Draft for discussion

Denver Regional Council of Governments

Report on Traffic Crashes in the Denver Region

REVIEW DRAFT

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Draft for discussion

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Draft for discussion

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1. INTRODUCTION

A. Background and Purpose

Traffic crashes represent a major safety concern. In 2015, over 38,000 people died on our nation's roadways. Every day in the Denver region, there are about 220 **reported** traffic crashes. Tragically, the crashes result in about five seriously injured persons per day and four traffic fatalities per week. These crashes incur large costs including property damage, medical expenses, lost productivity, excess traffic congestion, and the pain and suffering associated with an injury or fatal crash.

The purpose of this report is to raise awareness of traffic safety issues within the Denver region using crash-related data. The data will assist DRCOG in developing long range goals and targets. Extensive information is provided on many different types of crashes, causes, and characteristics. Techniques to help reduce crashes are also presented in applicable sections.

This report is divided into the following seven sections:

- Regional traffic crash trends
- Crash demographics
- Crash characteristics (e.g., crash causes and time of day)
- Specific crash types (e.g., bicycle and pedestrian crashes)
- High-risk behavior crashes
- Locations of crashes
- Other safety efforts

B. Notes on Crash Data

Crash data is not perfect, as field reports may not contain complete information. The majority of the detailed crash data used in this report reflects the latest data available (through 2013) from the Colorado Department of Transportation (CDOT)[1]. Fatal crash data is presented through 2015 as it must be immediately reported to the National Highway Traffic Safety Administration (NHTSA)[2]. NHTSA then presents data annually through the Fatality Analysis Reporting System (FARS)[3].

[1] *https://www.codot.gov/*
[2] *http://www.nhtsa.gov/*.
[3] *http://www.nhtsa.gov/FARS*

2. DENVER REGION CRASH DATA

A. Traffic Fatality Trends

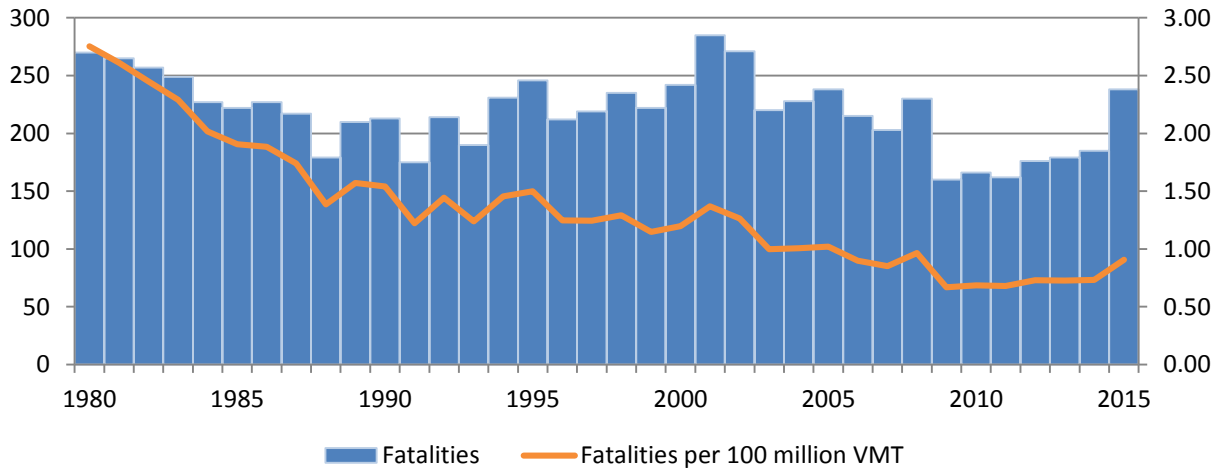
The number of annual traffic fatalities in the Denver region reached a three-decade low in 2009. Between 2001 and 2009, the number of traffic fatalities decreased by 44 percent (285 to 160). Since 2009, however, annual fatalities have increased 49 percent (160 to 238 in 2015).

Another way of presenting crash information is by the "rate" per amount of miles that vehicles are driven. The amount of driving is usually defined as "vehicle miles of travel" or VMT. For example, on Denver regional roadways in 2015:

- Motor vehicles were driven over 25 billion VMT (78 million per weekday).
- Dividing the 185 fatalities into 25 billion results in a rate of 0.79 fatalities per 100 million VMT.

The chart below shows the number of traffic fatalities rate per 100 million VMT from 1980 to 2015. The fatality rate has decreased from 2.75 to 0.91 over the last 35 years, though there has been a slight increase since 2009.

Figure 1. Annual Traffic Fatalities and Fatal Crash Rate in the Denver Region (1980-2015)



Regardless of what the data says, one traffic fatality is one too many, even if a fatality occurs "only" once every 125 million vehicle miles traveled. A new initiative, known as *Towards Zero Deaths*, was established by the United States Department of Transportation (USDOT)[4]) in 2014. The initiative has been embraced by the Colorado Department of Transportation (CDOT) and will be incorporated into DRCOG's Metro Vision Regional Transportation Plan[5].

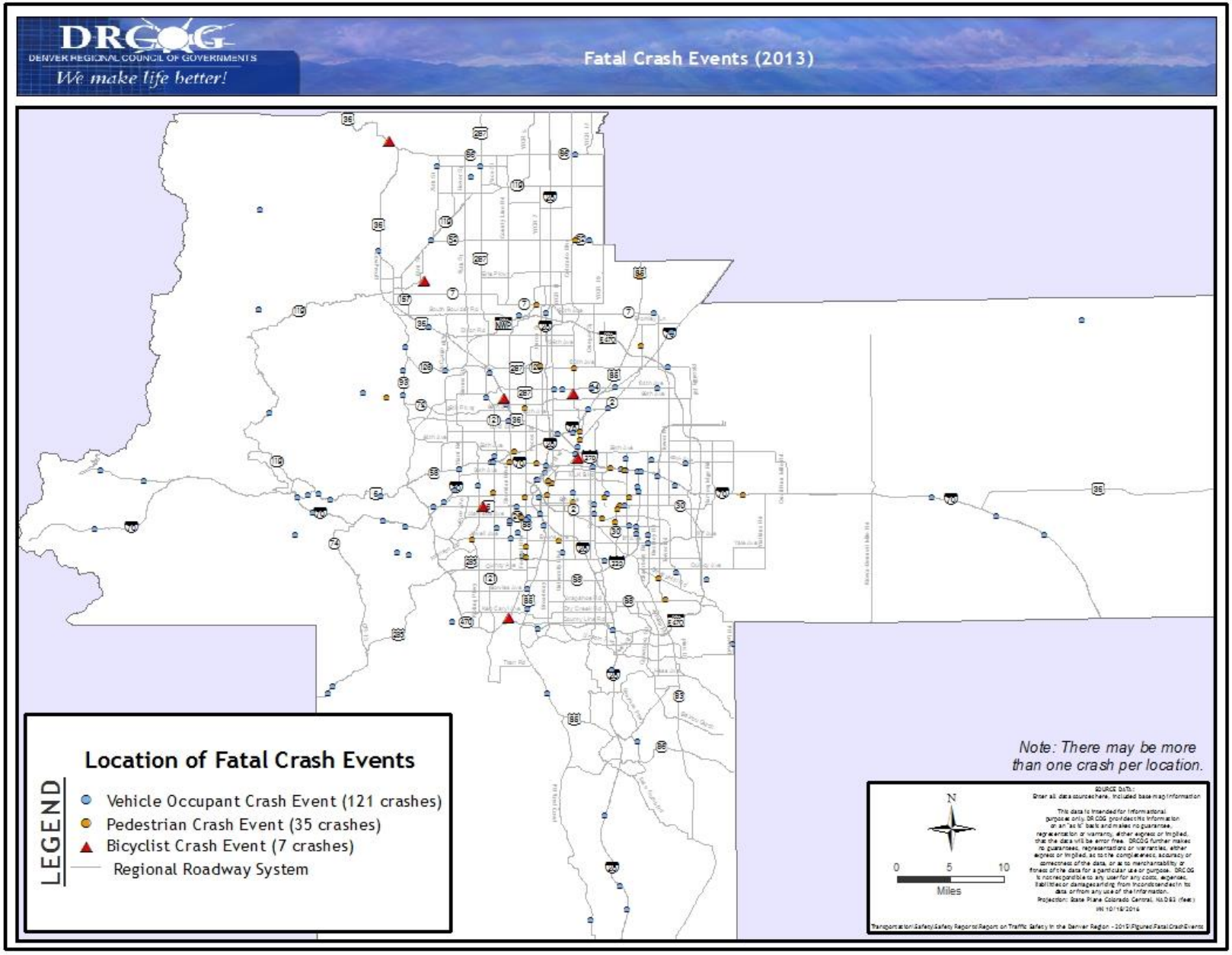
A third way of presenting traffic fatality data is in a public health perspective. For the Denver region, in 2015 there were 6.8 fatalities per 100,000 persons in the Denver region. The seriousness of the traffic safety issue can be portrayed comparably to other public health issues.

Several factors have contributed to the reduction of the traffic fatality rate over the past 35 years. Improvements in vehicle safety design (e.g., increased prevalence of front and side airbags) and phasing out older vehicles from the motor vehicle fleet have played a critical role, as has increased seat belt use. According to CDOT, overall seat belt use in Colorado rose from 50 percent in 1990 to 82 percent in 2014. Education and enforcement efforts have drastically reduced the occurrence of impaired driving fatal crashes. In the Denver region, impaired-driving fatalities dropped by 62 percent between 2004 and 2013 (from 111 to 42 fatalities). Improvements in emergency response and medical care technology have also helped to reduce traffic fatalities, as well as better designed roadways and safety features.

Figure 2 shows a map of fatal crash locations in 2013. Traffic fatalities occur throughout the region and occur on all roadway facility types. In 2013, 26 percent of fatal crashes occurred on freeway facilities and 74 percent along streets or at intersections. Upcoming sections of this report will go into further detail on certain types of fatal crashes, such as those associated with pedestrians, bicyclists, motorcyclists, trucks, and construction zones.

[4] *https://www.transportation.gov/*
[5] *https://drcog.org/programs/transportation-planning/regional-transportation-plan*

Figure 2


DRCOG
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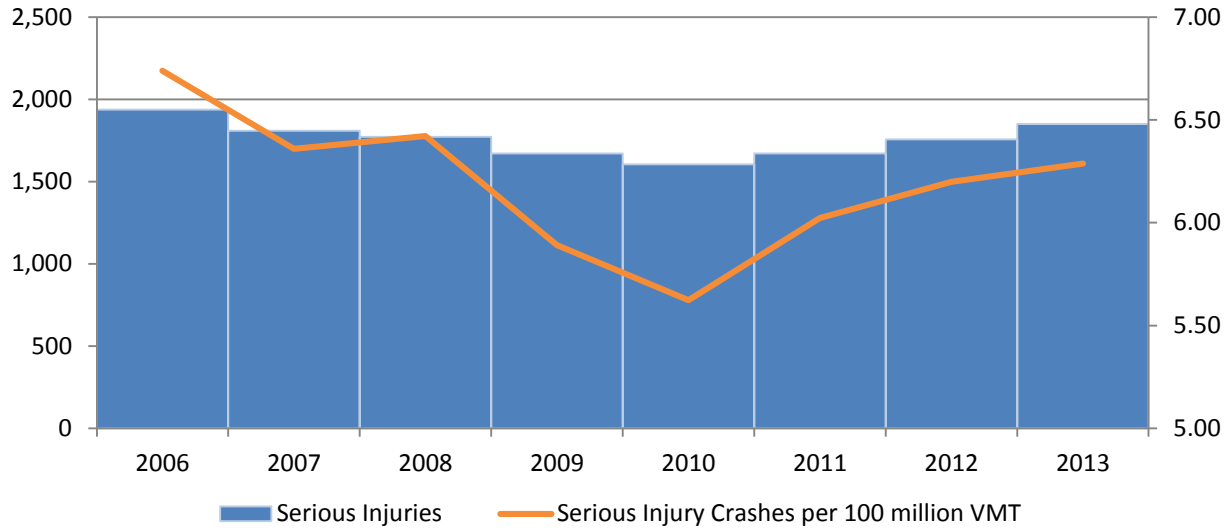
Fatal Crash Events (2013)
Location of Fatal Crash Events
LEGEND
Vehicle Occupant Crash Event (121 crashes)
Pedestrian Crash Event (35 crashes)
Bicyclist Crash Event (7 crashes)
Regional Roadway System
Note: There may be more than one crash per location.
N
0 5 10
Miles

B. Serious Injury Trends

The number of people seriously injured in traffic crashes has fluctuated, ranging between 1,600 and 1,940 injuries per year between 2006 and 2013. The rate of injuries was dropping through 2010, but has since been on the rise.

