LARIMER COUNTY
COMMITTED TO EXCELLENCE

2012
Traffic Safety Annual Report

Public Works Division
Engineering Department
Road and Bridge Department

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Executive Summary

Every year, there are about 400 vehicular crashes in unincorporated Larimer County resulting in injuries to about 100 people, which represents a total cost in excess of $6 million dollars. Larimer County's traffic safety program in the Public Works Division addressees this need and strives to reduce the numbers and severity of crashes on the 1,050 miles of County-maintained roads in unincorporated areas. The program uses a toolbox of mitigation measures from engineering solutions to crash monitoring to support traffic safety.

2012 Traffic Safety Assessment

Roadway crashes that occur in unincorporated Larimer County along mainline county roads (not state highways) were analyzed and are detailed in the traffic safety assessment beginning on page 3. A few of the summary statistics include:

- Since reaching a high in 2009, overall numbers of crashes are down 25% and injury crashes are down more than 12%. For the first time in recent memory, there were no fatal crashes during the past calendar year.
- The percentage of severe crashes (crashes with injuries or fatalities) remains relatively consistent and accounts for about 23% of all crashes.
- Crash rates for severe crashes, which accounts for varying amounts of traffic, have also decreased by 23% in the past five years.
- Only 29% of crashes occur at intersections.
- Almost 2/3 of all crashes on unincorporated Larimer County roads are single vehicle crashes. This number is up from about 50% just five years ago. In fact, 46% of all crashes are a result of a single vehicle leaving the roadway.
- More than 1/2 of crashes (54%) occur during daylight hours on dry, paved roads.
- Distracted driving and DUI together account for approximately 20% of all crashes.
- Drivers less than 20 years old drive only 3% of total miles driven, but account for 21% of all crashes.
- Drivers not wearing seatbelts are three (3) times more likely to be injured or killed than drivers wearing seatbelts.
- Motorcyclists are almost 4 times more likely to be injured or killed than those in vehicles, and motorcyclists not wearing a helmets are 2.5 more likely to die in a crash than those wearing helmets.
- Bicycle crashes, while relatively low in numbers (9) are increasing and 70% of the crashes result in an injury.

Traffic Safety Mitigation Efforts

The approach of the traffic safety program is to systematically identify, prioritize, mitigate and evaluate the performance of safety investments on the roadway system. In 2012, 17 locations were identified for safety audits. Crash history review and on-site evaluation resulted in six locations where low cost engineering based solutions were determined.

There are also several other locations with pending safety improvements (such as re-alignment or change in intersection control) that have been otherwise funded through capital improvement dollars or federal funding.

Collaborative efforts among other jurisdictions, law enforcement and education outreach to citizens are also an increasing element of the program.

Monitoring and Program Evaluation

Low cost improvements completed in the first four years of the program have resulted in a 10% decrease in minor crashes and an 87% decrease in severe crashes at those locations. This is an annual crash reduction of seven (7) severe crashes at those locations, with a societal savings of almost $250,000 annually.

Other locations that were analyzed through the program and higher cost improvements made resulted in 20 fewer crashes each year, including nine (9) fewer severe crashes.

Several guardrail projects were recently completed, including two locations funded through Federal Hazard Elimination funds, and two locations completed in 2012 with low cost safety dollars. To date, the safety monitoring on these location is very positive. There was also a road re-alignment of CR 27 completed with federal hazard elimination funding which has also resulted in a safety improvement.

Roundabouts continue to show a safety benefit. There has been a 90% reduction in injury crashes at the two locations where roundabouts have been built in Larimer County. Several more roundabouts are in varying stages of design.

Summary

Roadway crashes remain an everyday occurrence on Larimer County roads, and their impacts are significant. The traffic safety program is key in understanding, identifying, implementing and evaluating improvements.

The program has produced a substantial, quantifiable decrease in crashes at locations improved through either low cost solutions, or identified through the program and improved through other funding sources. Ultimately, this results in a lasting positive impact on the citizens of Larimer County.

Introduction

Every year on the 1,050 miles of Larimer County mainline roadways in the unincorporated area, about 400 vehicular traffic crashes occur. Those crashes include more than 80 severe crashes that involve an injury or fatality for as many as 100 people. Annual societal cost of these crashes was in excess of $6 million dollars last year.

In 2009, the Public Works Division began a traffic safety program with the goal to reduce the numbers and severity of crashes on our roadways. Working towards this goal requires a systematic approach towards traffic safety involving the following components:

- Collect, review and analyze crash data,
- Determine high crash locations and complete on- site safety audits to identify mitigation options,
- Prioritize and implement traffic safety projects through low cost or other funded programs,
- Work with partner agencies including other jurisdictions and law enforcement,
- Develop education based outreach for citizens
- Remain current on nationwide best practices and new innovations
- Monitor improvements to evaluate the benefit and performance of investments in transportation safety.

Traffic Safety Program Goal:

Reduce the numbers and severity of crashes on our roadways.

Each year, this annual report is produced to summarize the general trends in roadway safety, and document the program's efforts and results.

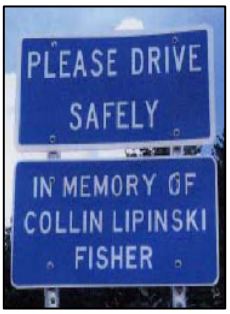
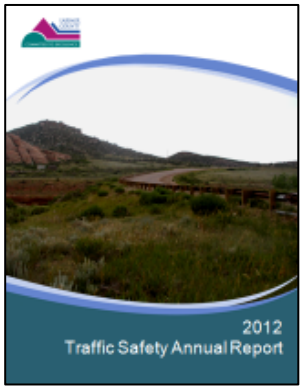
Roadway Safety Toolbox

Traffic safety is a function of a complex set of parameters. Vehicle design including crumple zones and airbags have significantly reduced the severity of injuries in crashes. Upcoming technology such as crash avoidance systems will further support the efforts of traffic safety. While important, vehicle design is not an area that the Larimer County Public Works Division can impact, and thus this report focuses on other elements affecting traffic safety.

Traffic safety solutions that can be impacted by our work typically fall into one of several categories, known as the "Five E's" of traffic safety: Engineering, Education, Encouragement, Enforcement, and Evaluation. See Table 1.

Some solutions are very low cost, while others require major expenditures. One element of the safety program is to identify not just the location of needed improvements, but to determine the least costly mitigation measure.

Table 1 – Example Traffic Safety Toolbox Items for Each of the 5 "E"s

Category	Typical Applications and Solutions	
Engineering (roadway)	Signing, striping, pavement markings, guardrail, auxiliary turn lanes, intersection traffic control, medians, rumble strips, sight distance improvements, lighting, delineators, speed limits, roadside hazards removal, minor widening, road realignment, pedestrian considerations, etc.	  
Education / Encouragement	The County's effort in this area includes education outreach program for schools and general public, speed display on roadway, traffic calming program, memorial signing, etc. This area of traffic safety also includes driver's education, and awareness campaigns such as "click it or ticket" and drunk(en) driving campaigns not managed by the County.	 
Enforcement	This is predominantly related to partnership with Sheriff's Department and Colorado State Patrol, and also an element of speed limits. Public Works establishes speed limits and provides information and analysis related to crashes to enforcement agencies.	
Evaluation	Annual Safety Report that tracks crash information, identifies trends, and monitors the effectiveness of implementation projects.	

Traffic Safety Assessment (Crash Information)

Crash Data

Roadway crashes that occur in unincorporated Larimer County are reported to the Colorado State Patrol (CSP). Unlike local cities, the Larimer County Sheriff's Department does not complete traffic crash reports, even though they may respond to the scene of an accident. The CSP fills out the accident report and files the report at their office. Every month, Larimer County Engineering Department staff works with the state patrol office to get copies of the crash reports in unincorporated Larimer County. The reports are reviewed, annotated, the data is input into the County's accident database, and then further refined as it is transferred to a geographic information system (GIS).

Using GIS allows the crashes to be spatially depicted on a map. The map is provided to the enforcement agencies, and used to visually identify areas of concern.

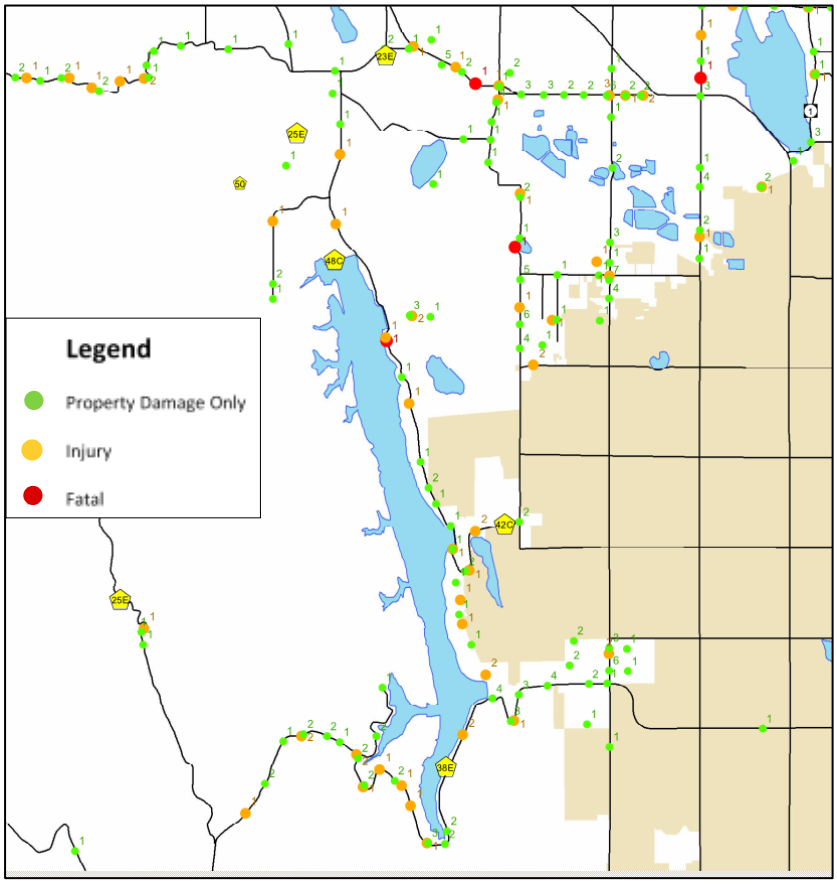
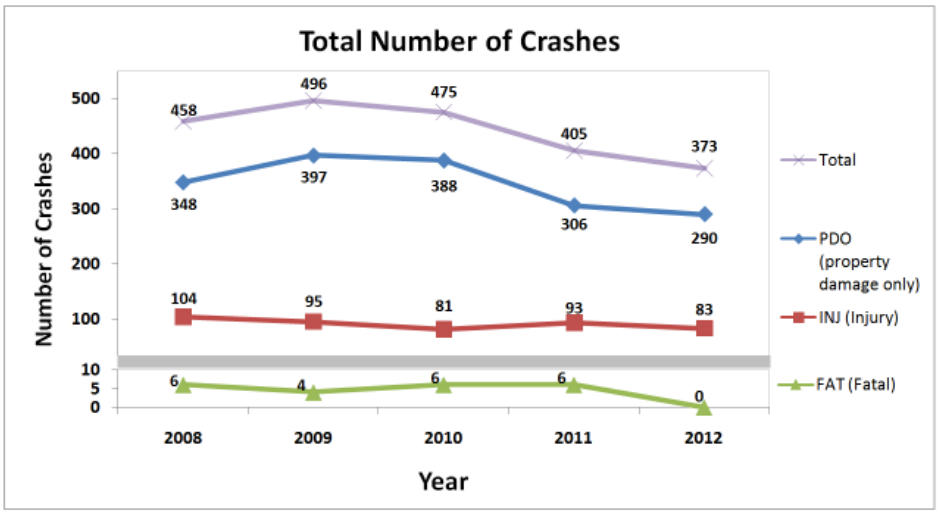


Figure 1 – Sample Crash Map for 2010-2012 Crashes

The following section provides an overview of crash data and trends that impact traffic safety. The data comes from both the County's accident database, and GIS system. Many of the graphs reflect a 5-year crash history from 2008 – 2012.

