motor-vehicle crash fatalities area considered rural.
- The rural and urban designation of roadways and motor-vehicle crashes are determined by the state DOT and FHWA. The five-county case study area used in this project was almost entirely rural. The impact on the results of the one community in the case study area with a population of 5,000 people or more (i.e., urban) was ignored. All the statistics discussed in this document, therefore, generally apply to crashes occurring in rural roadway situations.
- Data from the Mn/DOT, DPS, and United States Census Bureau were used in this project. Overall, information from more than 28,800 crashes was considered. The focus of this research, however, was fatal crashes and these accounted for about 1.2 percent of the data.
- Crash data has consistently shown that young drivers and males are more involved with fatal crashes than expected. In Minnesota 15-to-24-year-olds were 16 percent of the licensed drivers but were involved in 28 percent of the crashes. In the case-study area, less than 3 percent of the population was 20 to 24 years old and male, but this group was involved in about 12 percent of rural fatal crashes.
- Run-off-the-road and head-on collisions represent a large percentage of rural fatal crashes. Approximately 37 percent of the fatal crashes in the case study area were run-off-the-road and 19 percent were head-on collisions. Similar results were found statewide.
- More than half of the fatal crashes in the case study area occurred from Friday to Sunday. These incidents may be the result of the traffic volumes related to the recreational nature of the case study area. During the remainder of the week about 26 percent of the fatal crashes occurred during the afternoon peak travel period (i.e., 3:00 p.m. to 6:00 p.m.). August also had the highest number of fatal crashes in any month and about 40 percent of this type of crash occurred from October to January.

- In 2006 about 45 percent of the fatal crashes in Minnesota occurred along rural Interstates, United States highways, and Minnesota state trunk highways. A similar percentage of fatal crashes was also found in the urban areas of Minnesota. However, in the rural case study area approximately 57 percent of the fatal crashes were along these roadways.
- More than one contributing factor can be recorded on each crash report. However, in the case study area approximately 61 percent of the reports did not indicate a contributing factor or described the factor as “other.” Many of these reports were for non-fatal incidents. About 81 percent of factors that were noted for the crashes in the case study area are related to human behavior (e.g., seat belt use). The two factors noted the most for fatal crashes were related to speed choice (i.e., illegal or unsafe) and driver inattention or distraction. These were also the top two factors noted for crashes of all severities reported (and designating a contributing factor) in the case study area. The relationship between motor-vehicle crashes and seat belt and alcohol use are described below.
- Seat belt and alcohol use were also specifically considered in this summary. In the rural case study area, about 54 percent of the motor-vehicle fatalities that occurred were unbelted occupants. This percentage, however, ranged from 37 to 76 percent in the individual counties within the case study area. In the United States about 57 percent of the people that died in rural crashes were unbelted.

In the United States about 32 percent of the motor-vehicle crash fatalities were related to alcohol impairment (i.e., a BAC of 0.08 or greater). NHTSA reported that this percentage was about the same for Minnesota in 2006. The Minnesota DPS also summarizes the crashes in the state that are alcohol-related (i.e., a BAC of 0.01 or greater or the officer’s perception of alcohol involvement is noted on the crash report). About 35 percent of the fatalities in the case study area were alcohol-related, but this percentage ranged from about 21 to 48 percent within the individual case study area counties. The Minnesota definition is more all-inclusive, but is also still about the same as that reported by NHTSA for the entire state.

- A series of safety improvement measures and programs that address the characteristics and/or contributing factors of rural fatal crashes are being used in the case study area. Some of these programs include staggered sentences for DUI offenders, letters to licensed drinking establishments, and an anti-teenage drinking and driving message competition. Only the staggered sentencing approach has been evaluated in any manner. It appears to reduce DUI recidivism and costs.

The “Toward Zero Deaths” campaign is also applied statewide. This campaign is a comprehensive collaborative effort of many safety-related agencies and groups that encourages programs that focus on the implementation of safety improvement measures related to engineering, education, enforcement, and emergency response. In addition, a number of Minnesota counties have also started to comprehensively evaluate the crash data for their roadways. The roadway safety reviews are used to determine what measures

or programs should be used to address the characteristics and contributing factors of the crashes that are occurring.

## 8. RECOMMENDATIONS

- This case study considered several of the more important fatal crash characteristics that were generally identified in past research. Not surprisingly these characteristics also appeared to be important in the case study area and statewide. It is recommended that more of the factors and combination of factors that define a rural fatal crash in this case study area be examined. It is also recommended that the behavioral and infrastructure-related factors of these crashes be analyzed by connecting the roadway characteristic database with the crash data. The application of this methodology to the fatal and all rural roadway crashes in the state is suggested. The addition or focus on those crashes that occur along local roadways may also be of interest.
- It is recommended that a more descriptive series of metrics might be investigated to better describe roadways in the United States as rural and urban. The current approach used in the definition of crash data is generally focused on jurisdiction borders and overall population. A set of new metrics could account for other characteristics of the roadway environment that define it as rural or urban to the driver. Two of the factors that would need to be considered in the investigation would be how easy it is to consistently implement a new urban/rural definition throughout the United States and how changes in the rural/urban definition of particular roadway segments would be shared with those that record this information for crash reports. A better definition of roadway type (e.g., urban or rural) might improve the ability to identify more applicable safety improvement measures.
- It is recommended that the safety improvement measures and programs implemented in rural areas respond to the primary characteristics of rural roadway crashes. These are described above for the case study area. In some cases, particular crash characteristics (e.g., driving under the influence) are more significant in rural areas than urban. A summary of data for all crash severities may not always discover this difference. It is also important to implement those measures and/or programs that have been shown to have an impact on these incidents (see below for a recommendation on the need for further evaluation). Data-driven decision-making will show, through performance measures, how the safety improvement mitigation measures will assist a jurisdiction in meeting its specific crash reduction goals.
- In the case study area, statewide, and nationally many of the primary characteristics or contributing factors related to rural roadway crash fatalities appear to be connected to driver behavior and/or choices (e.g., seat belt or alcohol use, speed, etc.). It is recommended that one of the focus or emphasis areas of a comprehensive safety program include measures and strategies that improves driver to decision-making. In addition, certain demographics of drivers may be of particular interest (e.g., teenagers). Programs that focus on helping teenagers become better drivers are important. Other emphasis areas that should be included in a comprehensive safety program are improvements to roadway infrastructure and roadsides, enforcement, and policy or legislative changes.

- Mapping or plotting the location of rural roadway crash fatalities in a geographic information system (GIS) can assist with the analysis, development, and correct implementation of safety improvement measures or strategies. It is recommended that projects be funded to help upgrade and apply GIS tools to plot and evaluate safety data with respect to driver behavior and roadway conditions. The implementation of systems that focus on local and rural roadways connecting crash and inventory conditions is critical.
- It is recommended that impacts of the safety improvement programs described in this report be scientifically evaluated. Research is needed to determine the effectiveness of programs such as Toward Zero Deaths. These programs have been implemented, but like many strategies that are focused on changes in human behavior, they have not been evaluated for their expected or measured reduction in crashes, injuries, or fatalities. Only one of the programs described in this document (i.e., staggered sentencing) has been evaluated in any manner. The programs that are determined to be effective in Minnesota might be of value in other areas of the United States.

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