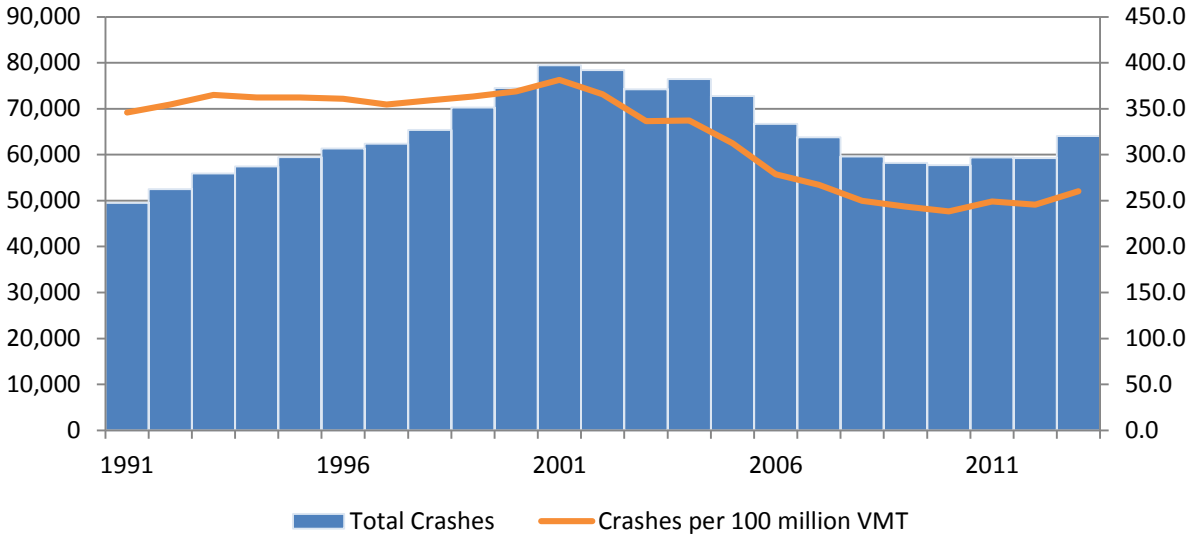
Figure 3. Serious Injuries and Injury Crash Rate in the Denver Region (2006-2013)



C. Total Traffic Crash Trends

The number of reported crashes in the region increased from about 50,000 in 1991 to about 70,000 crashes in 2005. The increase was likely due primarily to the rapid growth in VMT. The number of reported crashes decreased to approximately 60,000 by 2012, but increased to approximately 64,000 in 2013. Specific reasons for the fluctuation is not easy to define. As shown in the chart below, the crash rate per 100 million VMT increased just slightly from 1991 to 2001, but has declined since. The overall crash data shown in this report does not include unreported traffic crashes. The National Highway Traffic Safety Administration (NHTSA) estimates that about half of all crashes are reported to the police.

Figure 4. Total Crashes and Crash Rate in the Denver Region (1991-2013)

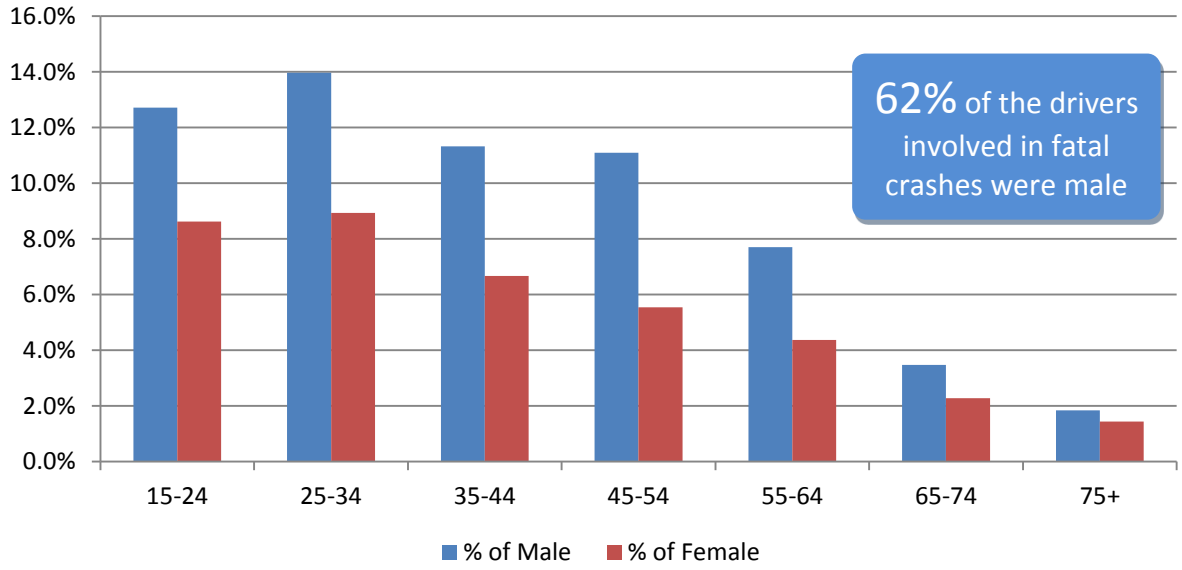


The crash data shown in this report does not include unreported crashes.

3. DEMOGRAPHICS OF PERSONS INVOLVED IN CRASHES

Crashes were analyzed by the age and gender of the persons involved. The term "involvement in a crash" does not imply the person was at fault. Figure 5 shows crash involvement statistics by age and gender based on data from 2011 to 2013.

Figure 5. Involvement in Fatal and Serious Injury Crashes by Age and Gender (2011-2013)



Two key conclusions emerge from the table:

1) 62 percent of persons involved in fatal crashes were male. This value is almost twice that of females
2) Young male drivers between the ages of 15 and 34 are involved in disproportionately more crashes – in particular, fatal crashes.

One in every five licensed 16-year-olds was involved in a crash, according to Driver Smart Colorado. Teen drivers are a high-risk crash demographic primarily because they lack driving experience. Motor vehicle crashes are a leading cause of death for 15- to 20-year-olds, according to the National Center for Health Statistics.

Several efforts have been made in Colorado to reduce teen involvement in crashes. Graduated Drivers License (GDL) laws restricting the number of occupants in the vehicle of a young driver were initiated in 1999. Laws also prohibit cell phone use by drivers under age 18. New vehicle

technologies have also been introduced to improve safety for young (and all) drivers, such as stereo disabling if seat belts are not fastened.

Though statistics do not indicate a disproportionately high number of crashes among older adults (aged 65+), there are unique concerns for this rapidly growing population group. Many concerns can be addressed through roadway engineering actions such as clearer pavement markings, larger text size on signs, and improved pedestrian crossings. Vehicle technologies related to driver alerts, automated breaking, and run-off-road prevention will also help.

4. CRASH CHARACTERISTICS

A. Crash Types

Table 1 shows the distribution of crash types. The majority of crashes (68 percent) occur between two or more moving motor vehicles. About 17 percent of crashes occur with a fixed object. Among crashes occurring between moving motor vehicles, about half are rear-end collisions and 26 percent are broadside collisions (i.e., a front to side impact).

Half of all crashes between moving vehicles are rear-end collisions. Following too closely and inattentiveness are primary reasons.

Table 1. Crash Types (2011-2013)

Crash Type		Collisions between Moving Vehicles	
Moving motor vehicle	67.6%	Front to rear	52.3%
Fixed object (e.g., light pole)	17.3%	Front to side	25.9%
Parked vehicle, train, or bicycle	8.6%	Sideswipe - same direction	14.2%
Rollover or non-collision	4.1%	Front to front	5.3%
Pedestrian	1.3%	Sideswipe - opposite direction	1.1%
Animal	1%	Rear to side or Rear to rear	1.2%
Total	**100%**	**Total**	**100%**

B. Crash Conditions

Table 2 shows the lighting and road surface conditions during crashes. The majority of crashes occur during daylight. Fatalities during dark and twilight hours occur at a much higher proportion than the share of travel (VMT) occurring at these times. It should be noted many snow crashes go unreported.

Table 2. Prevailing Conditions at Time of Crash (2011-2013)

Lighting	% of Crashes	% of Fatalities	% of VMT
Daylight	71%	41.9%	75%
Dark, Dawn, or Dusk	29%	58.1%	25%
Total	**100%**	**100%**	**100%**

Note: Daylight 7am-7pm annual average

Road Condition	% of Crashes	% of Fatalities
Dry	83.6%	91.07%
Wet	6.8%	5.16%
Snow, Ice, Slush	9.5%	3.77%
Foreign Materials, Debris	0.1%	0.0%
Total	**100%**	**100%**

C. Crash Causes

Table 3 and Table 4 show the contributing causes of traffic crashes, based on the responding police officer's report. A driver/human factor was denoted in about 85 percent of the 182,700 crashes in 2011-2013. This implies about 15 percent of crashes may have been out of the driver's control. Careless driving was the most common driver action followed by following too closely. Distracted driving was the most common human contributing factor.

38% of traffic crashes are attributed to careless driving

Table 3. Causes of Traffic Crashes by Driver Action (2011-2013)

Driver Action	Persons	% of Total
Careless driving	59,631	38.2%
Following too close	28,035	18%
Fail to yield to ROW at stop sign	22,481	14.4%
Lane violation	13,144	8.4%
Exceeded safe/posted speed	9,119	5.8%
Failed to stop at signal	7,497	4.8%
Improper backing	4,133	2.6%
Improper turn	3,187	2%
Disregard stop sign	2,471	1.6%
Reckless driving	2,405	1.5%
Turning from wrong lane or position	1,340	0.9%
All other driver actions	2,679	1.7%
Total (for crashes with denoted driver action)	**156,122**	**100%**

Table 4. Traffic Crashes Involving Other Human Factors (2011-2013)

Other Human Factors	Persons	% of Total
Distracted driving	25,513	25.9%
Driver inexperience	16,760	17%
Aggressive driving	10,359	10.5%
DUI/DWAI/PUID	9,796	9.9%
Driver unfamiliar with area	5,905	6%
Illness/medical	1,730	1.8%
Asleep at wheel	1,614	1.6%
Driver fatigue	1,176	1.2%
All other human factors	25,841	26.2%
Total (for crashes with denoted driver action)	**98,694**	**100%**

5. SPECIFIC CRASH TYPES

A. Truck-related Crashes

Heavy trucks are an important consideration in traffic safety because of their proportionally greater impacts per crash (injuries, fatalities, congestion). Trucks also have unique maneuverability and visual considerations in relation to roadway design and other road users. The crash database classifies a truck as a vehicle with a gross weight greater than 10,000 pounds. As a point of reference, a Ford F350 pickup marks the bottom end of the weight threshold. In 2013, there were about 2,600 crashes involving trucks in the Denver region, resulting in 51 serious injuries and 12 fatalities.

There were 162 fatal truck crashes in the state of Colorado between 2012 and 2014 (National Highway Traffic Safety Administration). When analyzed by truck type, 114 of the fatal truck crashes in Colorado (70.4 percent) involved a tractor trailer.

Figure 6. Colorado Fatal Truck Crashes by Truck Type (2012-2014)

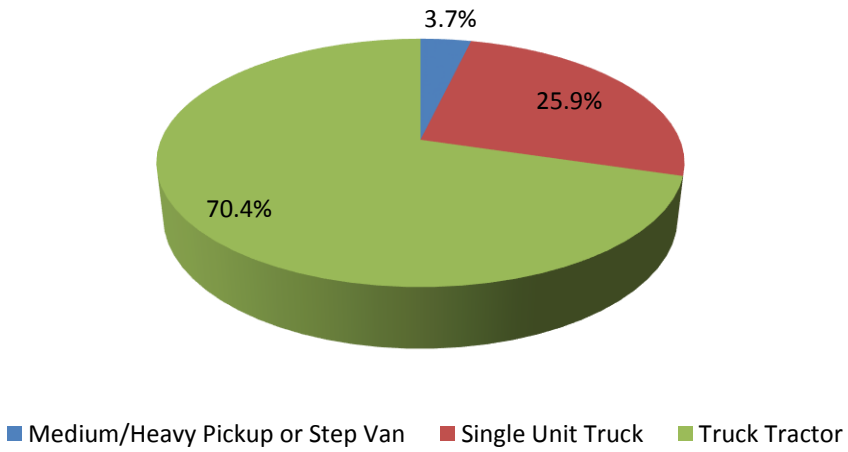


Table 5 shows truck crash characteristics from 2011 to 2013. An equal number of truck crashes occurred on arterials (36 percent), freeways (34 percent) and local roads (31 percent). About half of truck-related crashes occurred at non-intersections, while intersection related crashes accounted for about one third (38 percent). The most common truck movement at the time of the crash was going straight (43 percent). Most truck-related crashes occurred during the day.

Table 5. Truck Crash Characteristics (2011-2013)

Facility Type	Crashes	Percent
Arterials	2,567	35.6%
Freeways	2,428	33.7%
Collector or local roads	2,210	30.7%
Total truck crashes	**7,205**	**100%**

Crash Location	Crashes	Percent
Non-intersection	3,627	50.3%
At intersection or intersection related	2,766	38.4%
At driveway access	415	5.8%
Highway interchange (ramp)	278	3.9%
In alley	81	1.1%
Parking lot	12	0.2%
Roundabout	26	0.4%
Unreported	**0**	**0%**
Total truck crashes	**7,205**	**100%**

Truck Movement	Crashes	Percent
Going Straight	3,223	43.1%
Making left-turn	803	10.7%
Making right-turn	734	9.8%
Stopped in Traffic	590	7.9%
Changing Lanes	585	7.8%
Backing	458	6.1%
Slowing	360	4.8%
Parked	232	3.1%
All other movements	**497**	**6.6%**
Total truck movements*	**7,482**	**100%**

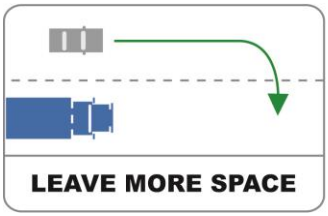
Lighting	Crashes	Percent
Daylight	5,924	82.2%
Dark	1,023	14.2%
Dawn or dusk	237	3.3%
Unknown	21	0.3%
Total truck crashes	**7,205**	**100%**

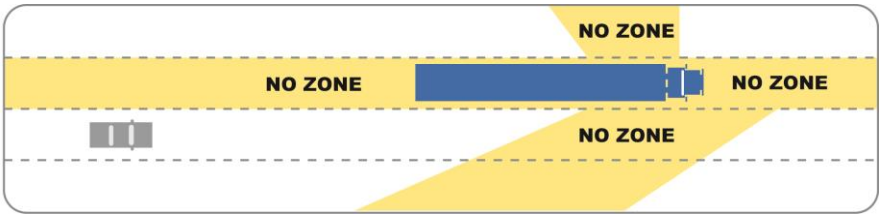
*Note – The larger number of movements is due to the number of truck crashes that involved more than one truck.