Overall Crashes



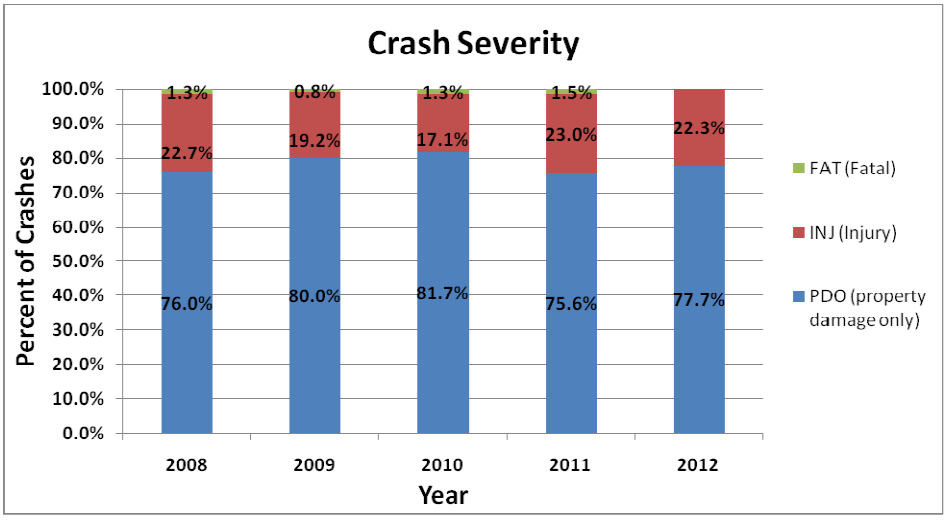
Overall, there are **25%** Fewer crashes than in 2009.

Injury Crashes are down more than **12%** since 2009.

No Fatalities in 2012!

Figure 2 – Total Number of Crashes

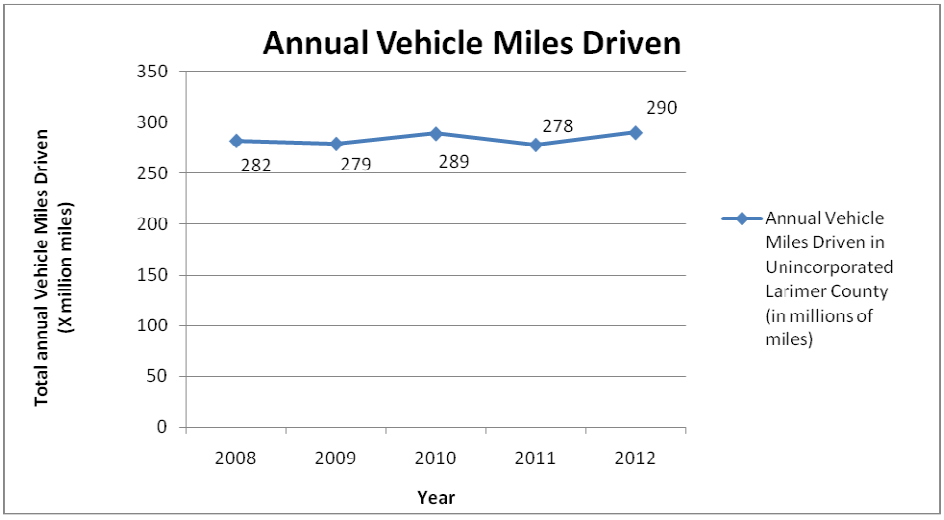
The overall trend in numbers of crashes continues to be downward – overall 25% fewer crashes in 2011 than in 2007. Injury crashes are also down over the 5-year period.



The percentage of severe crashes (injury+fatal) is remaining about the same and account for **20 - 25%** of all crashes.

Figure 3 – Crash Severity

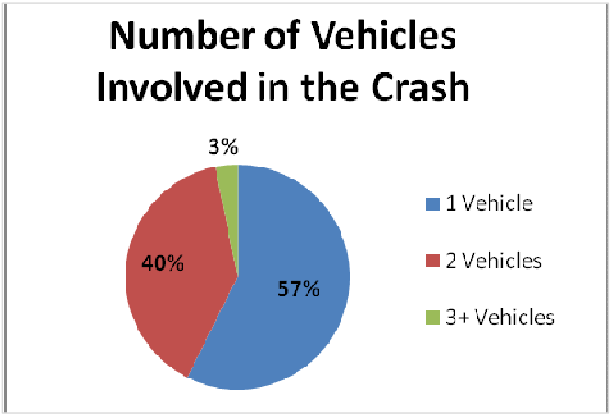
The crash numbers reflect events on roads in unincorporated Larimer County only. As road segments are annexed into municipalities, the total number of road miles decreases by a small amount. The economy and fuel prices also impact vehicle miles traveled with decreases occurring from 2007 – 2009. Overall in the past five years, the change in vehicle miles driven on unincorporated county roads is less than 3%. See Figure 4.



Annual vehicle miles driven has changed less than **3%** In the past five years.

Figure 4 – Annual Vehicle Miles Driven

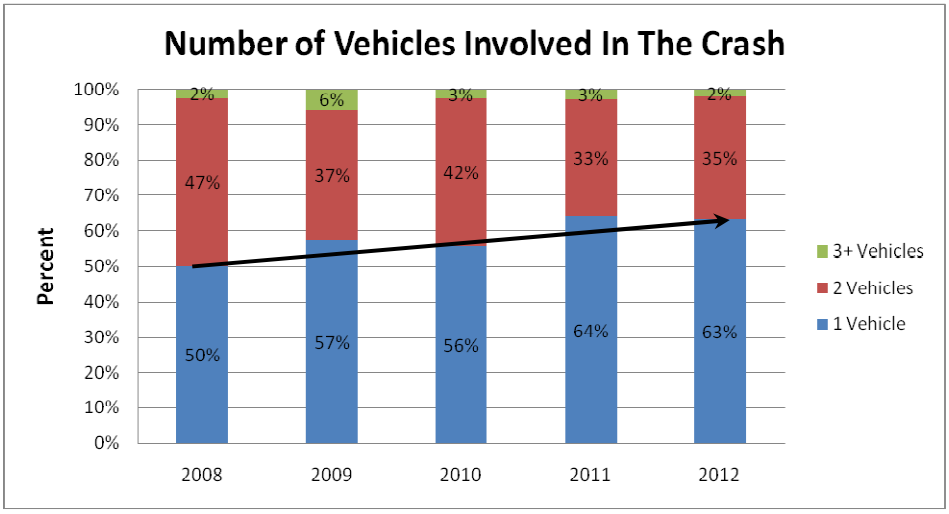
Number of Vehicles



In most urban areas, multiple car incidents account for the majority of vehicular crashes. That is not the case in more rural areas, where a majority of crashes involve just one vehicle.

When the data is not aggregated, but rather viewed over time (see figure 6), a definite trend can be seen in that the percentage of single car crashes is increasing.

Figure 5 – Number of Vehicles per Crash (5 year period: 2008-2012)



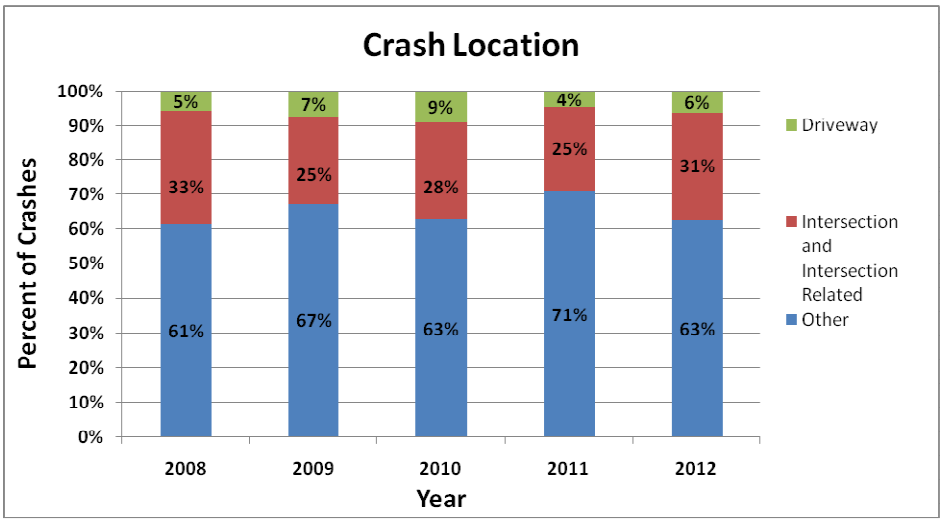
More than ½ of all crashes are single vehicle crashes.

The percentage has increased from **50% to 63%** in the last five years.

Figure 6 – Number of Vehicles per Crash

Location of the Crash

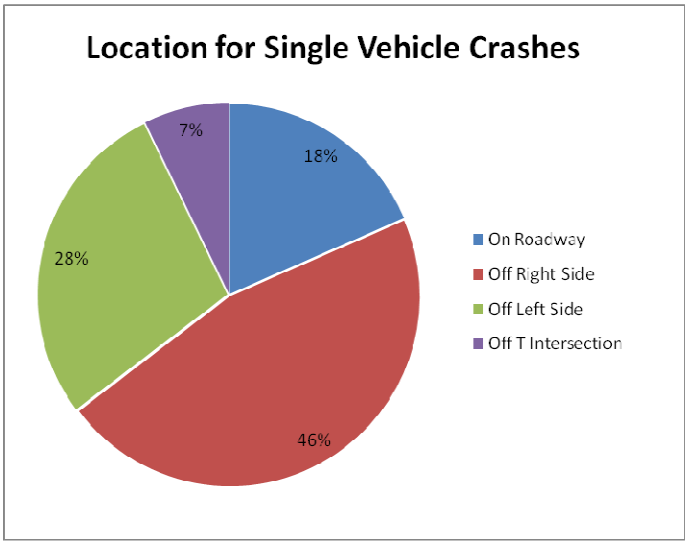
A review of the location of the crash helps to identify areas that need the most attention within a safety program. Much like the number of vehicle information on the previous page, the typical location of the crash is different between urban and rural areas. Most urban crashes occur at intersections. In rural areas, only 29% of crashes are related to intersections. The 'other' category in the graph below includes crashes the occur when vehicles leave the roadway.



An average of **29%** of crashes occur in or are related to intersections.

Figure 7 – Crash Location

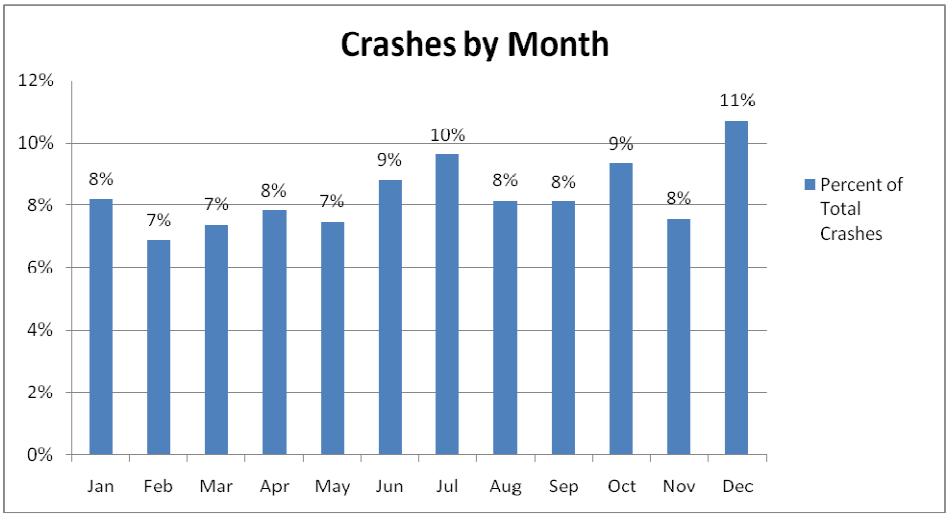
While all crashes involving multiple vehicles in 2012 occurred on the roadway, the location for single vehicle crashes tells a very different story. Of the cars leaving the roadway, half of them do so on a curve.



Almost **75%** of all single vehicle crashes (or **46% of ALL crashes**) are a result of a single car leaving the roadway.