Truck Crash Mitigation

The Colorado State Patrol campaign, *Ticketing Aggressive Cars and Trucks (TACT)*, was launched in 2010 and aims to reduce crashes between passenger cars and trucks[6].

The diagram below, featured in the campaign brochure, highlights truck blind spots.



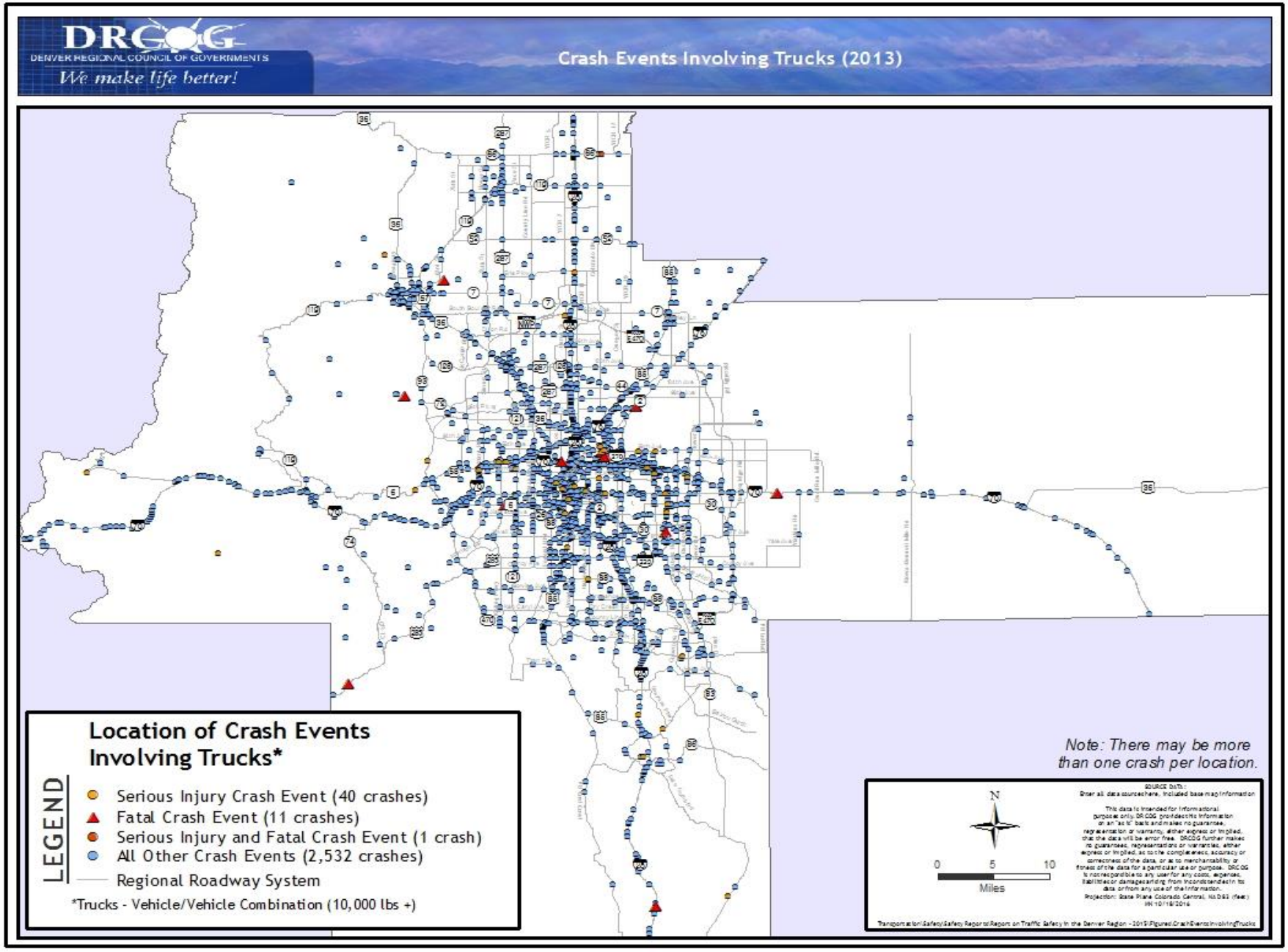


Other examples of truck safety improvements include:

- Speed and lane restrictions in mountainous areas
- Winter chain requirements and provision of safe pull-off areas to install/remove chains or check brakes
- Truck parking and rest areas

[6] *www.givetrucksmoreroom.com*

Figure 7


DRCOG
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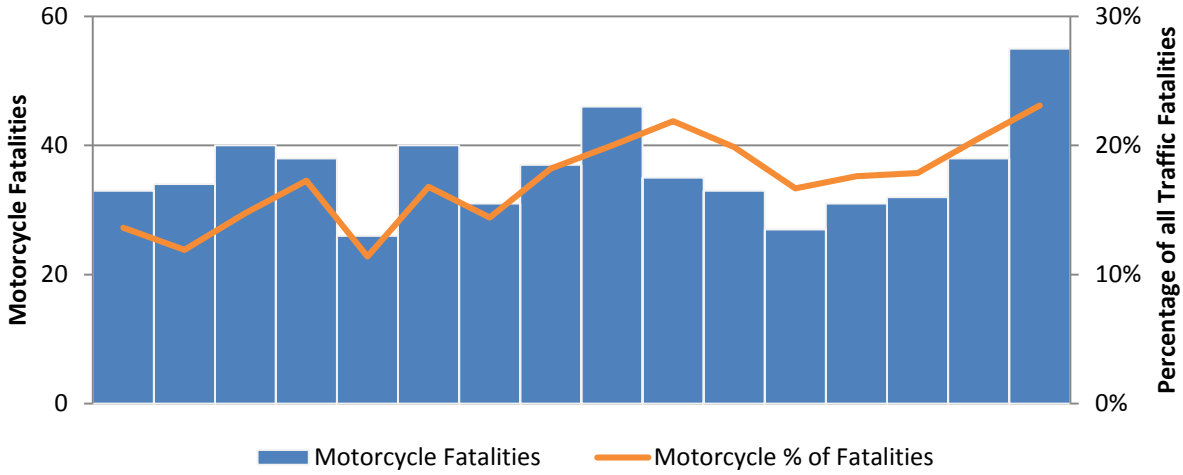
Crash Events Involving Trucks (2013)
Location of Crash Events Involving Trucks*
LEGEND
Serious Injury Crash Event (40 crashes)
Fatal Crash Event (11 crashes)
Serious Injury and Fatal Crash Event (1 crash)
All Other Crash Events (2,532 crashes)
Regional Roadway System
*Trucks - Vehicle/Vehicle Combination (10,000 lbs +)
Note: There may be more than one crash per location.
N
0 5 10
Miles

B. Motorcycle-related Crashes

Motorcyclists are more vulnerable to serious injuries and fatalities than persons driving cars. They have less protection than persons in cars and are harder to see. Between 2011 and 2013, an average of 1,200 motorcycle crashes occurred per year in the Denver region. The chart below shows motorcycle fatalities from 2000 to 2015, averaging 36 fatalities per year. Motorcyclists make up an increasing proportion of all traffic fatalities (14 percent in 2000 to 23 percent in 2015).

Figure 8. Motorcycle Fatalities in the Denver Region (2000-2015)



The number of motorcycle registrations has increased substantially over the last five years. The fatality rate per number of motorcycle registrations has remained about the same (see Table 6).

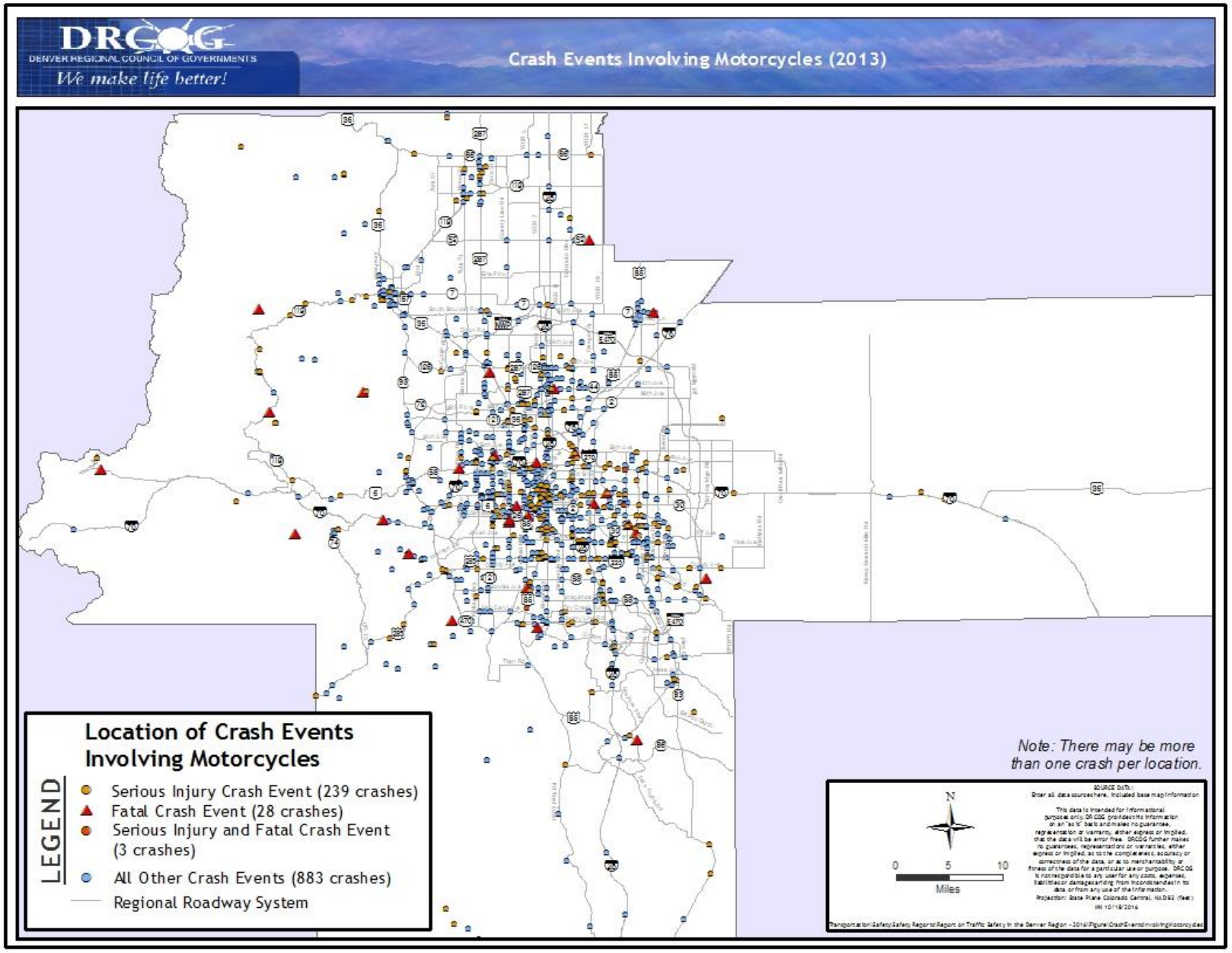
Table 6. Motorcycle Fatality Rate in the Denver Region (2010-2014)

Year	Motorcycle Registrations	Motorcycle Fatalities	Motorcycle Fatalities per 1,000 Registrations
2010	94,750	33	0.35
2011	99,284	27	0.27
2012	99,528	31	0.31
2013	103,543	32	0.31
2014	105,035	38	0.36

In Colorado, helmet use is not required for adults, but is required for operators and passengers under the age of 18. CDOT also found motorcyclists were at fault in 7 out of 10 fatal crashes in 2010. For additional information on CDOT motorcycle safety efforts, visit https://www.codot.gov/safety/live-to-ride.

Figure 9 shows a map of motorcycle crash locations from 2013.

Figure 9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Crash Events Involving Motorcycles (2013)
Location of Crash Events Involving Motorcycles
LEGEND
Serious Injury Crash Event (239 crashes)
Fatal Crash Event (28 crashes)
Serious Injury and Fatal Crash Event (3 crashes)
All Other Crash Events (883 crashes)
Regional Roadway System
Note: There may be more than one crash per location.
N
0
5
10
Miles

C. Pedestrian-related Crashes

Pedestrians are the most vulnerable roadway users. They are more difficult to see in many situations, and face high odds of serious injury or death if hit by a car or truck. Between 2011 and 2013, an average of 1,363 pedestrian crashes occurred per year in the Denver region, resulting in 113 fatalities and 517 serious injuries over that time. The chart below shows pedestrian fatalities in the region from 2000 to 2015. Pedestrians account for a disproportionately high percentage of traffic fatalities, considering the length and time of travel by this mode. Between 2011 and 2013, pedestrians accounted for 22 percent of traffic fatalities, but less than 5 percent of all person miles of travel in the region (DRCOG Travel Model, 2015).

Figure 10. Pedestrian Fatalities in the Denver Region (2000-2015)

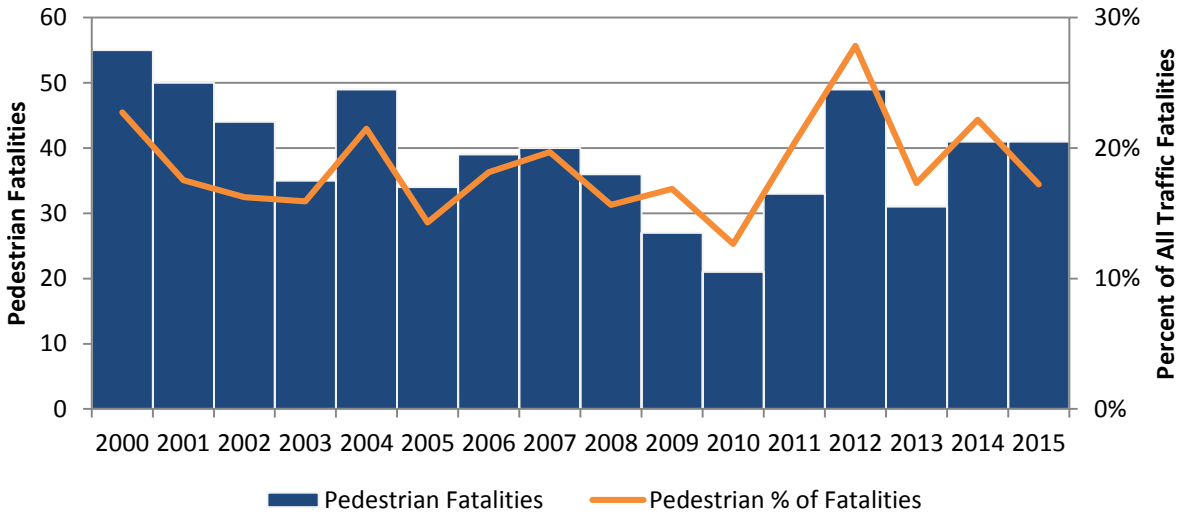


Table 7 shows the ages of pedestrians involved in crashes. Pedestrians between the ages of 15 and 24 had the highest involvement in pedestrian crashes.

Table 7. Age of Pedestrians in Traffic Crashes (2011-2013)

	Pedestrians Involved in Crashes		Pedestrians Killed		Pedestrians Seriously Injured	
Age Group	**Number**	**Percent**	**Number**	**Percent**	**Number**	**Percent**
0-14	391	9.8%	4	3.7%	75	12.6%
15-24	971	24.5%	16	14.8%	128	21.5%
25-34	758	19.1%	14	13%	108	18.2%
35-44	612	15.4%	22	20.4%	76	12.8%
45-54	596	15%	16	14.8%	98	16.5%
55-64	396	10%	19	17.6%	60	10.1%
65-74	165	4.2%	9	8.3%	32	5.4%
75+	81	2%	8	7.4%	18	3%
Total Reported	**3,970**	**100%**	**108**	**100%**	**595**	**100%**
Age Unreported	*641*	-	*4*	-	*70*	**-**
Total Pedestrians	**4,611**	**-**	**112**	**-**	**665**	**-**

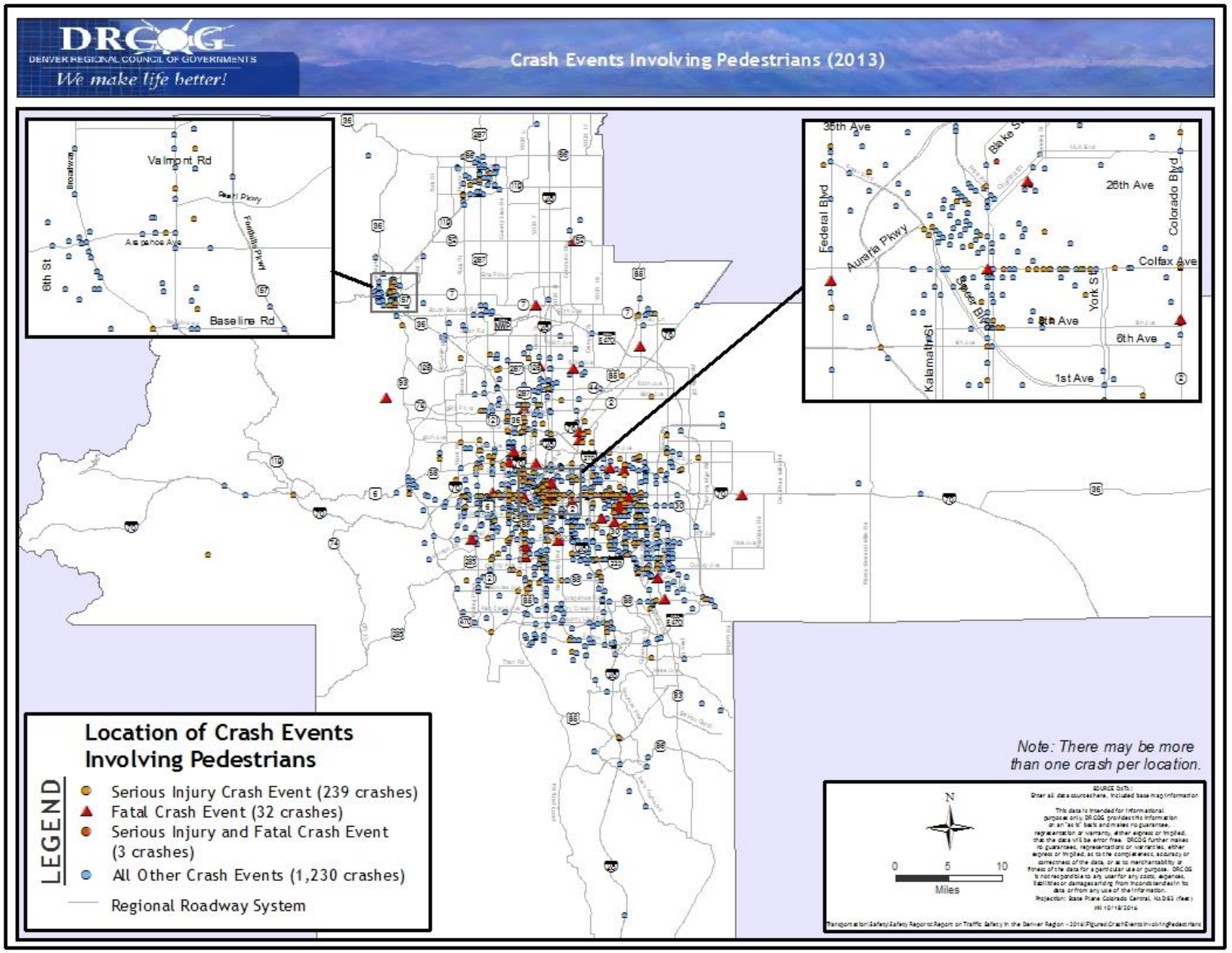
Table 8 shows pedestrian crash characteristics from 2011 to 2013. An equal number of pedestrian crashes occurred on arterials (49 percent) and local roads (48 percent) and the majority occurred at intersections (63 percent). In addition, the most common vehicle path in a pedestrian crash is traveling straight; the second most common path is making a left turn. One-third of crashes occurred at night. The pedestrian was impaired by alcohol or drugs in eight percent of pedestrian crashes.

Table 8. Pedestrian Crash Characteristics (2011-2013)

Facility Type	Crashes	Percent
Arterials	1,991	48.7%
Collector or local roads	1,967	48.1%
Freeways	131	3.2%
Total Pedestrian-related crashes	**4,089**	**100%**
Crash Location	**Crashes**	**Percent**
At intersection or intersection related	2,553	62.4%
Non-intersection	1,211	29.6%
At driveway access	241	5.9%
In alley	40	1%
Highway interchange	34	0.8%
Other	9	0.2%
Unreported	1	0.0%
Total Pedestrian-related crashes	**4,089**	**100%**
Vehicle Movement	**Crashes**	**Percent**
Going straight	1,827	43.5%
Making left-turn	681	16.7%
Making right-turn	637	15.6%
All other movements	756	17.9%
Unreported	263	6.4%
Total Vehicle Movements	**4,089**	**100%**
Lighting	**Crashes**	**Percent**
Daylight	2,527	61.8%
Dark	1,337	32.7%
Dawn or dusk	211	5.2%
Unreported	14	0.3%
Total Pedestrian-related crashes	**4,089**	**100%**
Impairment	**Crashes**	**Percent**
Pedestrian sober	3,748	91.7%
Pedestrian impaired	341	8.3%
Total Pedestrian-related crashes	**4,089**	**100%**

Figure 11 shows a map of pedestrian crashes from 2013. There may be more than one crash at each identified intersection location.

Figure 11


DRCOG
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Crash Events Involving Pedestrians (2013)
Valmont Rd
Broadway
Arapahoe Ave
6th St
Baseline Rd
35th Ave
Federal Blvd
Aurora Pkwy
26th Ave
Colorado Blvd
Colfax Ave
York St
8th Ave
6th Ave
1st Ave
Kalamath St
Location of Crash Events Involving Pedestrians
LEGEND
Serious Injury Crash Event (239 crashes)
Fatal Crash Event (32 crashes)
Serious Injury and Fatal Crash Event (3 crashes)
All Other Crash Events (1,230 crashes)
Regional Roadway System
Note: There may be more than one crash per location.
N
0 5 10
Miles

Pedestrian Crash Mitigation Strategies

There are several safety treatments, which can reduce the occurrence of pedestrian crashes. See DRCOG's *Guidelines for Successful Pedestrian and Bicycle Facilities in the Denver Region* (2010)[7] for an overview of pedestrian facility design considerations.

A few examples of pedestrian safety improvements include:

- Mid-block crossing treatments,
- Median refuge islands, and
- Giving the pedestrian signal phase a three-second start-up time, allowing the pedestrian to begin crossing before motorist's see a green light (e.g., implemented at 13th Avenue and Broadway in Denver).

The *Manual on Uniform Traffic Control Devices* (MUTCD) recently lowered the assumed pedestrian walk "design speed" to 3.5 feet per second (from 4.0 feet per second), therefore giving the pedestrian a longer time to cross the intersection.

CDOT's *Safe Routes to School* program funds traffic safety education and infrastructure, such as sidewalk and signage enhancements, which enable school age children to walk or bicycle to school safely. CDOT's Share the Road campaign aims to raise driver awareness of pedestrians and bicyclists.

For more information on these CDOT programs visit: www.coloradodot.info/programs/bikeped.

[7] http://www.drcog.org/documents/2010%20Ped%20Bike%20Guidelines%20booklet.pdf

D. Bicycle-related Crashes

Similar to pedestrians, bicyclists are more vulnerable road users. Additionally, bicyclists spend a greater amount of time in roadways then pedestrians. Between 2011 and 2013, an average of 877 bicycle crashes occurred per year, resulting in 7 fatalities and 96 serious injuries per year. The chart below shows bicyclist fatalities in the Denver region from 2000 to 2015. Bicyclist fatalities have remained about the same in the last fifteen years, and make up about three percent of all traffic fatalities.

Figure 12. Bicyclist Fatalities in the Denver Region (2000-2015)

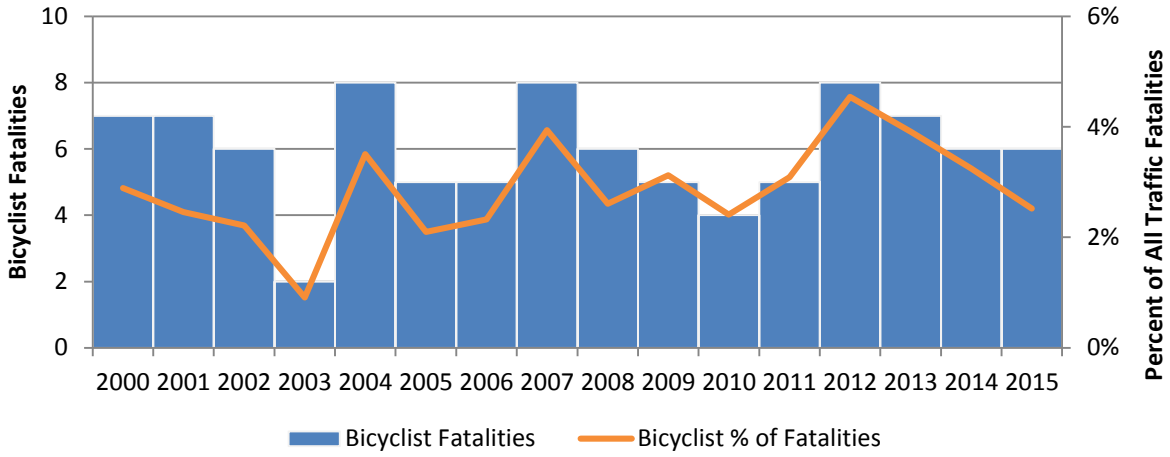


Table 9 shows the ages of bicyclists involved in traffic crashes. Similar to pedestrian crashes, bicyclists between the ages of 15 and 24 had the highest involvement in crashes. Bicyclists between the ages of 45 and 54 experienced the highest number of fatalities.