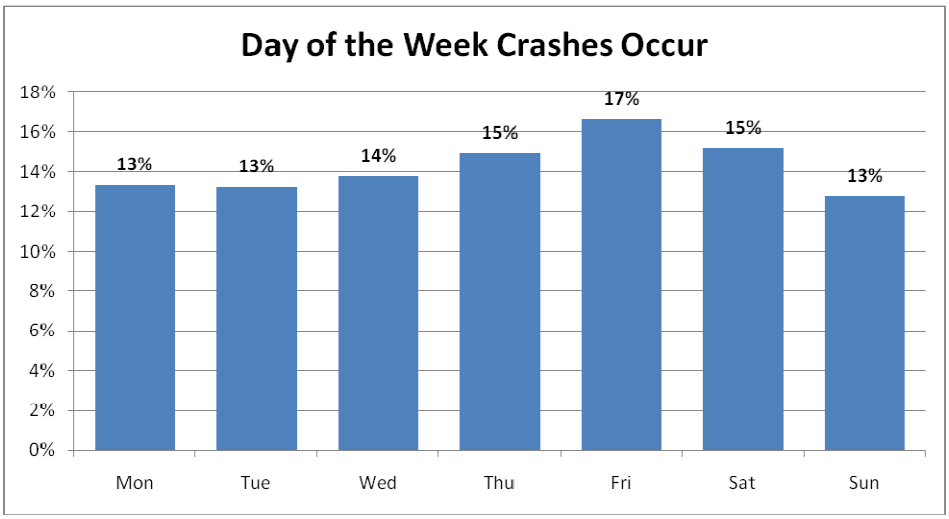
Figure 8 – Crash Location for Single Vehicle Crashes (2012 crashes)

Timeframe of Crashes



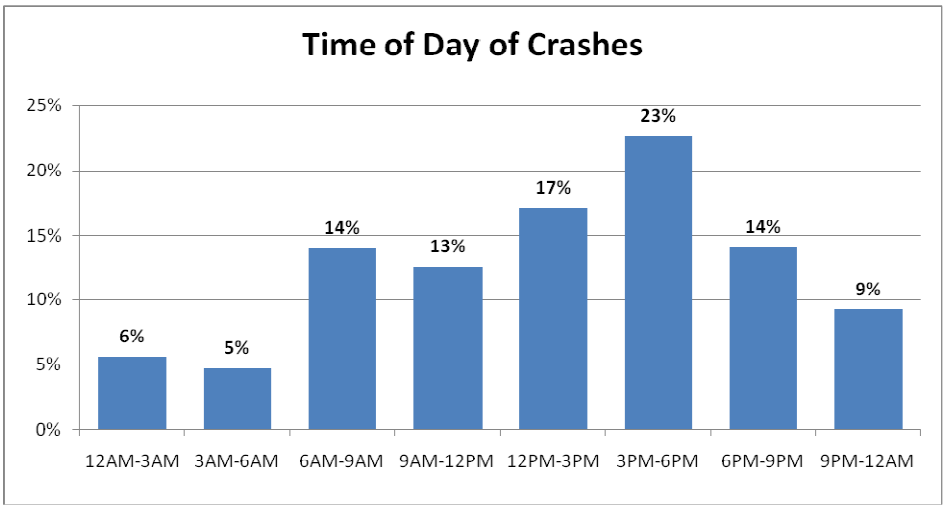
December sees the most reported crashes, although the **Summer** has the most crashes by season

Figure 9 – Crashes by Month (5-year period 2008-2012)



Fridays see the most reported crashes

Figure 10 – Crashes by Day of the Week (5-year period 2008-2012)



Nearly **1/4 (23%)** Of Crashes Occur During The Afternoon Peak (3-6 p.m.)

Figure 11 – Crashes by Time of Day (5-year period 2008-2012)

Road Surface and Condition

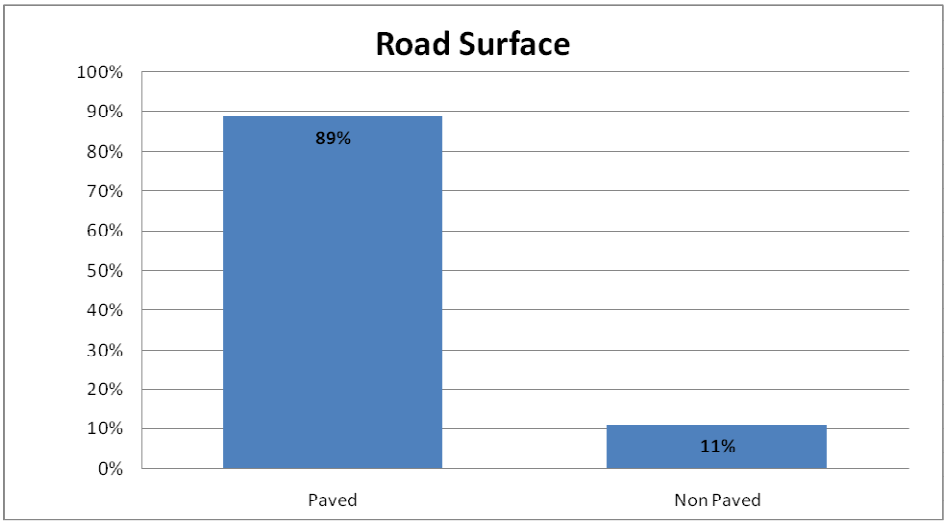


Figure 12 – Crashes by Type of Road Surface (5-year period 2008-2012)

Almost
90%
Of All Crashes Occur on the Paved Road System.

Accordingly,
90%
Of All vehicle Miles Travelled Take place on the Paved Road System.

Larimer County mainline road system includes about 60% paved roads and 40% non-paved roads – meaning about 90% of crashes occur on 60% of the roads. However, the paved roads see significantly more traffic than the non-paved roads. In fact, 90% of the vehicle miles traveled on Larimer County roads occur on paved roads.

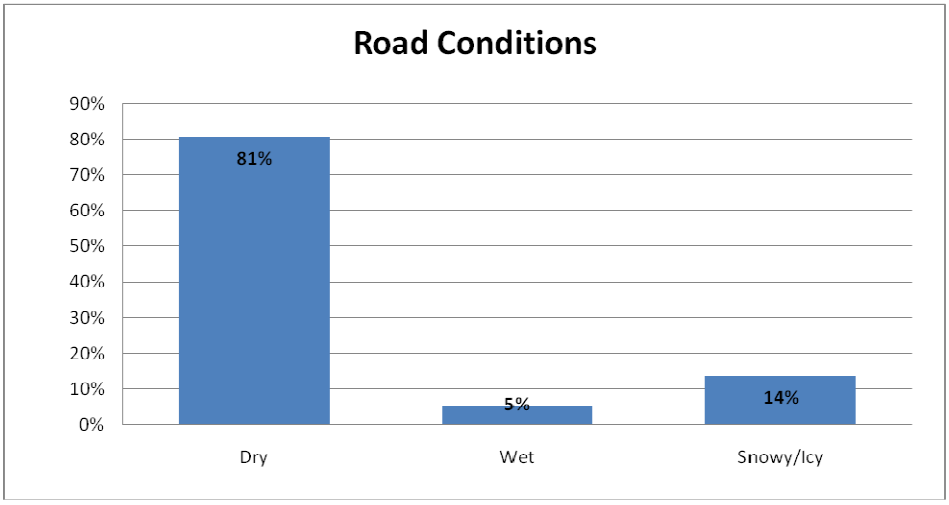
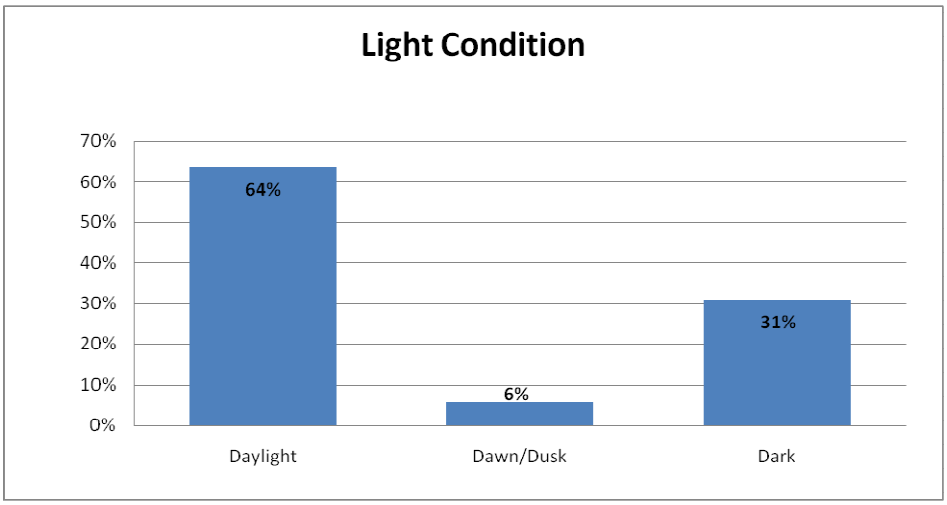


Figure 13 – Crashes by Road Condition (5-year period 2008-2012)

81%
of all crashes take place on dry roads.

Light Condition

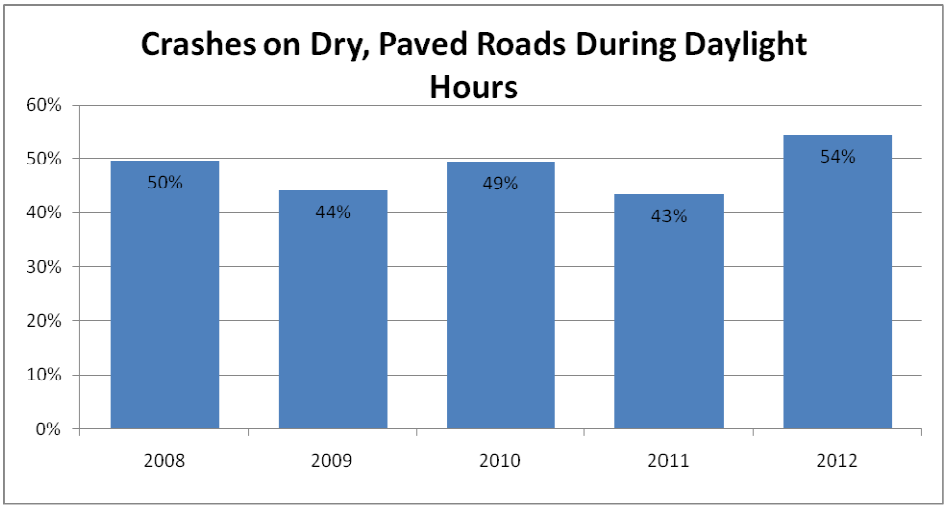


Almost
2/3
of crashes occur in the daytime

Figure 14 – Crashes by Light Condition (5-year period 2008-2012)

Conditions Combined

When considered in combination, 46% of all crashes on unincorporated Larimer County roads between 2007 and 2011 occurred on dry, paved roads during daylight hours.

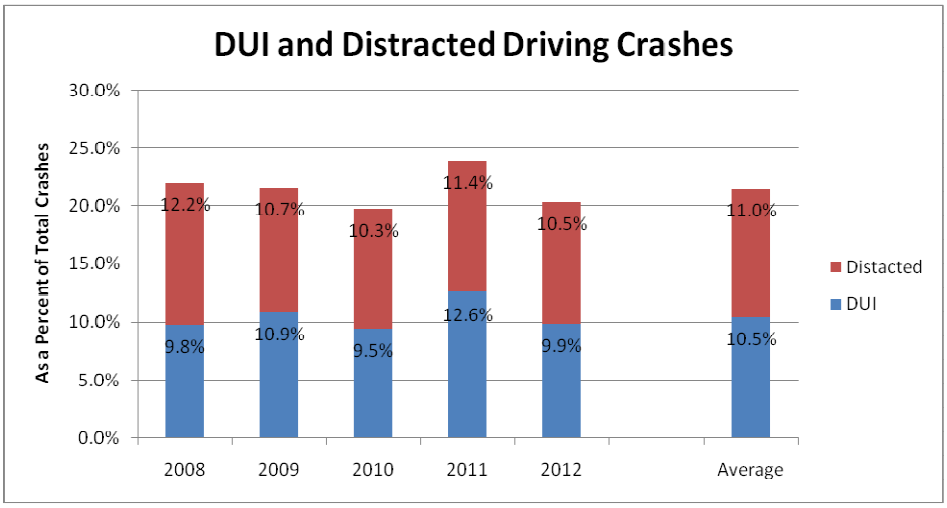


In 2012,
more than
1/2
of all crashes occurred on dry, paved roads during daylight hours.

Figure 15 – Percent of Crashes Occurring on Dry, Paved Roads During Daylight Hours

DUI and Distracted Driving

Driving Under the Influence (DUI) and distracted driving continue to be a source of concern for traffic safety.