Table 9. Age of Bicyclists in Traffic Crashes (2011-2013)

Age Group	Bicyclists Involved in Crashes		Bicyclists Killed		Bicyclists Seriously Injured	
	Number	Percent	Number	Percent	Number	Percent
0-14	129	12.3%	0	0%	15	11.1%
15-24	258	24.5%	1	4.8%	25	18.5%
25-34	195	18.5%	3	14.3%	27	20%
35-44	156	14.8%	2	9.5%	16	11.9%
45-54	180	17.1%	6	28.6%	30	22.2%
55-64	99	9.4%	5	23.8%	15	11.1%
65-74	29	2.8%	2	9.5%	6	4.4%
75+	7	0.7%	2	9.5%	1	0.7%
Total Reported	**1,053**	**100%**	**21**	**100%**	**135**	**100%**
Age Unreported	*1,537*	-	*2*		*150*	-
Total Bicyclists	**2,590**	**-**	**23**		**285**	**-**

Table 10 shows bicycle crash characteristics between 2011 and 2013. The table shows that over 60 percent of bicycle crashes occur on local roads and the vast majority of bicycle crashes occur at intersections (73 percent). The most common vehicle movements in a bicycle crash are “making right-turn” and “going straight.” Sixteen percent of bicycle crashes occurred at night.

73%
of bicycle crashes occurred at an intersection.

Table 10. Bicycle Crash Characteristics (2011-2013)

Facility Type	Crashes	Percent
Collector or local roads	1,651	62.8%
Arterials	959	36.5%
Freeway/Ramps	21	0.8%
Total Bicycle-related crashes	**2,631**	**100%**

Crash Location	Crashes	Percent
At intersection or intersection related	1,929	73.3%
Non-intersection	331	12.6%
At driveway access	317	12.0%
Alley related	43	1.6%
On/Off-ramp	9	0.3%
Parking Lot	2	0.1%
Total Bicycle-related crashes	**2,631**	**100%**

Vehicle Movement	Crashes	Percent
Making right-turn	956	36.1%
Going straight	911	34.4%
Making left-turn	512	19.3%
All other movements	267	10.1%
Total Vehicle Movements*	**2,646**	**100%**

Lighting	Crashes	Percent
Daylight	2,091	79.5%
Dark	415	15.8%
Dawn or dusk	115	4.4%
Unknown	10	0.4%
Total Bicycle-related Crashes	**2,631**	**100%**

*Note – Some crashes involved more than one vehicle resulting in a higher number of movements

Bicycle Crash Mitigation Strategies

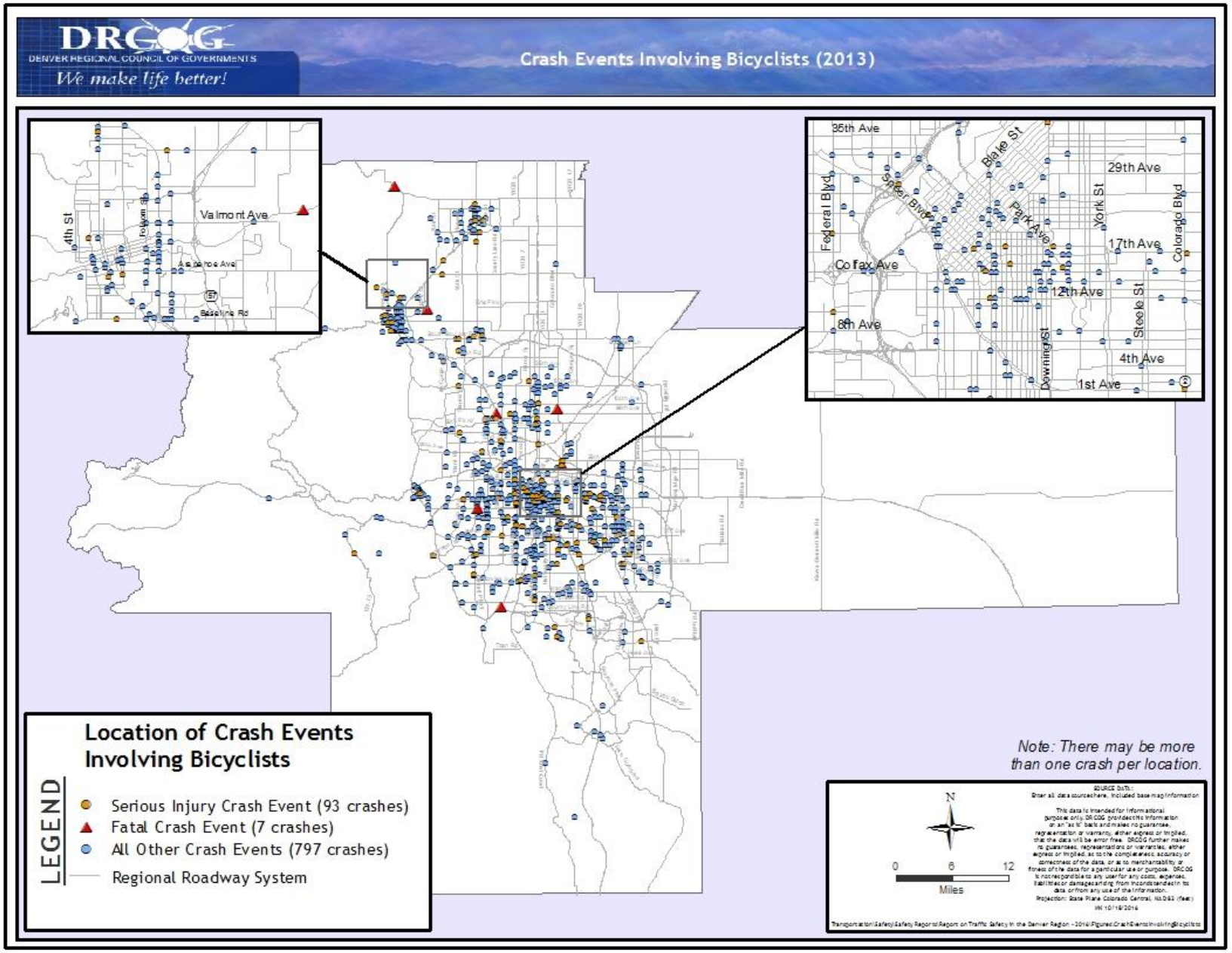
As the interest in bicycling as a viable mode of travel increases among a wider segment of the population, so does the demand for facilities that are both safe and comfortable. Providing high comfort (or low-stress) facilities can help reduce the occurrence of crashes while potentially inducing bicycle usage. Some examples of improvements which can improve comfort and safety include:

- conventional or protected bike lanes and intersections;
- buffered bike lanes;
- bicycle boulevards;
- shared-use paths;
- shared-use bridges/overpasses and underpasses;
- paved shoulder bicycle routes; and
- better maintenance of on-street and off-street bicycle facilities

The following resources include guidance for bicycle facility design:

- Urban Bikeway Design Guide, 2014 – Second Edition, (National Association of City Transportation Officials)
- *Guide for the Development of Bicycle Facilities*, 2012 – Fourth Edition, (American Association of State Highway and Transportation Officials)
- *CDOT Roadway Design Guide – Chapter 14 Bicycle and Pedestrian Facilities, Jan 2013, Revision 1, (CDOT).*

Figure 13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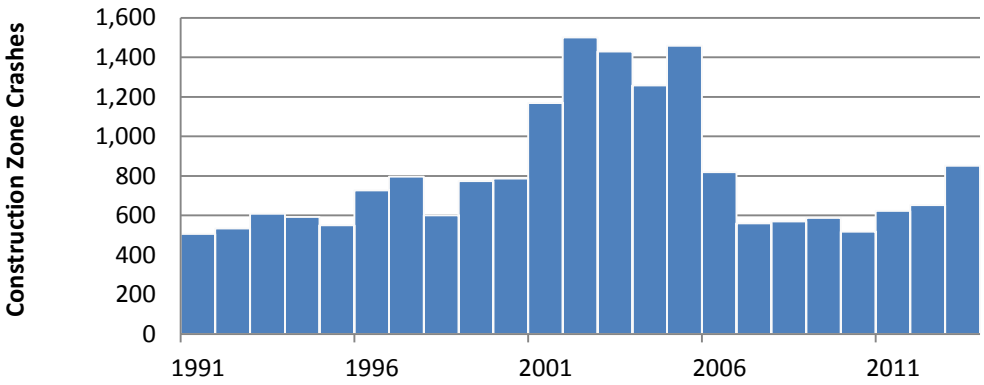
Crash Events Involving Bicyclists (2013)
Valmont Ave
4th St
Folsom St
Arapahoe Ave
Baseline Rd
36th Ave
Blake St
29th Ave
Federal Blvd
Speer Blvd
Park Ave
York St
17th Ave
Colorado Blvd
Colfax Ave
12th Ave
Steele St
8th Ave
Downing St
4th Ave
1st Ave
Location of Crash Events Involving Bicyclists
LEGEND
Serious Injury Crash Event (93 crashes)
Fatal Crash Event (7 crashes)
All Other Crash Events (797 crashes)
Regional Roadway System
Note: There may be more than one crash per location.
N
0
6
12
Miles

E. Construction Zone Crashes

Construction zones expose vulnerable workers to motor vehicle traffic on a day-to-day basis. Drivers may also have more difficulty maneuvering through these zones. Between 2011 and 2013, an average of 709 construction zone crashes occurred per year, resulting in 26 serious injuries and 3 fatalities per year. As shown in the chart below, the number of construction zone crashes is highly variable, depending on the location and amount of construction occurring each year.

Figure 14. Construction Zone Crashes in the Denver Region (1991-2013)



According to CDOT, 85% of work zone fatalities are motorists or occupants. Also, in a typical five-day work week, an average of seven motorists and one highway worker are killed nationwide. Rear-end collisions are by far the most common crash type in a construction zone, representing 70 percent of all collisions between moving motor vehicles in 2013. Careless driving and following too close were the most common driver actions, while distracted driving was the most common human factor.

Construction Zone Crash Mitigation Strategies

CDOT's *Slow for the Cone Zone* campaign[8] aims to enhance safety for motorists and workers in construction zones at construction projects each year from June to September. Higher fines for violating traffic laws in a construction zone also help to reduce unsafe behavior. In 2006, nearly all types of fines doubled in Colorado work zones. It is also important for construction and maintenance teams to provide clear markings, warnings, and guidance for motorists.

[8] *www.coloradodot.info/programs/cone-zone*

F. Wildlife-related Collisions

Wildlife-vehicle collisions (WVCs) increased from about 400 per year to 800 per year between 1991 and 2013. From 2011 to 2013 an average of 5 serious human injuries occurred per year in the Denver region due to WVCs. Beyond the initial safety threat of a WVC, dead animals on the roadway also present a hazard due to drivers swerving to miss the carcass. The Rocky Mountain Insurance Information Association found that the average claim for a WVC is $3,171.

66% of wildlife- vehicle collisions occurred within a quarter mile of open space in 2013.

Figure 15. Wildlife-Vehicle Collisions in the Denver Region (1991-2013)

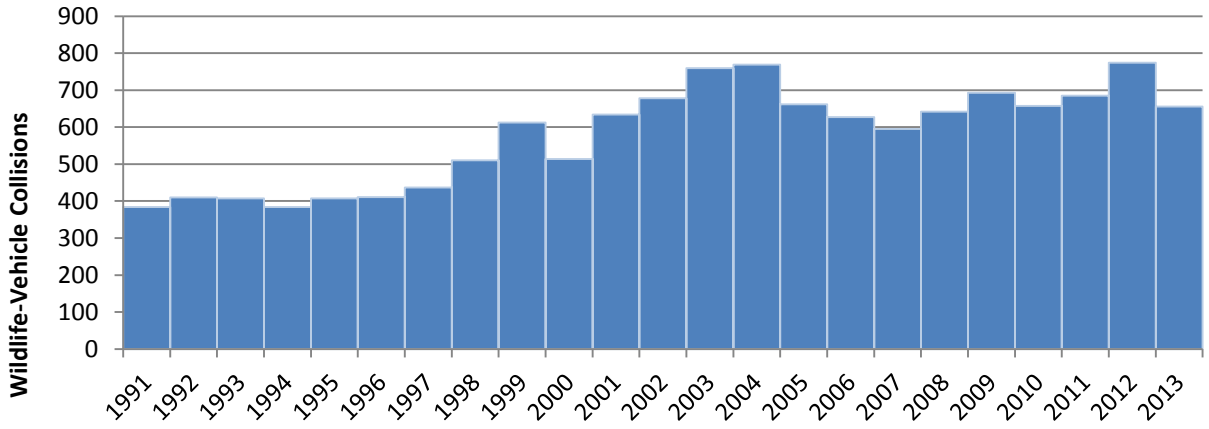


Figure 14 shows a map of WVCs during 2013 and the open space and flood plains within the region. When analyzed by crash location in 2013, 66 percent of WVCs occurred within a quarter-mile of open space.

Animal-Vehicle Crash Mitigation Strategies

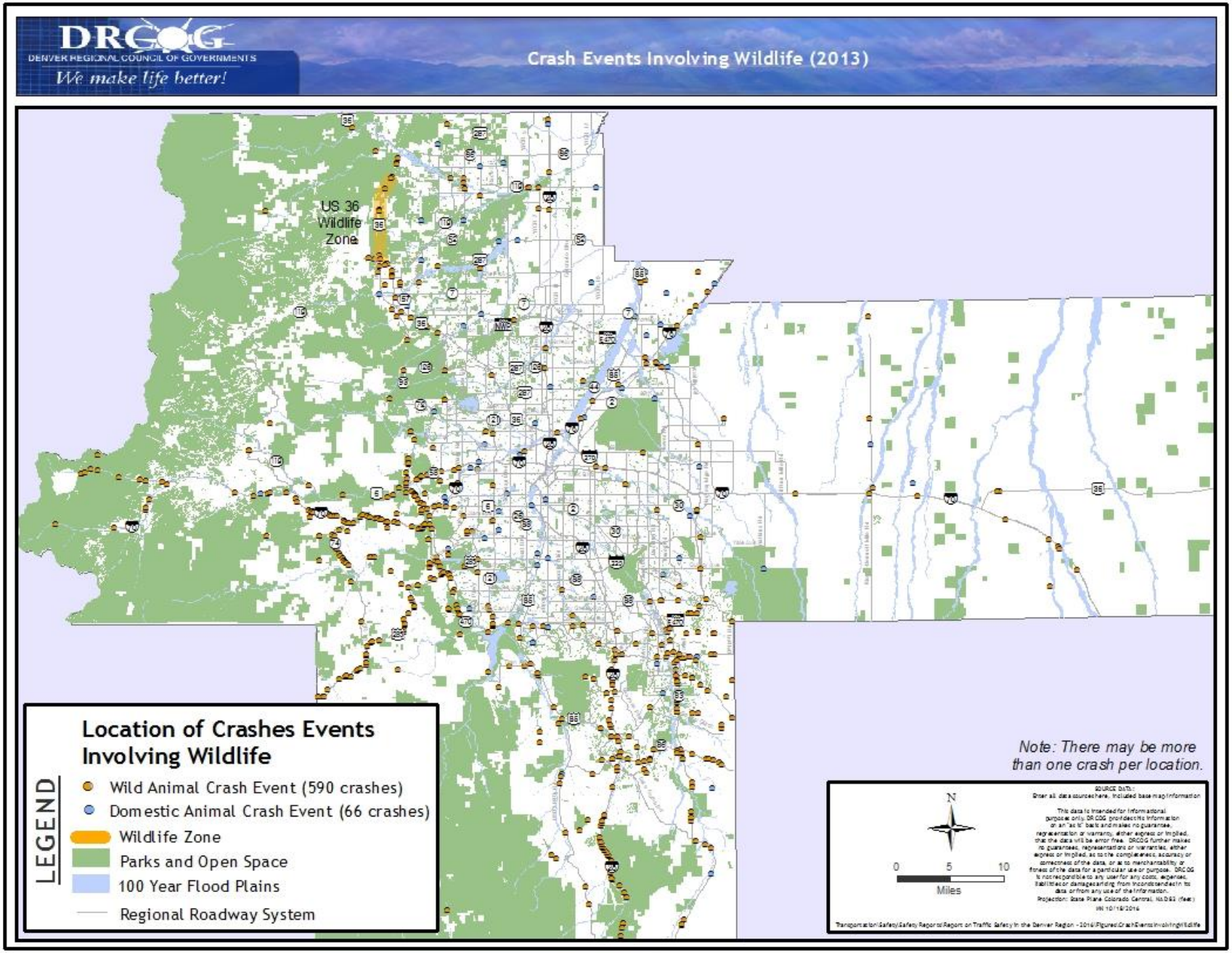
CDOT's *Wildlife on the Move campaign*[9] reminds drivers to drive with caution, especially in the fall, when animal migration is most common. The majority of WVCs occur at nighttime; therefore CDOT has designated certain at-risk corridors as Wildlife Zones, reducing the nighttime speed limit from September to April. The US 36 corridor from Boulder to Lyons is a designated Wildlife Zone. WVCs make up over 65 percent of nighttime crashes on this corridor.

CDOT also recently constructed a wildlife exclusion fence and crossing on US-6 in Golden. The eight-foot tall fence extends 2.5 miles and funnels animals to a single wildlife crossing. Flashing beacons and dynamic message signs at the crossing alert motorists when an animal is detected.

Source: CDOT

[9] *https://www.codot.gov/programs/environmental/wildlife/wildlifeonthemove*

Figure 16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Crash Events Involving Wildlife (2013)
US 36 Wildlife Zone
Location of Crashes Events Involving Wildlife
LEGEND
Wild Animal Crash Event (590 crashes)
Domestic Animal Crash Event (66 crashes)
Wildlife Zone
Parks and Open Space
100 Year Flood Plains
Regional Roadway System
Note: There may be more than one crash per location.
N
0 5 10
Miles

6. HIGH-RISK BEHAVIOR CRASHES

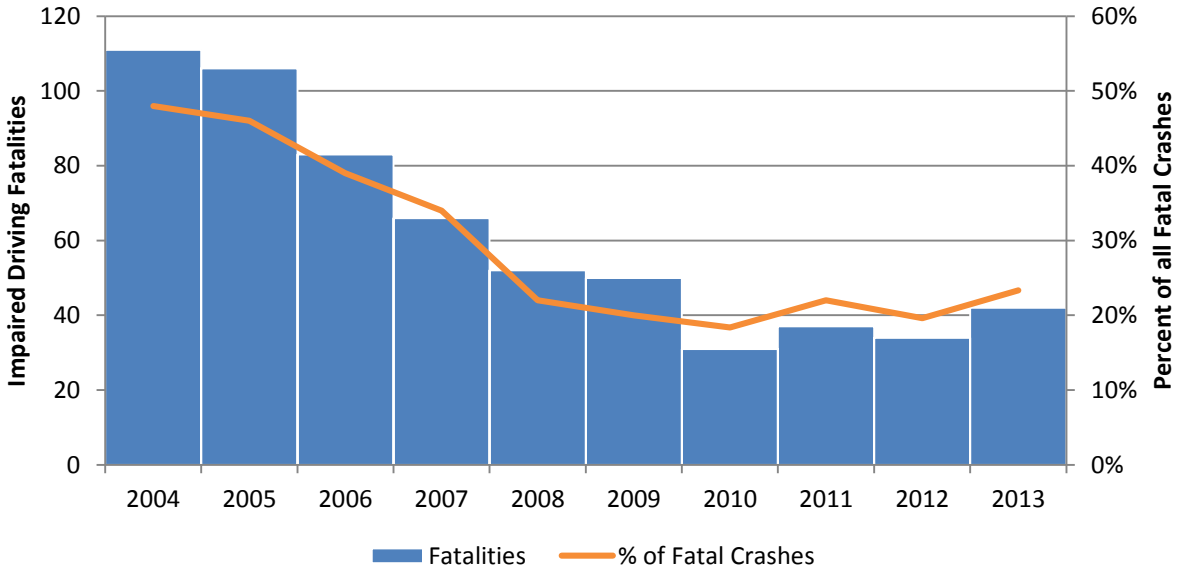
A. Impaired Driving

Between 2011 and 2013, an average of 3,265 impaired driving crashes occurred per year. These crashes resulted in an average of 291 serious injuries and 38 fatalities per year. The chart below shows trends in impaired driving fatalities from 2004 to 2013. Impaired driving fatalities in the Denver region have experienced a downward trend over the last nine years, from 111 fatalities in 2004 to 42 fatalities in 2013. In addition, the percentage of all fatal crashes related to impaired driving has decreased steadily over the same time period (from 48 percent to 23 percent).

27% of impaired driving crashes occur between 12 and 3 a.m.

Impaired driving fatalities have dropped by **69%** in the last eight years.

Figure 17. Impaired Driving Fatalities in the Denver Region (2004-2013)



The chart below shows the demographics of impaired drivers that were involved in a fatal crash between 2011 and 2013. Drivers under the age of 45 make up the vast majority of impaired drivers in fatal crashes with 33% being between the ages of 15 and 24.

Figure 18. Impaired Drivers by Age Group Resulting in Fatality (2011-2013)

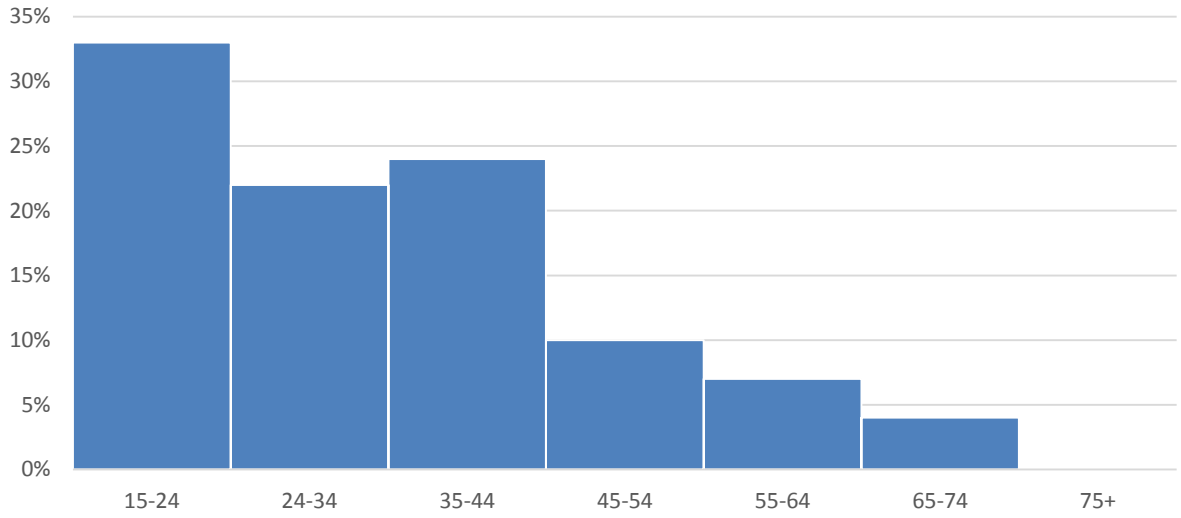


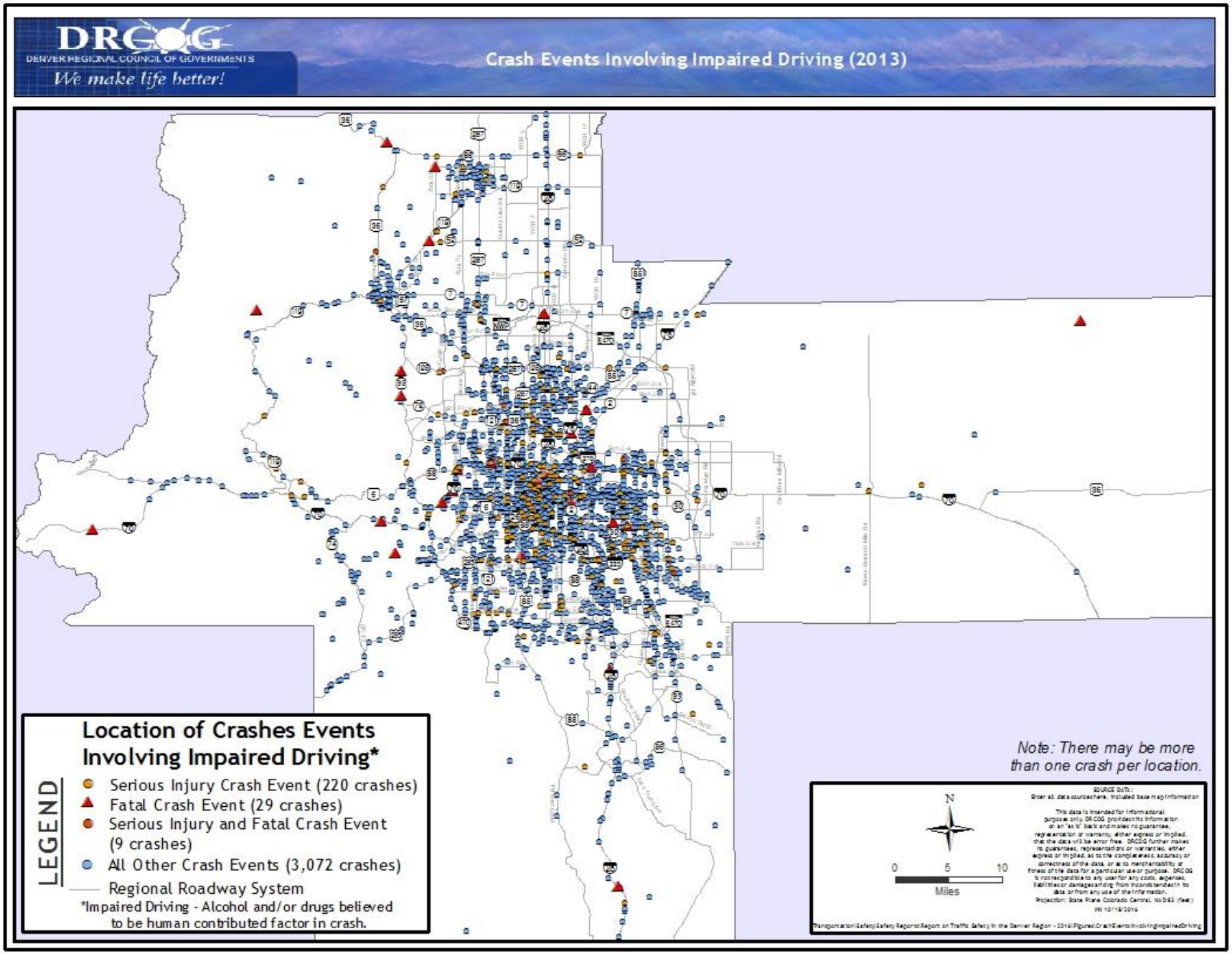
Table 11 shows impaired driving crashes by time of day. The highest hours are from 12 a.m. to 3 a.m., when 28 percent of impaired driving crashes occur, but only 1.4 percent of daily VMT.

Table 11. Impaired Driving Crashes by Time of Day (2011-2013)

Time of Day	Crashes	% Crashes	% VMT
12-3am	2,810	27.6%	1.4%
3-6am	893	8.8%	2.9%
6-9am	360	3.5%	18.1%
9am-12pm	383	3.8%	15.9%
12-3pm	536	5.3%	18.1%
3-6pm	1,154	11.4%	23.4%
6-9pm	1,808	17.8%	14.3%
9pm-12am	2,219	21.8%	5.8%
Total	**10,163**	**100%**	**100%**

Figure 19 shows a map of impaired driving crash locations from 2013.