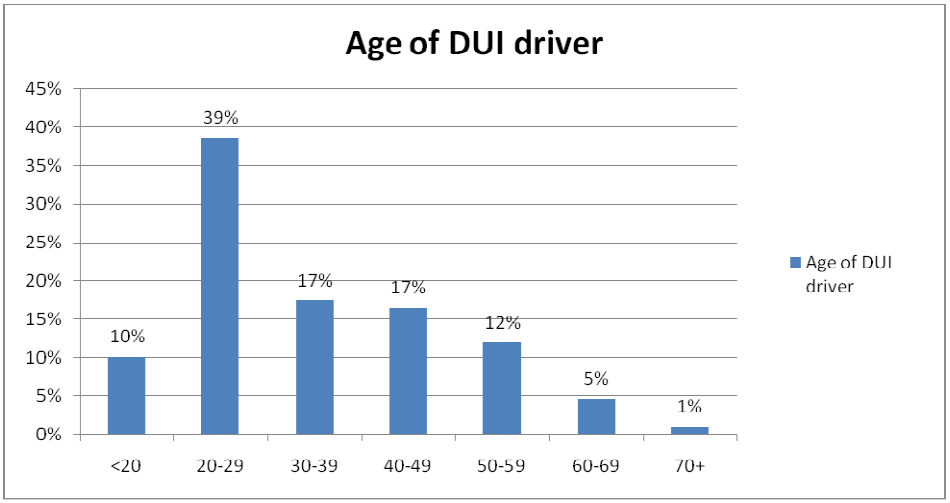


Driving Under The Influence (DUI) and Distracted Driving account for approximately **20%** of all crashes.

Figure 16 – Percent of Crashes Attributed to DUI or Distracted Driving

The percentage of drivers that were indicated to be 'distracted' as the ***primary*** contributing factor to the crash includes those distracted by passengers, cell phone, radio, etc. While the crash reports for Larimer County from 2008 to 2012 indicate this percentage to be 11%, the US DOT National Highway Traffic Safety Administration Traffic Safety Fact September 2010 indicated that nationwide 17% of all traffic crashes are identified by responding officers as caused by distracted driving.

DUI Crash Details



39% Of DUI crashes involve a driver in their 20s.

80% of DUI crashes involve a male driver.

Figure 17 – Age of DUI Driver (5-year period 2008-2012)

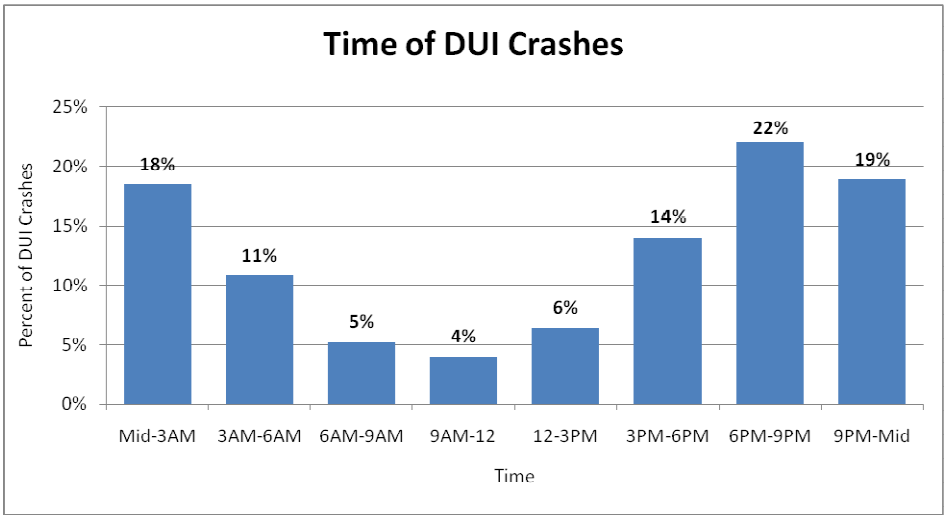


Figure 18 – Time of DUI Crashes (5-year period 2008-2012)

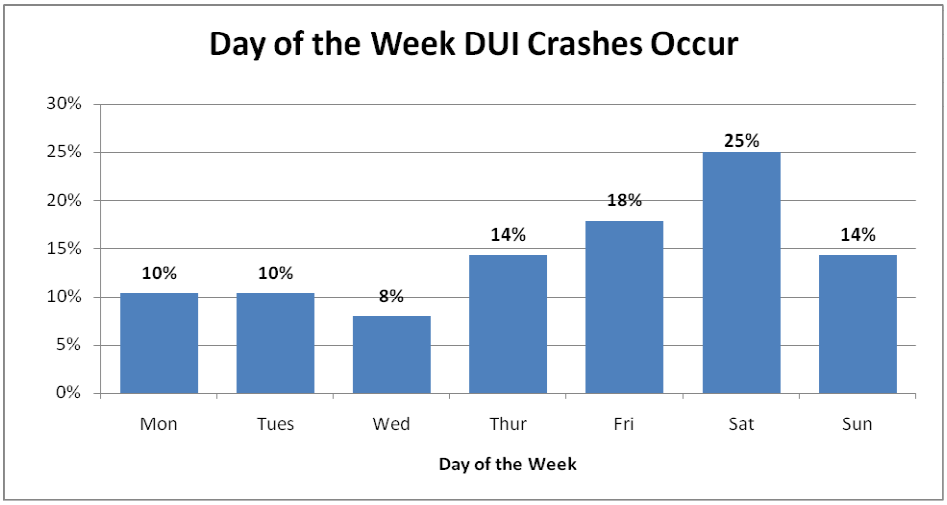
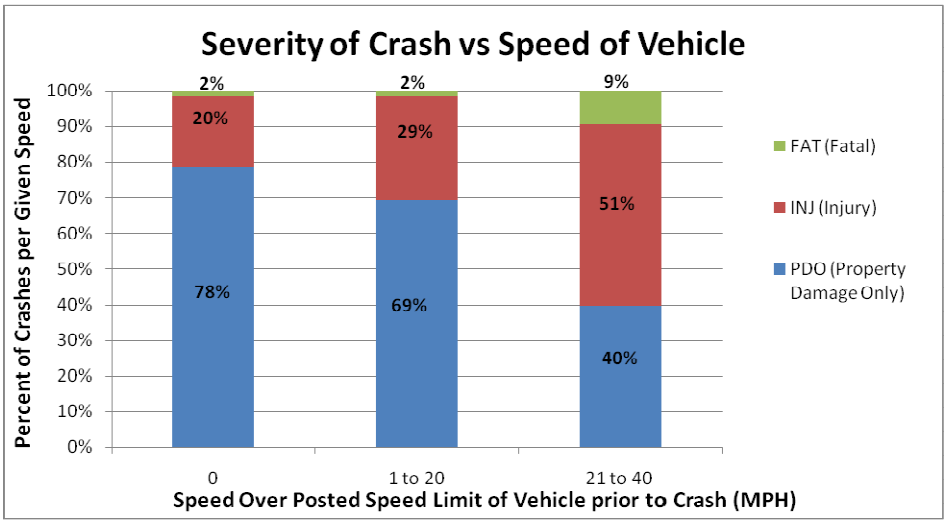


Figure 19 – Day of the Week for DUI Crashes (5-year period 2008-2012)

Impact of Speed

The figure below illustrates the severity of a crash sorted by the speed of the vehicle in relation to the speed limit at the time of the crash. The severity of crashes is significantly higher for vehicles traveling well above the speed limit.



For vehicles driving at least 20 mph over speed limit, the likelihood of injury more than **Doubles**

and likelihood of a fatality is **Six Times** as high.

Figure 20 – Severity of Crash vs Speed of Vehicle Over Speed Limit (5-year period 2008-2012)

Driver Information

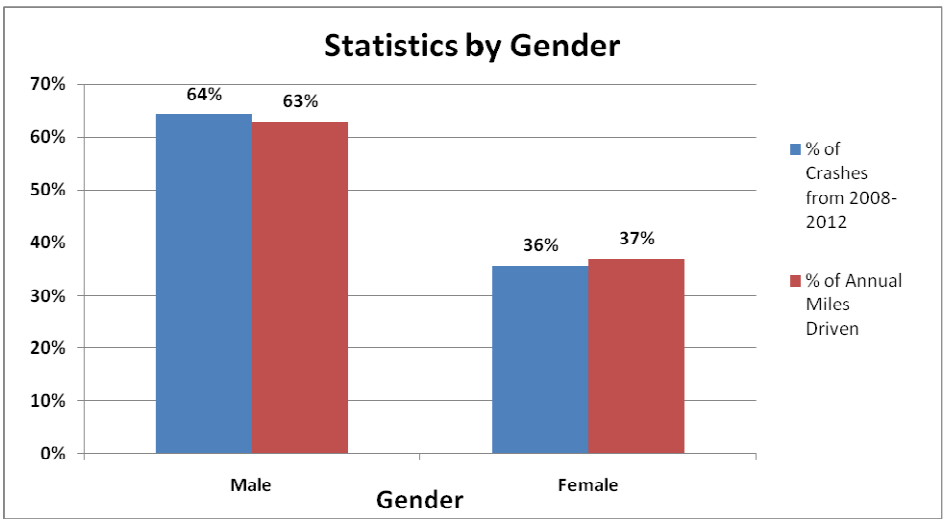


Figure 21 – Crash Statistics by Gender (5-year period (2008-2012)

Note: miles driven from Federal Highway Administration - Office of Highway Policy Information

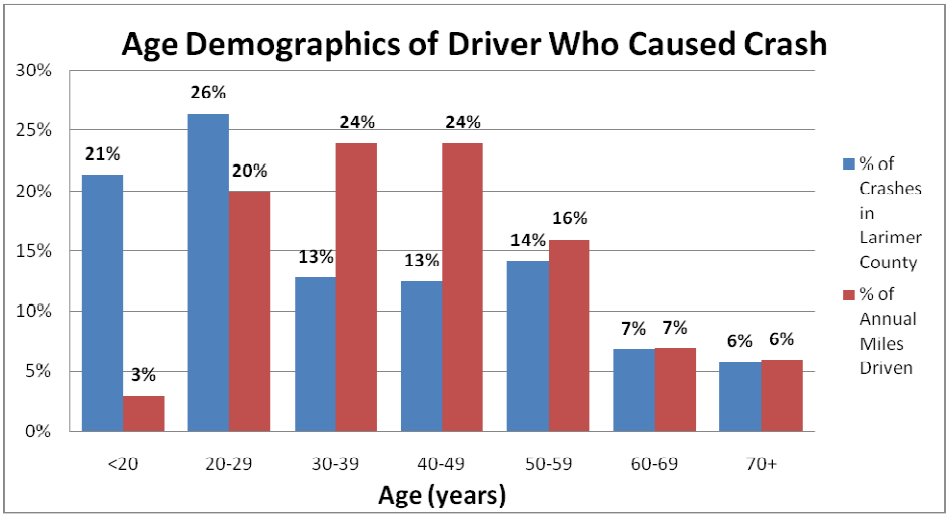


Figure 22 – Crash Statistics by Age Group (5-year period (2008-2012)
Miles driven from Federal Highway Administrations – Office of Highway Policy Information

Young drivers continue to be substantially overrepresented in crashes.

Drivers younger than 30 drive about **1/4** of all miles but are responsible for **1/2** Of all crashes

Driver Restraint

Driver restraint during crashes in unincorporated Larimer County is shown in the graph below. The nationwide seat belt use was 84% in 2011 (Per National Highway Traffic Safety Administration National Occupant Protection Use Survey), and Colorado's average is 82%.

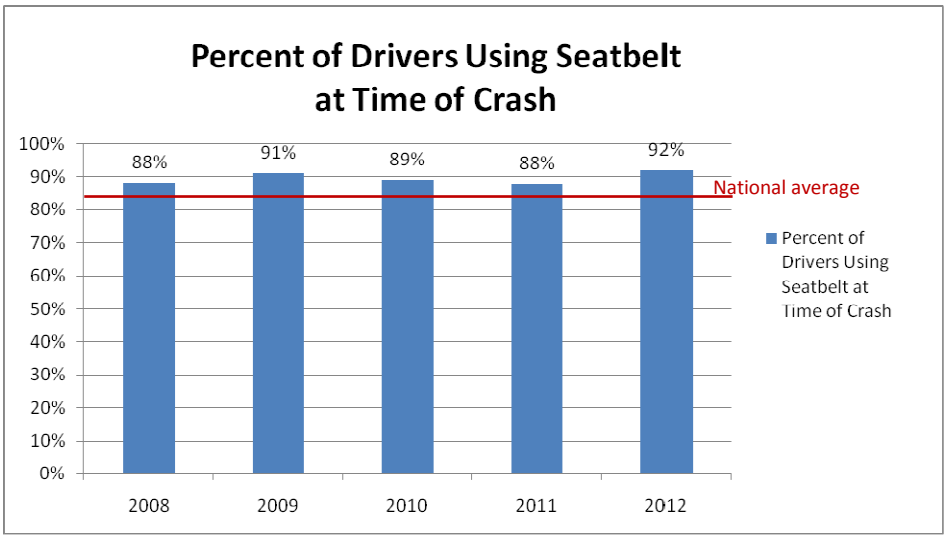


Figure 23 – Percent of Drivers Using Seatbelt at Time of Crash

Seatbelt usage has been similar in the last five years and is above the national average of 84%.