Figure 19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Crash Events Involving Impaired Driving (2013)
Location of Crashes Events Involving Impaired Driving*
LEGEND
Serious Injury Crash Event (220 crashes)
Fatal Crash Event (29 crashes)
Serious Injury and Fatal Crash Event (9 crashes)
All Other Crash Events (3,072 crashes)
Regional Roadway System
*Impaired Driving - Alcohol and/or drugs believed to be human contributed factor in crash.
Note: There may be more than one crash per location.
N
0
5
10
Miles

Impaired Driving Education and Enforcement Efforts

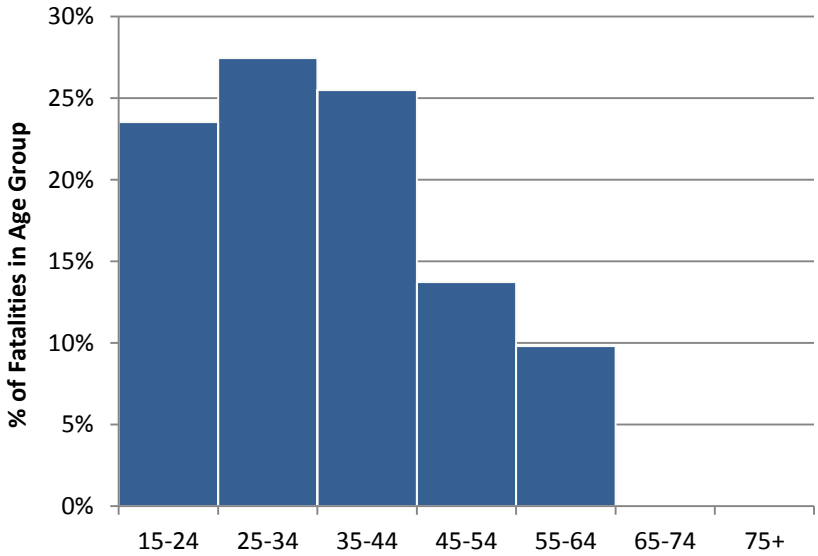
CDOT runs several campaigns and programs to reduce impaired driving. *The Heat is On!* campaign raises public awareness of DUI through high visibility enforcement and sobriety check points during 12 key periods of the year (e.g., Labor Day, Fourth of July, Memorial Day, and New Year's Eve). From Memorial Day to Labor Day, the *100 Days of Heat* campaign increases enforcement visibility by placing two large banners at the Eisenhower and Johnson tunnels on I-70 and a traveling dynamic message sign counts the number of DUI arrests made year to date. Visit www.HeatIsOnColorado.com for more information on CDOT enforcement activities and DUI arrest statistics.

CDOT recently launched a new education campaign on marijuana impaired driving. Visit https://www.codot.gov/safety/alcohol-and-impaired-driving/druggeddriving to learn more and to find drugged driving statistics.

B. Speeding

Speeding generally involves exceeding the posted speed limit or driving too fast for the road conditions. For this analysis, speeding was defined as a driver traveling at 10 miles or more per hour above the speed limit. Between 2011 and 2013, an average of 3,040 speeding-related crashes occurred per year in the Denver region. These crashes resulted in an average of 19 fatalities and 91 serious injuries per year. Speeding was involved in about 11 percent of all fatal crashes between 2011 and 2013. The charts below show the age of drivers involved in speed-related fatal crashes and the types of roadways where speeding-related fatal crashes occurred.

Figure 20. Age of Driver in Speeding-related Fatality (2011-2013)



Speeding was involved in
11%
of fatal crashes between 2011 and 2013.

Young drivers make up the vast majority of fatalities occurring due to excessive speed. The age group of 15 to 34 makes up more than half of all fatalities. Speeding-related fatalities occur on all types of roadways. As shown in the pie chart (Figure 21), 39 percent of speeding-related fatal crashes occurred on arterials, 37 percent occurred on collector/local roads, and 25 percent occurred on freeways.

Figure 21. Speeding-related Fatalities by Facility Type (2011-2013)

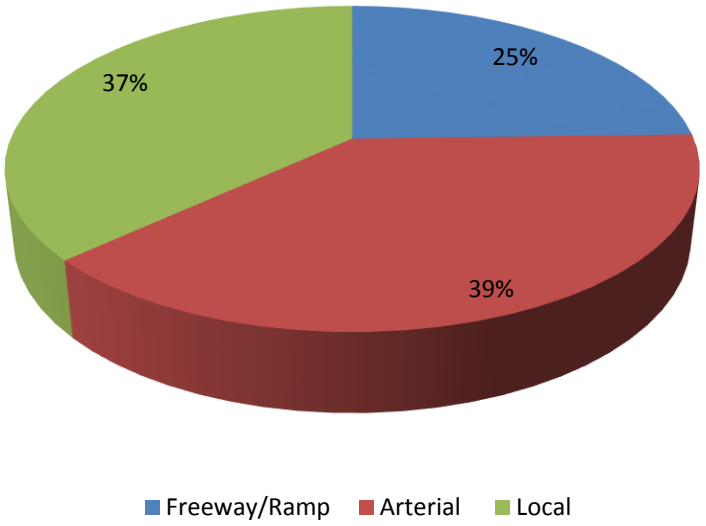


Figure 22 shows the locations of speeding-related crashes in 2013.

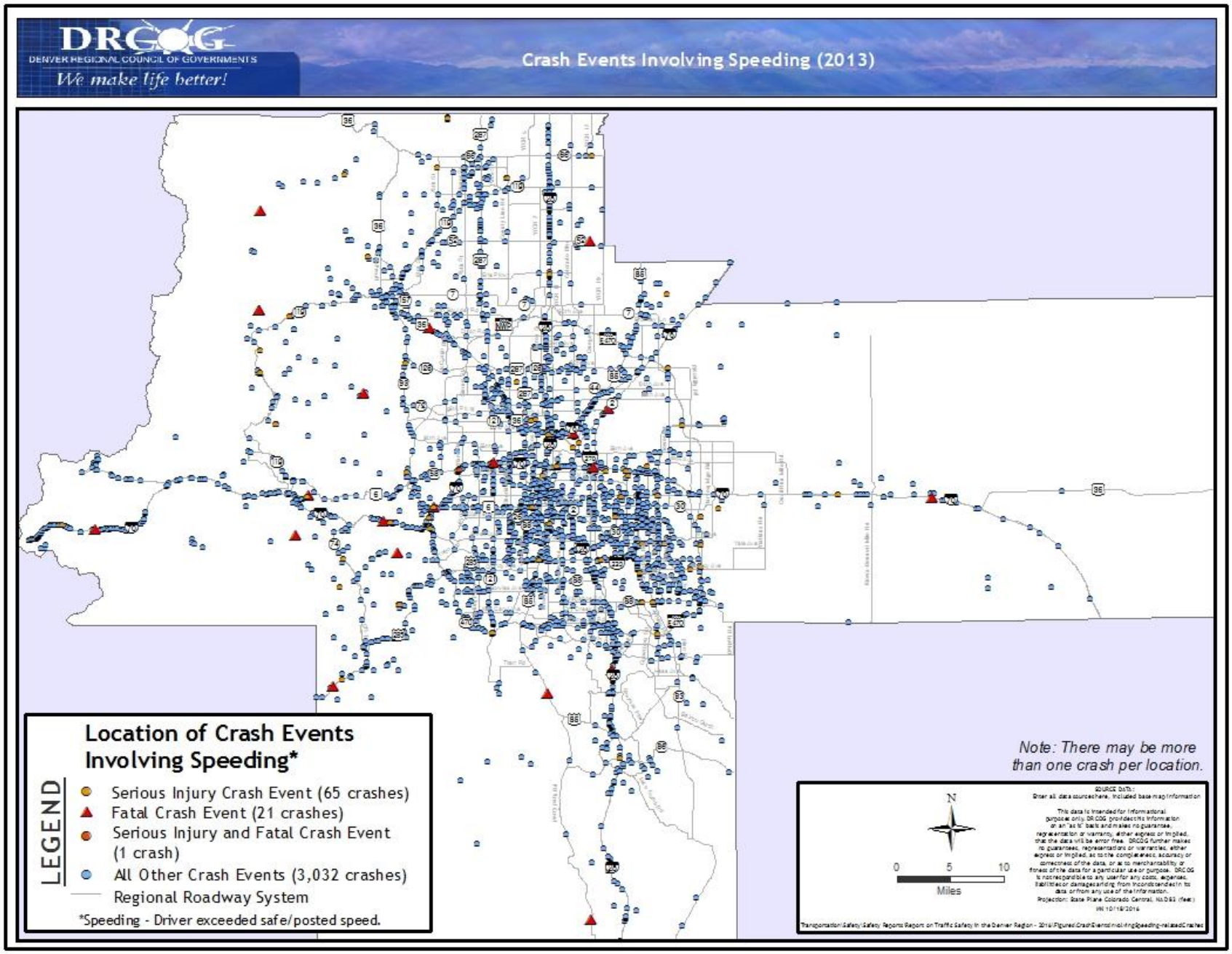
Speeding Education and Enforcement Efforts

CDOT's Speed Enforcement and Control Program aims to reduce speed-related crashes through "concentrated, repetitive, and high-visibility" speed enforcement. In 2009 and 2010, the program provided funds to the Denver Police Department to focus on speeding violations on the I-25 and I-70 corridors. For more information on CDOT Speed Enforcement program activities see the Annual Report for the CDOT Office of Transportation Safety and Traffic Engineering[10].

Many speeding-related crashes occur due to high speed differentials between vehicles on a roadway. Achieving speed harmonization (i.e., all vehicles traveling at roughly the same speed) greatly enhances roadway safety. In August 2011, CDOT began implementing 55 mph pacing vehicles on the I-70 Mountain corridor to reduce crashes and congestion during peak travel times.

[10] *https://www.codot.gov/safety/safety-data-sources-information/transportation-safety-and-traffic-engineering-annual-report*

Figure 22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Crash Events Involving Speeding (2013)
Location of Crash Events Involving Speeding*
LEGEND
Serious Injury Crash Event (65 crashes)
Fatal Crash Event (21 crashes)
Serious Injury and Fatal Crash Event (1 crash)
All Other Crash Events (3,032 crashes)
Regional Roadway System
*Speeding - Driver exceeded safe/posted speed.
Note: There may be more than one crash per location.
N
0 5 10
Miles

C. Red Light Running

From 2011 to 2013, an average of 2,500 red light running (RLR) crashes occurred per year in the Denver region. These crashes resulted in an average of 7 fatalities and 130 serious injuries per year. In 2011, according to the Insurance Institute for Highway Safety, about half of the red-light running deaths in the United States were people other than the red-light runner.

Figure 23 shows the locations of red light running crash locations in 2013.

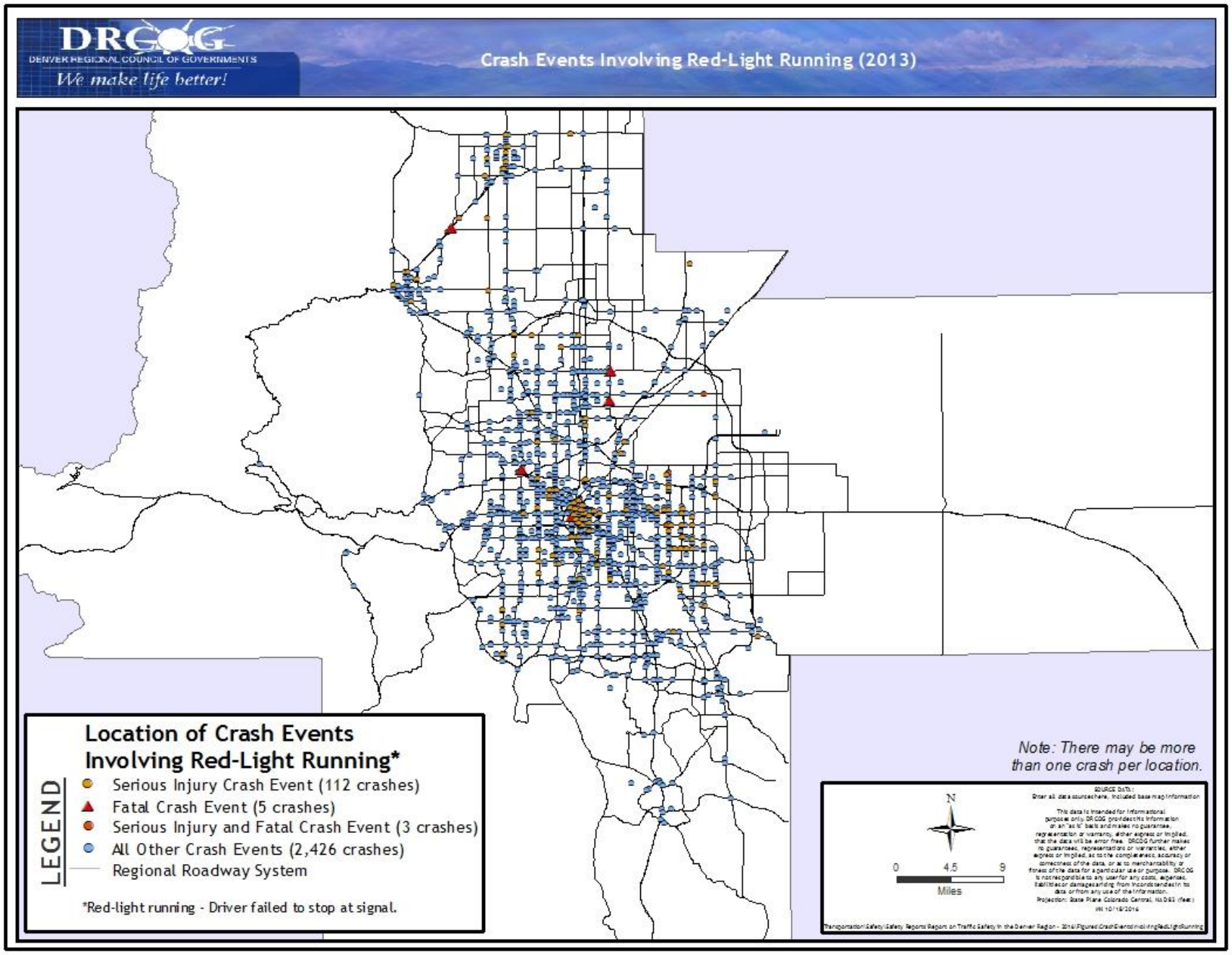
Red Light Running Crash Mitigation

RLR crash mitigation is divided into two categories; engineering treatments to reduce unintentional RLR and enforcement activity, which reduces intentional RLR. In regard to engineering countermeasures, some common treatments include:

- Improved signal visibility (e.g., placement of a signal head over each through lane),
- Installation of signal ahead warning signs,
- Adjustment of the yellow and all-red intervals, and
- Signal upgrades to allow for dilemma zone preemption (i.e., extending the green when a vehicle is detected in the dilemma zone).

Increased enforcement, via red light running cameras, is commonly used to reduce intentional RLR. There are about 50 intersections in the Denver region with RLR cameras.

Figure 23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Crash Events Involving Red-Light Running (2013)
Location of Crash Events Involving Red-Light Running*
LEGEND
Serious Injury Crash Event (112 crashes)
Fatal Crash Event (5 crashes)
Serious Injury and Fatal Crash Event (3 crashes)
All Other Crash Events (2,426 crashes)
Regional Roadway System
*Red-light running - Driver failed to stop at signal.
Note: There may be more than one crash per location.
N
0
4.5
9
Miles

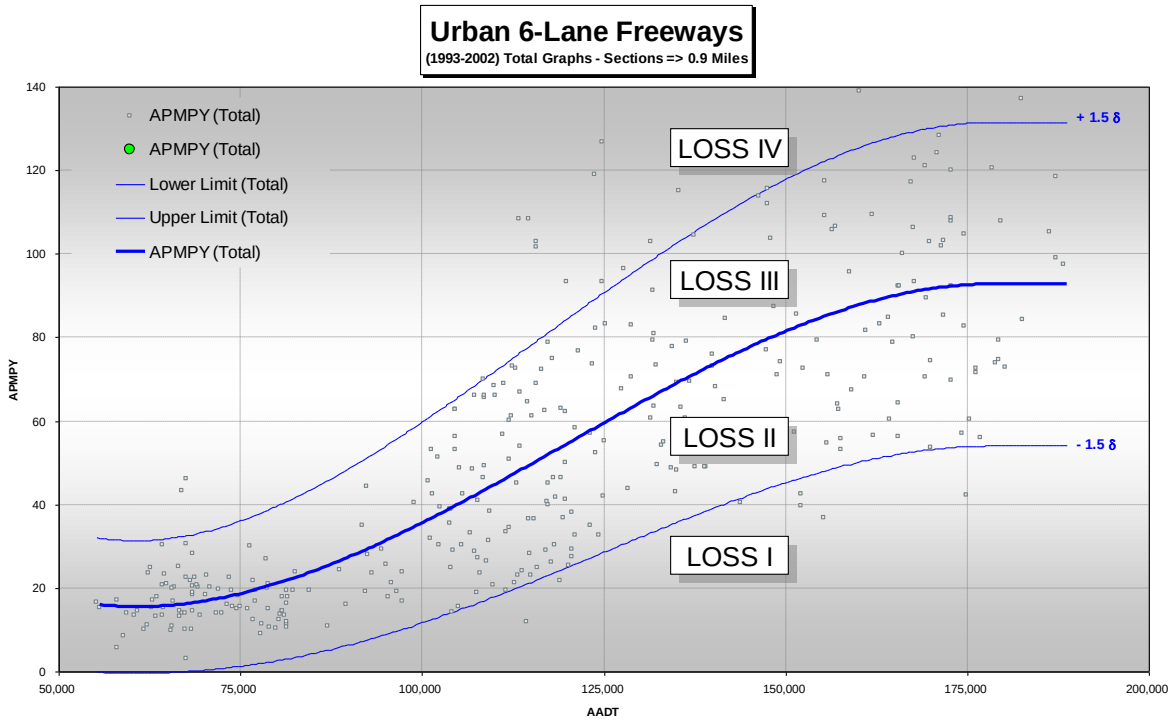
7. IDENTIFICATION OF HIGH CRASH LOCATIONS

A. Freeway Segment Crashes

CDOT tabulates and analyzes freeway crashes using the Level of Service of Safety (LOSS). LOSS reflects how a roadway segment is performing in regard to its expected accident frequency and severity at a specific level of annual average daily traffic. LOSS is based on the concept of Safety Performance Functions (SPF). SPFs represent the statistically expected accidents per mile per year (APMPY) for unique types of facilities.

The LOSS ranges from I to IV, with a LOSS IV assigned to segments with a crash history at least 1.5 standard deviations higher than the average for that facility type. As an example, the SPF for total crashes on a 6-lane urban freeway is shown in the chart below.

Figure 24. Safety Performance Function-Urban 6-Lane Freeways



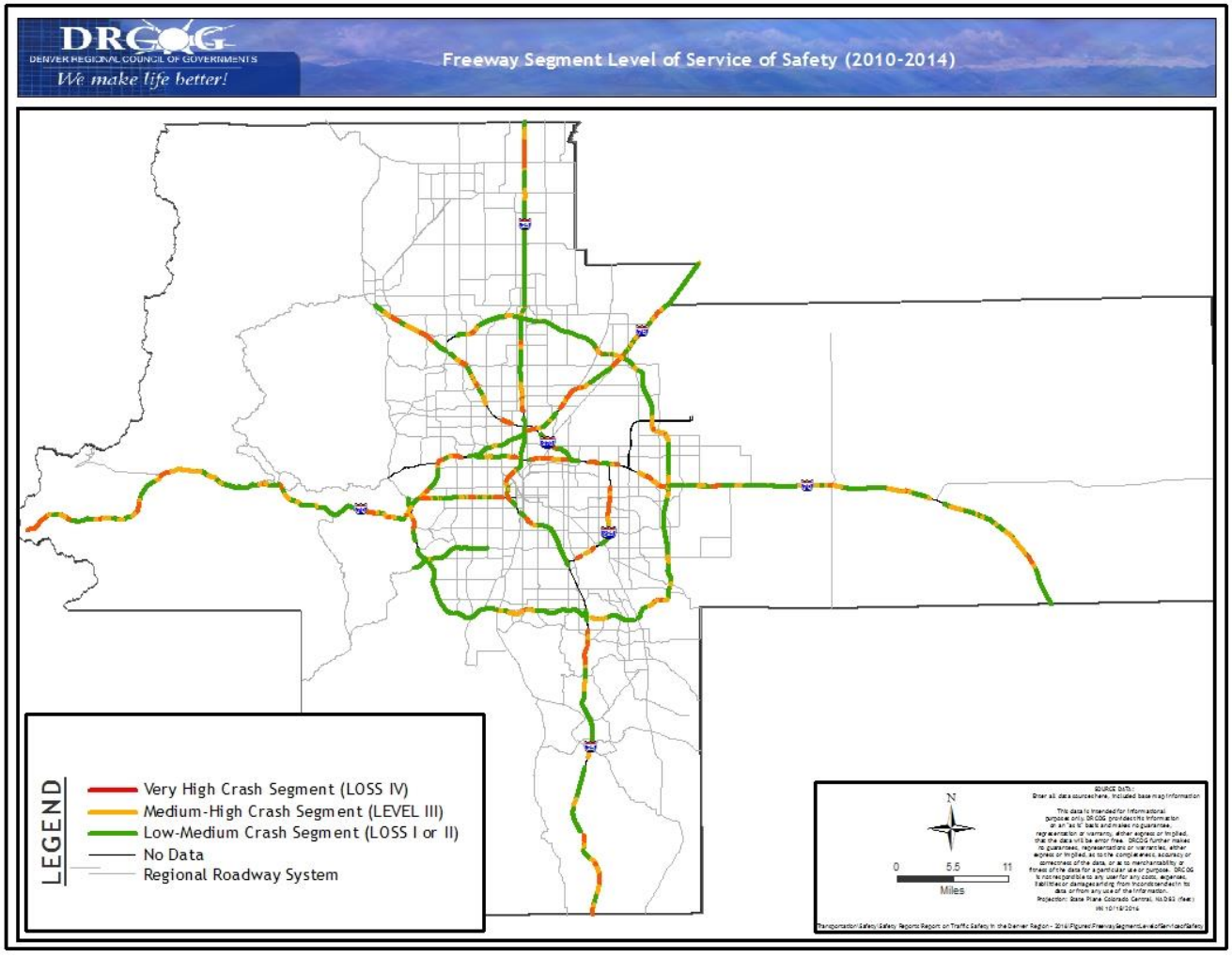
CDOT tabulated and mapped freeway segment LOSS scores for the 2010-2014 timeframe. The results for the DRCOG region can be found in Table 12. Table 12 shows that 14% of freeway segments in the DRCOG region have a LOSS of IV, or a high potential for crash reduction. LOSS scores for freeways in the DRCOG region are plotted in Figure 23. High crash segments are

scattered throughout the DRCOG region, with the highest concentration of segments located in the central part of the region along I-25, I-70 and US-6.

Table 12. Level of Service of Safety on DRCOG Freeway Segments

	Level of Service of Safety Score			
	I *(fewer crashes than expected)*	II	III	IV *(more crashes than expected)*
DRCOG Freeway Segments	443 (15%)	1,369 (45%)	801 (26%)	420 (14%)

Figure 25



8. OTHER SAFETY EFFORTS

A. Engineering Safer Roadways

A large part of roadway safety relies on proper signage, roadway design, maintenance, and vehicle design. The American Association for State and Highway Transportation Officials (AASHTO) publishes several manuals, which provide roadway and roadside design criteria based on the functional classification and traffic volume on the facility. In addition to appropriate design, regular maintenance, resurfacing, and restriping are needed to maintain roadway safety.

Proper communication with the roadway user, via signage and signals, is also critical to roadway safety. The MUTCD governs the design and placement of traffic signs, signals, and pavement markings nationwide. The purpose of the MUTCD is to ensure uniformity of traffic control devices, as user understanding is greatly enhanced when messages are displayed in the same way at all times.

Also, advancements in vehicle technology can help prevent crashes. Vehicle technology is advancing quickly; several technologies in testing include traffic sign recognition (e.g., recognition of speed limit signs), automatic braking when a collision is sensed, and pedestrian protection systems, which lessen injuries to a pedestrian when hit by a vehicle. Autonomous vehicles and connected vehicle technology are also on the horizon.

B. Emergency Response and Crash Clearance

Crashes on freeways and major roads during peak hours have a major impact on traffic congestion. For this reason, emergency response time and removal of an incident from the traffic stream is very important. CDOT has several programs underway, which aid in faster clearance of the roadway following a traffic crash. These programs include:

- CDOT's *Mile High Courtesy Patrol* provides assistance for passenger cars and other small vehicles when stalled or involved in minor traffic crashes. The program has been in place since 1992 and patrols key areas of I-25, I-70, I-225, and US-6 during rush hours. The program provides services including flat tire repair, fueling, jump starts, short-distance towing, accident scene protection, and minor mechanical assistance. The *Courtesy Patrol* also serves the I-70 mountain corridor during weekends and holidays from November to March.

- CDOT's *Heavy Tow Quick Clearance* program[11] clears stalled commercial vehicles from the travel lanes on I-70 between Floyd Hill and Vail Pass. The program operates on weekends and holidays between November and April. The average clearance time for the 2010/2011 winter season was 22 minutes. Before the program's implementation, in late 2008, the average clearance time was 50 minutes.

[11] *https://www.codot.gov/travel/winter-driving/CommercialVehicles.html*

9. SUMMARY OF FINDINGS

This report provides benchmark crash statistics for the Denver region and aims to increase awareness among planners, engineers, and elected officials as they contemplate safety issues in their communities. Some of the key findings of safety conditions in the Denver region are as follows:

- **The overall crash rate decreased between 2001 and 2013.**
- **The number of annual traffic fatalities in the region has increased since 2009.** Although the number of annual traffic fatalities decreased between 2001 and 2009, the number of annual fatalities has since increased 49 percent.
- **Young male drivers are involved in more crashes.** Young male drivers between the ages of 15 and 34 are involved in disproportionately more crashes – in particular fatal crashes.
- **Pedestrians are particularly vulnerable transportation system users.** Between 2011 and 2013 pedestrians accounted for 22 percent of traffic fatalities.
- **Motorcyclists make up an increasing proportion of all traffic fatalities.** Motorcyclists made up 14 percent of traffic fatalities in 2000, increasing to 23 percent in 2015.

Fortunately, many crashes can be prevented. As mentioned earlier, CDOT estimates 85 percent of crashes are due to improper driver behavior, while only 15 percent of crashes occur due to conditions out of the driver's control. However, transportation safety is multidisciplinary in nature, and involves the effort of many entities, including all roadway users, educators, law enforcement, tow truck operations, emergency medical response professionals, and government agencies, to name a few.