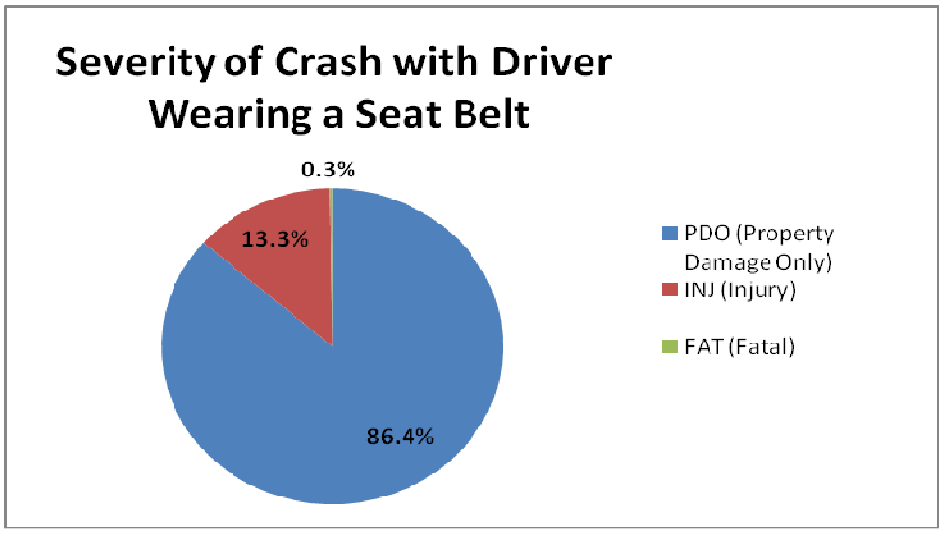


Figure 24 – Severity of Crash with Driver Wearing a Seat Belt (5-year period 2008-2012). (No motorcycles)

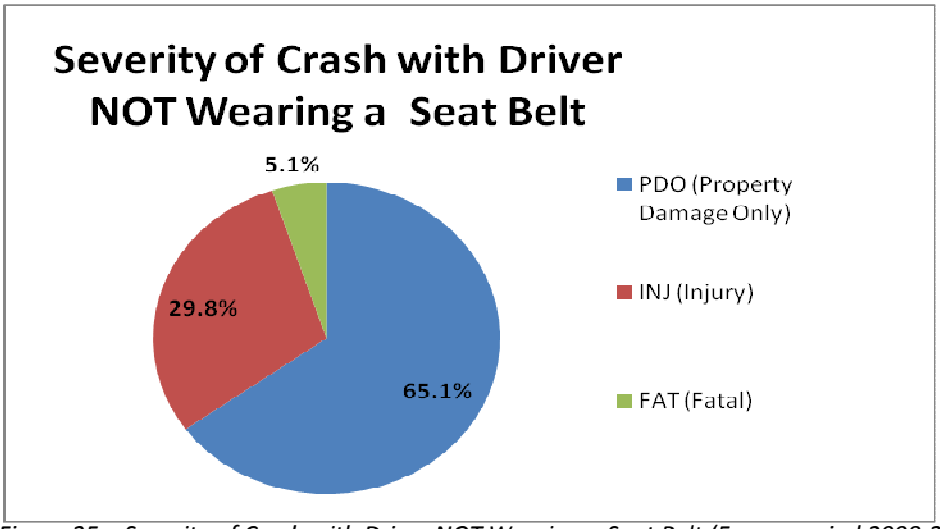


Figure 25 – Severity of Crash with Driver NOT Wearing a Seat Belt (5-year period 2008-2012). (No motorcycles)

Drivers not wearing seatbelts are

17

times more likely to be killed and more than

2

times more likely to be injured than drivers wearing seatbelts.

Motorcycle Crashes

The number of motorcycle crashes as a percent of total crashes has averaged between 6 and 8% of total crashes for the past five years. Motorcycle crashes have decreased from 41 in 2008 to 35 in 2012. 90% of motorcycle crashes are single 'vehicle' crashes. More than 90% of the crashes involve male riders.

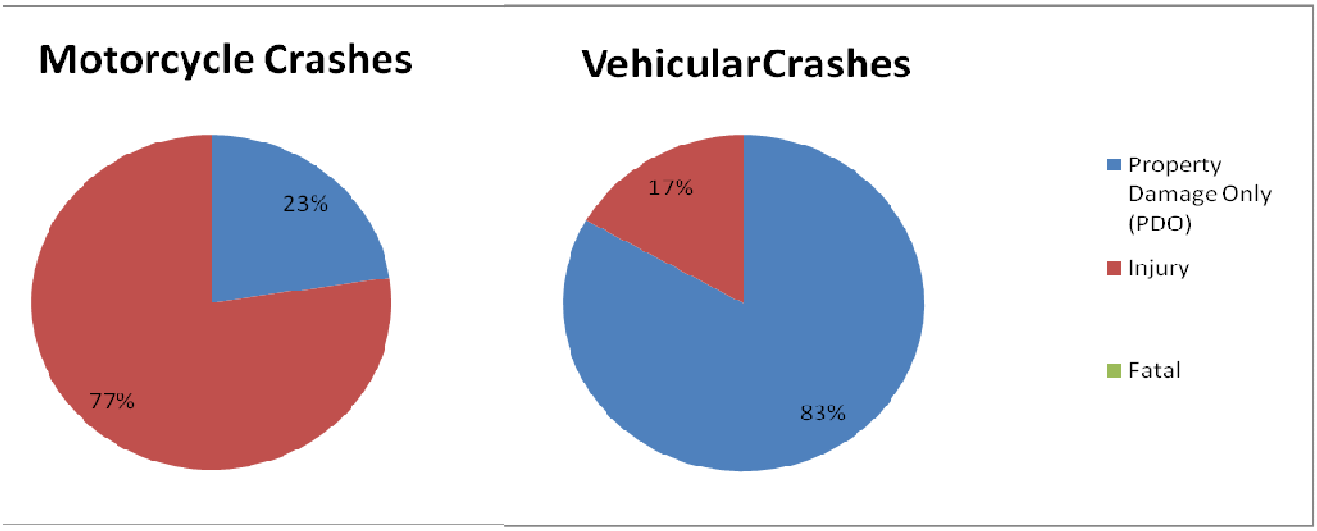


Figure 26 – Crash Severity Comparison between Vehicles and Motorcycles (5-year period 2008-2012)

Motorcyclists are almost **4** times more likely to be involved in a severe crash than drivers in vehicles

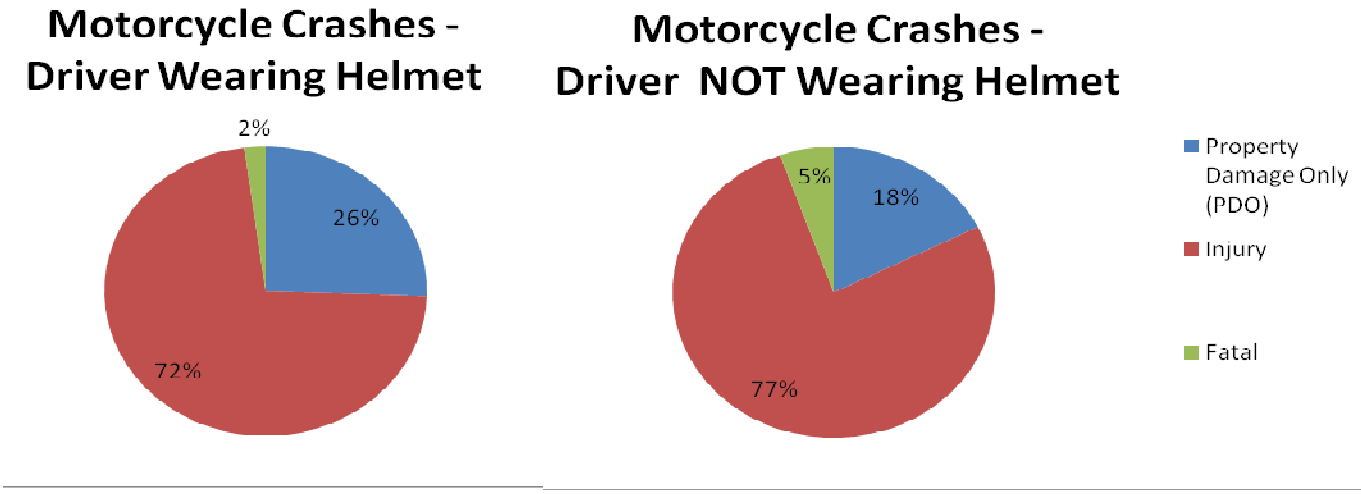


Figure 27 – Crash Severity Comparison for Helmet Use In Motorcycle Crashes (5-year period 2008-2012)

Motorcyclists NOT wearing a helmet are **2.5** times more likely to die in a crash than motorcyclists wearing helmets.

Pedestrian Crashes

Pedestrian crashes have numbered less than five each year in the past five years. In 2012, the two injury crashes involved a child walking home from school, and an adult hit along side of the road at 11:15 at night.

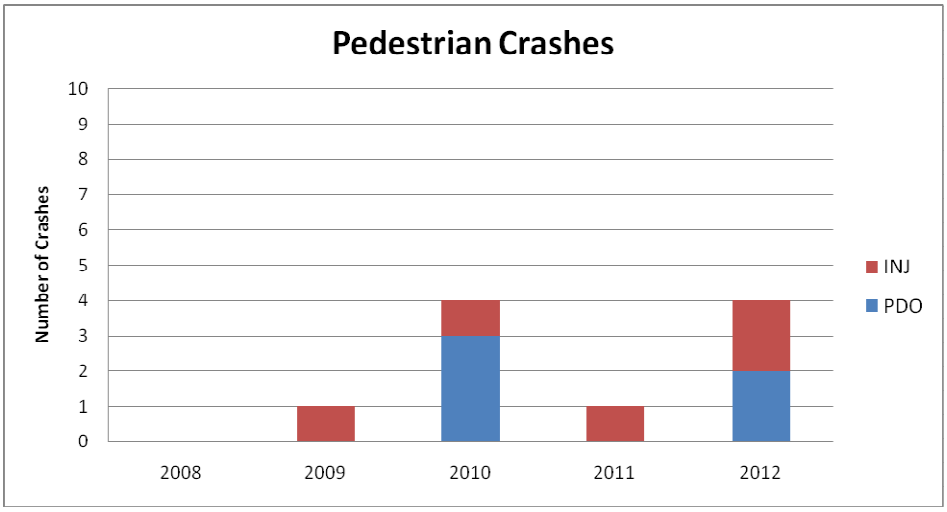


Figure 28 – Crashes involving a pedestrian in the past five years

Bicycle Crashes

Bicycle crashes saw a significant increase in 2012. Four crashes were at intersections (3 of them non-injury) and four cyclists were hit while riding on the road (all four injury crashes). Three of the crashes occurred between Fort Collins and Lovenad, two took place in the vicinity of Horsetooth Reservoir, and the rest in rural areas.

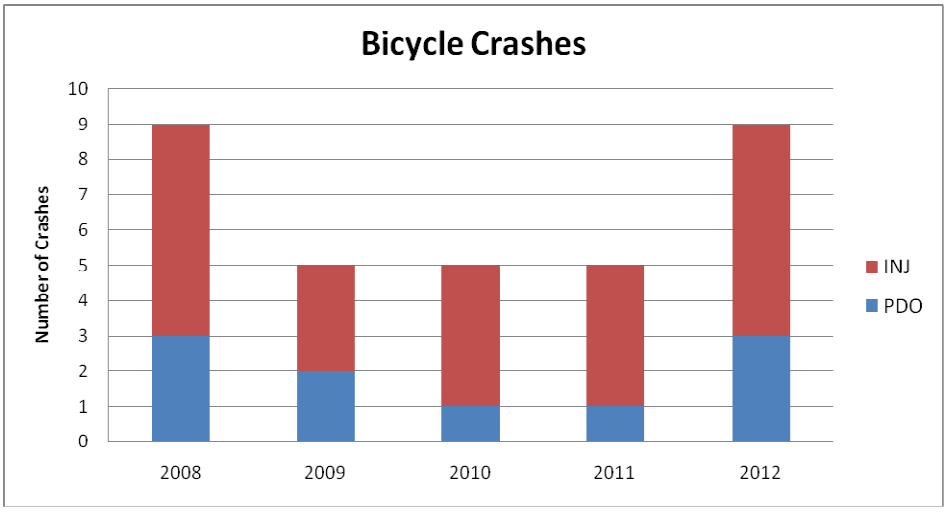
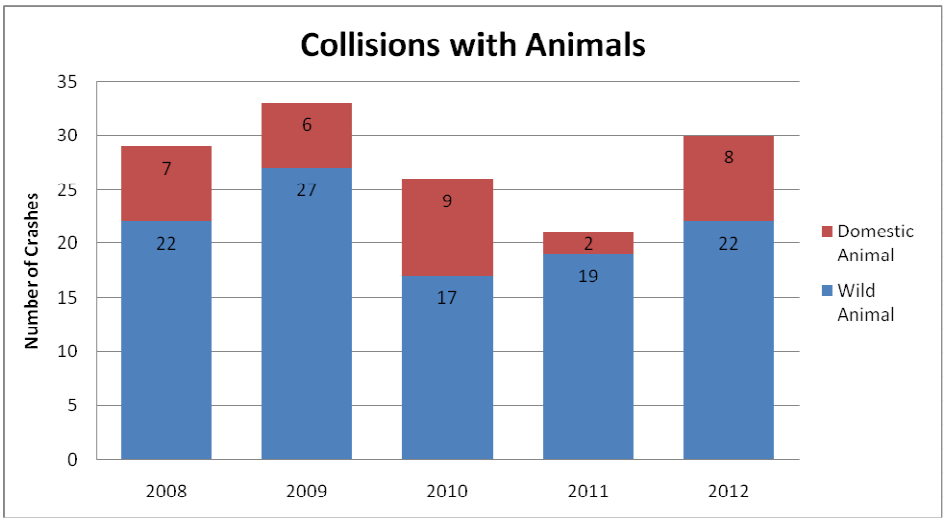


Figure 29 – Crashes involving a Bicycle in the past five years

In the past 5 years,
70%
Of bike crashes result in an injury.
80%
of bike crashes are NOT the fault of the cyclist.

Collisions with Animals



An average of
21
crashes with wild animals occur each year.

Figure 30 – Crashes involving a collision with an animal

Railroad Crossings

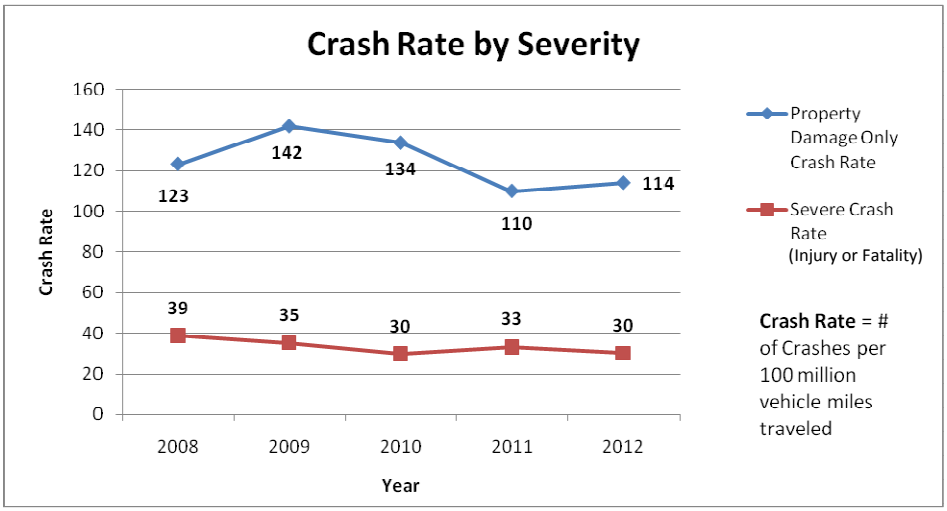
There were no crashes associated with railroad crossings in unincorporated Larimer County in 2012. There was one crash that involved a car hitting a railroad bridge, but none that involved the crossing surface.

Workzone Crashes

Workzone safety is an important area of interest for both motorists and workers. There was only one minor rear-end crash in a workzone in 2012.

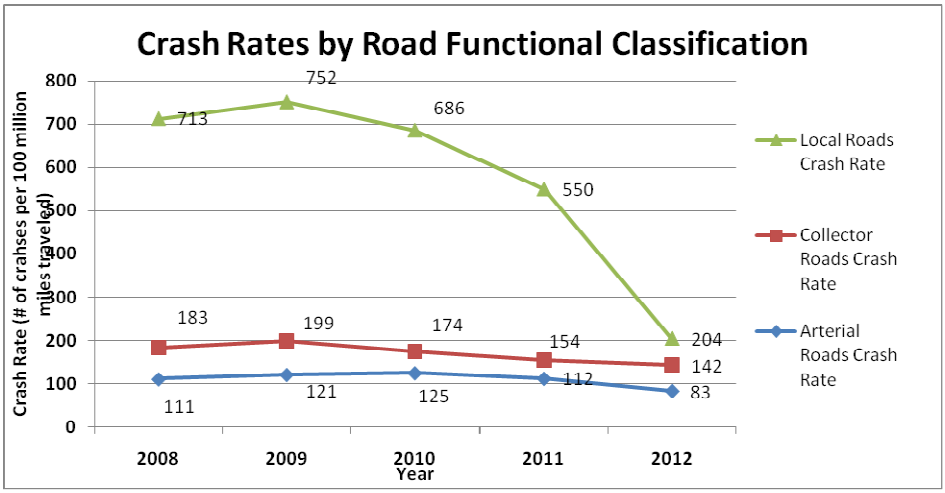
Traffic Safety Assessment (Crash Rates)

The number of crashes at a given location is influenced by a lot of factors, including the volume of traffic using the road system. The crash statistics on different types of roads may not represent an unbiased comparison as the traffic volumes can vary dramatically. In order to account for varying amounts of traffic, a measure of crash ***RATE*** is used in addition to crash ***NUMBERS***. A crash rate is expressed in the number of crashes per 100 million vehicles miles traveled.



23%
Decrease in crash rate of severe crashes from 2008 - 2012

Figure 31 – Crash Rate by Severity



Arterials
continue to statistically be the 'safest' roads. Due to limited number of crashes on local roads, that rate is highly variable.

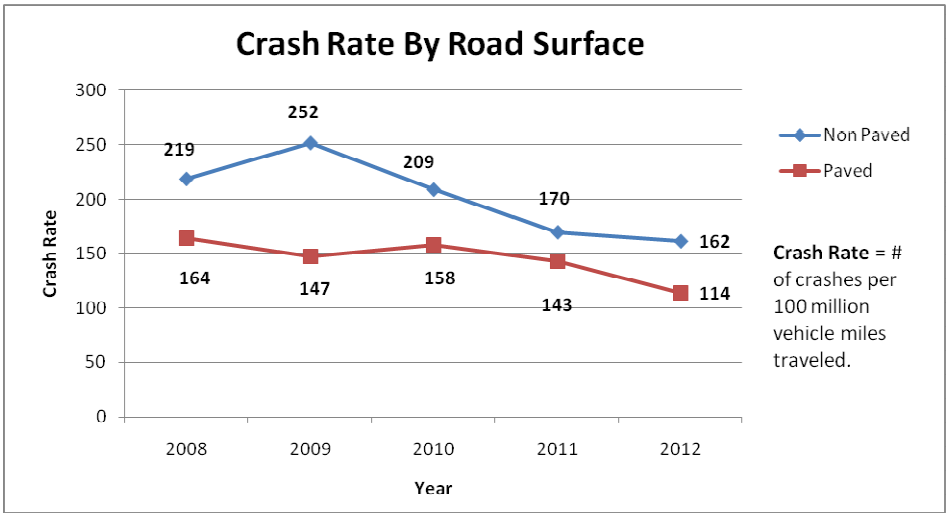
Figure 32 – Crash Rate by Road Functional Classification

Table 2 shows the comparative crash information for 2012 for the different functional classifications of the County's roadway system.

Table 2 – 2012 Statistics by Major Functional Classification

	Arterials	Collectors	Local Roads
2012 Number of Crashes *	103	228	12
Vehicle Miles Traveled (in millions)	124.2	160.1	5.9
Crash Rate /100 million miles	83	142	204

* *Crashes on mainline roadways only – no crashes on subdivision roads included*



Crash rates in all categories continue to decrease.

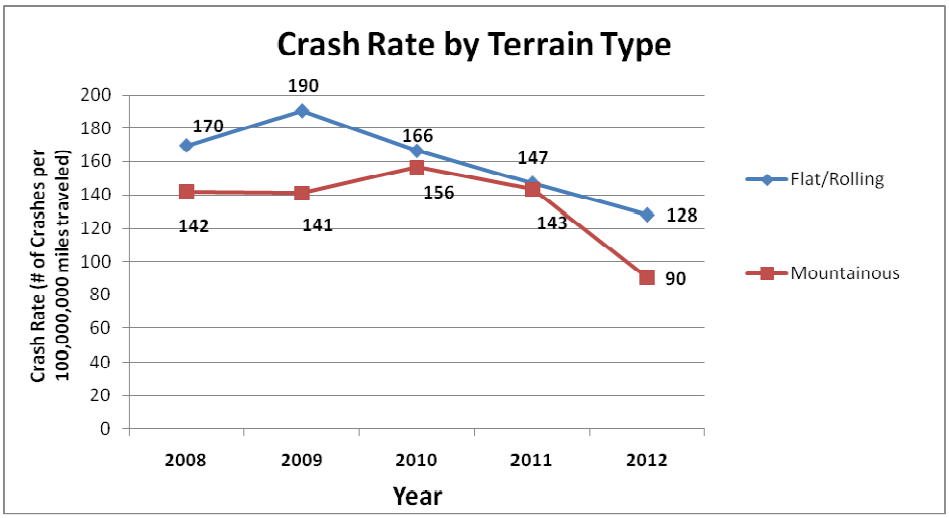
Down
25-30%
In the last five years.

Figure 33 – Crash Rate by Road Surface

Table 3 – 2012 Statistics by Pavement Type

	Paved	Non-Paved
2012 Numbers of Crashes *	298	45
Vehicle Miles Traveled (in millions)	262.3	27.8
Crash Rate /100 million miles	114	162
Percent of Severe Crashes	92%	8%

* *Crashes on mainline roadways only – no crashes on subdivision roads included*



Crash rates are consistently
higher
in flat / rolling terrain than in mountainous terrain.

Figure 34 – Crash Rate by Terrain Type

Comparing Larimer County Crash Rates to Others

It is difficult to compare similar crash information among entities and different types of roads as calculations are completed in a number of different ways. However, fatality crash rates can be used to gain a general understanding of how the County's road system compares to the state and national averages.

Transportation professionals often note that rural two lane roads are the most dangerous part of the nation's road system. Travel on local urban roads and the interstate system is, comparatively, safer than travel on rural county roads. The figure below shows the fatality rate comparison from 2011. Because there were no fatalities on the unincorporated roadway system in 2012, the fatality rate for 2012 is highly unusual and is 0.00.

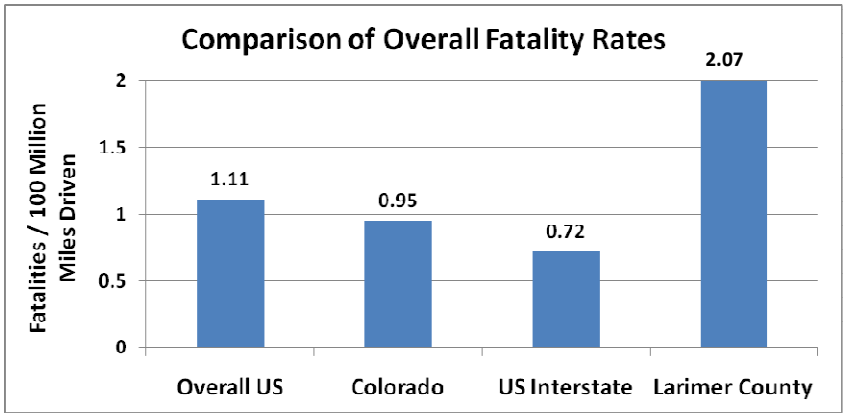


Figure 35 – Fatality Crash Rate Comparison - 2011

Note: *US value: National Highway Traffic Safety Administration (2010)*
Colorado value: National Highway Traffic Safety Administration (2010)
US Interstate value from: International Traffic Safety Data and Analysis Group (date unknown)
Larimer County value from: County records (2011)

Rural two-lane roads are typically the most dangerous part of the road system. Larimer County's fatality rate has historically been almost **2 Times** that of the national average. In 2012 however, the rate is 0.00

Cost Impacts of Crashes

In 2010 the National Safety Council estimated that the societal cost for each traffic death is $1,400,000, while an injury ranges between $12,600 and $70,200. A Property Damage Only (or very minor injury) crash has an average economic cost of $8,900. These costs represent loss of wages, productivity, medical expenses, administrative expenses, motor vehicle damage and employers' uninsured costs.

Using 2012 crash numbers with 2009 monetary values, the cost to society of traffic crashes in unincorporated Larimer County is more than $6 million dollars.

$ 6 Million
Annual cost of crashes on the Larimer County road system.

Traffic Safety Mitigation Efforts

The traffic safety program has just finished its fourth year. The approach of the program is to systematically identify, prioritize, mitigate and evaluate the performance of transportation safety investments with the goal of reducing the number and severity of crashes. As noted in the introduction, there are five 'Es' of traffic safety. As the program grows and matures, it is intended to address each area of importance.

2012 Traffic Safety Audits

Each year, traffic engineering staff evaluates the safety of the road system in several ways to identify a list of potential candidates for improvements:

- The crash database was mined for locations with high accident counts.
- All locations of fatalities and associated accident reports in the past five years were reviewed.
- A map of crash locations and severities for the past three years was developed with the GIS system (see sample in Figure 36). This map was visually reviewed for areas of concern.

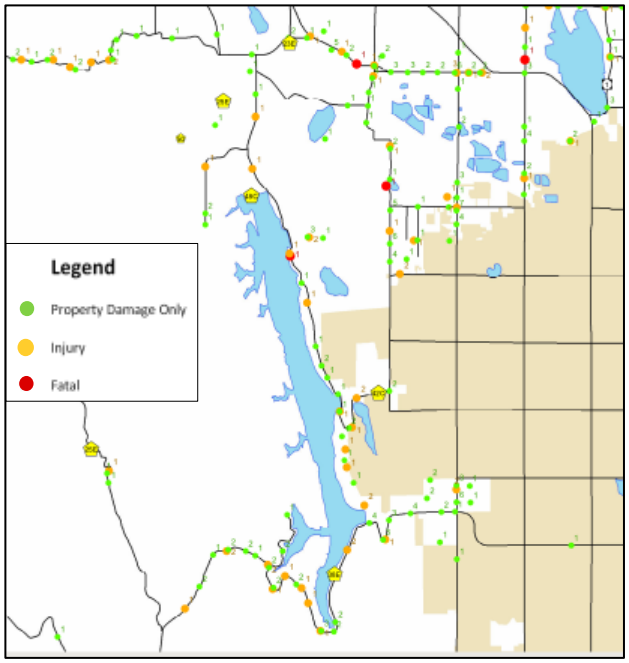


Figure 36 – Sample Crash Map for 2010-2012 Crashes

With an initial list of potential locations, specific crash data for those hot spots was compiled. Areas of single crashes on low volume roads were eliminated, and crash rates that adjust for traffic volumes were calculated. The crash rate in a specific location was then used to finalize the locations that would undergo the review process done by the Larimer County Engineering Department.

The locations selected for safety audits in 2012 are shown in Figure 37.

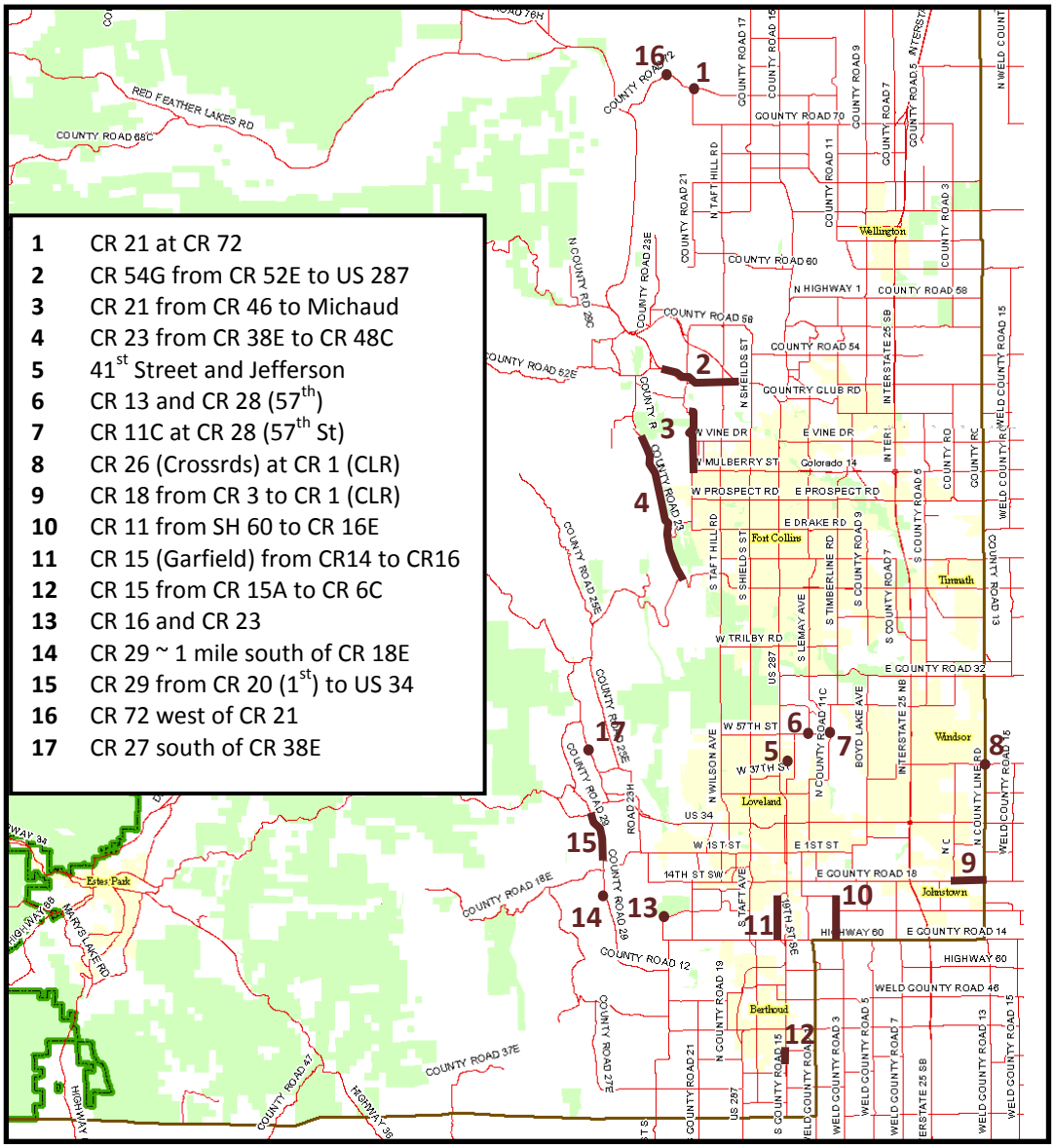


Figure 37 – 2012 Traffic Safety Program Safety Audit Locations

Engineering Improvements Identified

Through the safety audits, a number of engineering improvements were identified. Those are listed in Table 4. Not all locations resulted in an improvement plan if the crash data and field visits didn't identify a specific challenge or pattern of safety issues that could be mitigated with an engineering solution.

Table 4 – 2012 Safety Program Engineering Improvements Identified

No.	Location	Type of Work	Comments
1	CR 72 and CR 21	Improved wayfinding would be appropriate	Project on hold awaiting potential realignment project
4	CR 23 from CR 38E to CR 48C	Corridor signing upgrade	Improvements in process – including expansion of no parking zones
5	41st Street and Jefferson	Improved crosswalk	In response to citizen complaints – safe routes to school concerns
6	CR 13 and CR 28 (57th)	Striping and signing review	Thermoplastic striping and sign upgrades completed.
16	CR 72 west of CR 21	guardrail	Steep side slopes, high speeds and heavy truck traffic create hazard
17	CR 27 south of CR 38E	guardrail	Steep side slopes and narrow shoulder create hazard
	CR 5 and CR 36	Additional auxiliary lanes, shoulder widening	In conjunction with development review project
	Preformed thermoplastic work at various locations (turn lanes, intersection approaches and railroad crossings) throughout the County		Work Completed

New this year is the addition of colored rumble strips on approach to an intersection. Rumble strips have been used very effectively throughout the county, and it will be interesting to see if the addition of color enhances the safety benefit even more.

Education and Encouragement

The education component of the safety program will continue to develop over time. The temporary radar speed signs purchased in past years through the program have proven to be very popular. Therefore, in 2012 two additional signs were purchased that can be permanently installed. Site selection for those signs is underway.

Enforcement

Coordination with law enforcement is an area of interest for the engineering department. The annual crash map from the GIS system is shared with both the Larimer County Sheriff's office as well as Colorado State Patrol. Coordination meetings among engineering and law enforcement staff are well received.

Evaluation

Evaluation and monitoring is an important component of a safety program, and is discussed in detail in the following section on page 25.

Funding for Mitigation Efforts

Funding for mitigation efforts comes from a variety of sources. On a low-cost level, an allocation of $65,000 is made each year towards the program. Expenditures for that funding are shown in Table 5. (There was some roll-over funding from the previous year which allowed for expenses in excess of $65,000).

Table 5 – 2012 Low Cost Safety Program Expenditures

Type Of Work	Cost
Thermoplastic striping	$ 14,179
Signing materials	$ 1,000
Guardrail projects – CR 27 and CR 72	$ 45,876
Radar signs (2)	$ 9,560
Total	**$ 70,615**

Additional funding through the capital improvement program, federal grants, and partnerships with development are also being used to make safety improvements. Those are listed in Table 6.

Table 6 – Other Projects With Safety Components

Project	Funding Source
CR 30 / CR 11 and CR 30 / CR 11C	Federal Grant and local match
CR 19 extension	Capital Dollars
CR 5 and CR 36	Capital Dollars combined with development contribution

Monitoring and Evaluation

The monitoring and evaluation portion of the safety program is becoming more robust as post-improvement data becomes available and full years of data allow for a more thorough review.

Monitoring Low Cost Improvements

Tables 7 and 8 show a before and after comparison of crash frequency of various intersections and roadway corridors that were improved in the first three years (2009 - 2011) of the program using low cost funding only.

Table 7 –Intersections Improved Through Safety Program Using Low Cost Funding.

Intersection	Time Frame	Number Crashes Per Year PDO	INJ	FAT	Total Avg	Minor	Severe	Date Improved	Notes
Intersection of CR 52E (Rist Canyon) and CR 25E	Before Improvements	0.75	0.25	0	1	0.75	0.25	12/7/2009	Average 4 years before improvements and 3 years after
	After Improvements	0.33	0	0	0.33	0.33	0		
	Change	56%	100%	0%	67%	56%	100%		
	Type of Improvement	Additional warning signs and upgraded sign material							
Intersection of CR 17 (Shields) and CR 54	Before Improvements	1.5	0.25	0	1.75	1.5	0.25	11/1/2009	Average of 4 years before improvements and 3 years after
	After Improvements	0.67	0	0	0.67	0.67	0		
	Change	56%	100%	0%	62%	56%	100%		
	Type of Improvement	Upgrade sign materials, added pavement markings							
Intersection of CR 28 and CR 11C	Before Improvements	2.75	0.25	0	3	2.75	0.25	11/18/2009	Average of 4 years prior to improvements and 3 years after
	After Improvements	4	0	0	4	4	0		
	Change	-45%	100%	0%	-33%	-45%	100%		
	Type of Improvement	Additional pavement markings							
Intersection of CR 23E and CR 4	Before Improvements	1	0.4	0	1.4	1	0.4	2/5/2010	Average of 5 years before improvements and 3 years after
	After Improvements	0	0.33	0	0.33	0	0.33		
	Change	100%	17%	0%	76%	100%	17%		
	Type of Improvement	Added pavement markings, cross street warning signs, and speed limit signs							
Intersection of CR 11C and CR 46E	Before Improvements	3.5	0.25	0	3.75	3.5	0.25	11/19/2010	Average of 4 years before improvements and 3 years after
	After Improvements	0.67	0.33	0	1	0.67	0.33		
	Change	81%	-33%	0%	73%	81%	-33%		
	Type of Improvement	Relocated signs, upgraded material, added cross street warning signs, pavement markings, painted minor street centerline							
Intersection of CR 11 and CR 30	Before Improvements	1.75	1	0	2.75	1.75	1	11/10/2009	Average of 4 years before improvements and 3 years after
	After Improvements	5.33	0	0	5.33	5.33	0		
	Change	-205%	100%	0%	-94%	-205%	100%		
	Type of Improvement	Upgraded sign materals, added pavement markings. *(Now slated for capital project improvement)*							
Intersection of CR 5 and CR 48 (Vine)	Before Improvements	0.25	0.5	0	0.75	0.25	0.5	10/25/2009	Average of 4 years before improvements and 3 years after
	After Improvements	0	0	0	0	0	0		
	Change	100%	100%	0%	100%	100%	100%		
	Type of Improvement	Upgraded sign materials, added stop ahead pavement markings							

Intersection still a challenge. Additional improvements needed

Federally funded capital project in design (roundabout)

** 'severe' crash numbers refer to a combination of injury and fatal crashes*

Table 8 – Roadway Segments Improved Through Safety Program Using Low Cost Funding.

Segment	Time Frame	Number Crashes Per Year PDO	INJ	FAT	Total Avg	Minor	Severe	Date Improved	Notes
CR 50E (Near top of the hill)	Before Improvements	0	1	0	1	0	1	12/15/2009	Average 4 years before improvements and 3 years after
	After Improvements	0	0	0	0	0	0		
	Change	0%	100%	0%	100%	0%	100%		
	Type of Improvement	Added turn and chevron warning signs, ugraded sign material							
CR 38E (West of CR 19 (Taft))	Before Improvements	1.2	1.4	0.2	2.8	1.2	1.6	11/1/2010	Average of 5 years before improvements and 2 years after
	After Improvements	1	0	0	1	1	0		
	Change	17%	100%	100%	64%	17%	100%		
	Type of Improvement	Side slope reshaping, cleared vegetation to improve sight distance, upgraded sign material							
CR 16 (Between CR 21 and CR 19)	Before Improvements	2.75	0.75	0.25	3.75	2.75	1	6/1/2010	Average of 4 years before improvements and 3.5 years after
	After Improvements	0.86	0	0	0.86	0.86	0		
	Change	69%	100%	100%	77%	69%	100%		
	Type of Improvement	Relocated signs, upgraded sign material, added large arrows and chevrons							

** 'severe' crash numbers refer to a combination of injury and fatal crashes*

Of all the intersections and corridors that were improved through low cost efforts, the improvements made have resulted in a 10% decrease in minor crashes and an 87% decrease in severe crashes. This results in an average of more than seven (7) fewer severe crashes each year.

7
Annual reduction in severe crashes at locations improved through low cost solutions.

In areas where low cost improvements have not effected significant changes, the locations are being targeted for further improvements through federal funding, safety funding, and/or capital improvement projects.

Cost Savings Due to Low Cost Improvements

Monitoring of the locations where improvements have been made through low cost improvements shows an average annual reduction of more than nine crashes, seven of which would have been severe. Since the general trend in crashes is downward over the past five years, this number should be discounted to reflect the overall decrease in crashes between 2011 and 2012. Therefore, for the purposes of monitoring, an estimate of seven less crashes (six severe) is used to calculate societal cost savings.

Using the cost figures from the National Safety Council (see page 20) and utilizing an average societal cost for in injury crash of $41,400, this represents a savings of $250,000 per year to the community within Larimer County. Since the budget for the program is only $65,000 per year, the return on investment for the program is more than 380%.

$ 250,000
annual societal cost savings due to low cost safety improvements

Improvement Example - CR27

CR 27 between Stove Prairie (at CR 52E) and SH 14 has long been a roadway popular with summer motorcyclists. The sharp curve and vertical alignment for southbound vehicles was resulting in an average of two severe crashes per year, often a motorcycle crashing into guardrail. Staff initially attempted low cost signing and improvements in 2009. While the severe crashes were reduced, the total of number of crashes remained a concern (see Table 9a).

Table 9a – CR 27 Roadway Segment Monitoring – Initial Low Cost Improvements

		Number Crashes Per Year							
Segment	Time Frame	*PDO*	*INJ*	*FAT*	*Total Avg*	*Minor*	*Severe*	*Date Improved*	*Notes*
CR 27 (At turn north of CR 52E (Rist Canyon))	Before Improvements	0.25	2	0	2.25	0.25	2	10/20/2009	Average of 4 years before improvements and 2.5 years after
	After Improvements	1.2	0.4	0	1.6	1.2	0.4		
	Change	-380%	80%	0%	29%	-380%	80%		
	Type of Improvement	Relocated signs, upgraded sign material, added warning signs							

** 'severe' crash numbers refer to a combination of injury and fatal crashes*

At that point staff pursued a Hazard Elimination Grant through the state to re-align the roadway. The grant was awarded in 2011, and work completed last summer. Since the realignment was completed there have not been any reported crashes at the location (see Table 9b).

CR 27 before realignment

CR 27 after realignment

Table 9b – CR 27 Roadway Segment Monitoring – After Realignment

		Number Crashes Per Year							
Segment	Time Frame	*PDO*	*INJ*	*FAT*	*Total Avg*	*Minor*	*Severe*	*Date Improved*	*Notes*
CR 27 (At turn north of CR 52E (Rist Canyon))	Before Improvements	1.2	0.4	0	1.6	1.2	0.4	May, 2012	Average of 2.5 years before improvements and 0.5 years after
	After Improvements	0	0	0	0	0	0		
	Change	100%	100%	0%	100%	100%	100%		
	Type of Improvement	Hazard Elimination funded geometric roadway realignment							

** 'severe' crash numbers refer to a combination of injury and fatal crashes*

Monitoring Other Improvement Projects With Safety Components

There have been a number of other improvement projects with safety components completed in the past four years. This includes the construction of two modern roundabouts. The monitoring of all these improvements continues and is detailed below.

Table 10 – Intersection Projects with Safety Components

		Number Crashes Per Year							
Intersection	Time Frame	*PDO*	*INJ*	*FAT*	*Total Avg*	*Minor*	*Severe*	*Date Improved*	*Notes*
Intersection of CR 70 (Owl Canyon) and CR 15	Before Improvements	1	1.67	0	2.67	1	1.67	March, 2008	Average of 3 years before improvements and 5 years after
	After Improvements	0	0	0	0	0	0		
	Change	100%	100%	0%	100%	100%	100%		
	Type of Improvement	4-way stop with flashing beacons, added signing, rumble strips							
Intersection of CR 21C (Overland) and CR 50 (Michaud)	Before Improvements	0.67	0.33	0	1	0.67	0.33	6/9/2008	Average of 3 years before improvments and 4.5 years after
	After Improvements	0.22	0.22	0	0.44	0.22	0.22		
	Change	67%	33%	0%	56%	67%	33%		
	Type of Improvement	Added chevron warning signs, upgraded sign material							
Intersection of CR 19 (Taft) and CR 48 (Vine)	Before Improvements	3.5	1	0	4.5	3.5	1	8/1/2007	Average of 2 years before improvements and 5 years after
	After Improvements	3.8	0.2	0	4	3.8	0.2		
	Change	-9%	80%	0%	11%	-9%	80%		
	Type of Improvement	Replaced 4-way stop with modern roundabout. Signing updated in 2011							
Intersection of CR 9 (Boyd Lake) and CR 30	Before Improvements	4	1.33	0	5.33	4	1.33	8/1/2009	Average of 3 years before improvements and 5 years after
	After Improvements	0.8	0	0	0.8	0.8	0		
	Change	80%	100%	0%	85%	80%	100%		
	Type of Improvement	Replaced 2-way stop with modern roundabout							

** 'severe' crash numbers refer to a combination of injury and fatal crashes*

Table 11 – Roadway Segment Projects with Safety Components

		Number Crashes Per Year							
Segment	Time Frame	*PDO*	*INJ*	*FAT*	*Total Avg*	*Minor*	*Severe*	*Date Improved*	*Notes*
CR 19 (between CR 38E (Harmony) and CR 40 (Horsetooth))	Before Improvements	10	3	0	13	10	3	2006	Average of 1 year before improvements and 6 years after
	After Improvements	3.50	0.83	0	4	3.50	0.83		
	Change	65%	72%	0%	67%	65%	72%		
	Type of Improvement	Added 2-way center turn lane							
CR 19 (S-Curve between CR 60E and CR 64)	Before Improvements	0.33	0.67	0.33	1.33	0.33	1	May, 2008	Average of 3 year before improvements and 4.5 years after
	After Improvements	0.22	0.22	0	0.44	0.22	0.22		
	Change	33%	67%	100%	67%	33%	78%		
	Type of Improvement	Added warning signs and chevrons, upgraded sign material							
CR 13 Northwest of CR 30 - Sharp Turn near irrigation ditch	Before Improvements	1.56	1	0	2.22	1.56	1	11/15/2011	Average of 4.5 year before improvements and 1 years after
	After Improvements	2	0	0	2	2	0		
	Change	-29%	100%	0%	10%	-29%	100%		
	Type of Improvement	Upgrades to existing signing and additional signing							
CR 27 south of SH 14 at cattleguard on curve	Before Improvements	0.57	2.29	0	2.86	0.57	2.29	March, 2011	Average of 3.5 year before improvements and 2 years after
	After Improvements	0	0.5	0	0.5	0	0.5		
	Change	57%	78%	0%	83%	57%	78%		
	Type of Improvement	Upgrade signing and additonal warning to motorcycles							

** 'severe' crash numbers refer to a combination of injury and fatal crashes*

These intersection and roadway segment projects result in a total of 20 fewer crashes per year, including nine (9) severe crashes.

Recent Guardrail Projects

Through a Hazard Elimination Grant, two locations in rural areas of unincorporated Larimer County were improved through the installation of guardrail. The projects were detailed in the 2011 report. One location was in the Buckhorn area while the other location is on the road towards Red Feather Lakes. To date, the monitoring of the sections shows a positive impact on safety.

Table12 – Roadway Segment With Recent Addition of Guardrail Through Hazard Elimination Grant

		Number Crashes Per Year							
Segment	Time Frame	*PDO*	*INJ*	*FAT*	*Total Avg*	*Minor*	*Severe*	*Date Improved*	*Notes*
CR 27 south of CR 44H	Before Improvements	2.4	2	0	4.40	2.4	2	December, 2010	Average of 4 years before improvements and 2 years after
	After Improvements	0.50	0.00	0	0.5	0.50	0.00		
	Change	79%	100%	0%	89%	79%	100%		
	Type of Improvement	Guardrail							
CR 74E near Axtell Mtn Rd.	Before Improvements	1.25	0.25	0.5	2.00	1.25	0.75	December, 2010	Average of 4years before improvements and 2 years after
	After Improvements	0	0	0	0	0	0		
	Change	100%	100%	100%	100%	100%	100%		
	Type of Improvement	Guardrail							

** 'severe' crash numbers refer to a combination of injury and fatal crashes*

Roundabout Safety

Roundabout intersections are well documented as safety improvements over traditional 4-way stop, 2-way stop or signalized control methods. There are two roundabouts in unincorporated Larimer County, and the monitoring of their safety is included in the bottom of Table 10.

40% reduction in minor crashes and **90%** reduction in injury crashes at roundabouts in Larimer County.

The intersections were constructed to address both capacity / function issues as well as safety issues. From a function and capacity level of service, the intersections are now performing at a much higher level than before construction.

A safety review shows that on average, the intersections have seen a 40% reduction in minor crashes and a 90% reduction in injury crashes. This equates to almost three (3) fewer minor crashes each year, and two (2) fewer injury crashes each year. The societal savings is about $100,000 each year.

These types of safety enhancements are typical with the construction of modern roundabouts, and the County will continue to consider roundabouts as a potential intersection improvement type in coming years.

Monitoring Summary

A totaling of all the monitoring in the previous pages results in an average decrease of more than 35 crashes per year, including 19 severe crashes. Clearly a dedicated focus on roadway safety can have a positive impact on crashes and return a clear benefit to citizens. The societal savings from these projects is in excess of $975,000 per year.

Looking Forward

The first few years of the traffic safety program was a time to organize, establish and complete the initial implementation of basic improvements. As time has passed, the monitoring program has become more robust.

Safety components are now being included in various other projects, and the analysis of safety data has resulted in successful receipt of hazard elimination and other federal funds to complete more costly safety projects.

The results of the monitoring and review continue to show the value of the program, both in return on investment, as well as quantifiable reduction in number and severity of crashes.

As the program moves forward in coming years, it will continue to evolve and mature. Specifically, the early years of the program were reactionary, and the easily identified and most significant areas of concern based on crash history were addressed. While it is important to continue to analyze, monitor and address areas with crash history, an added component should be to also add a proactive component, where analysis of geometrics and implementation of known safety countermeasures occurs before a crash history develops. This approach is supported by the new Highway Safety Manual published by AASHTO, and it is intended that the Larimer County traffic safety program find a balance between reactionary and proactive solutions to traffic safety.

Specific emphasis for the coming year is to better understand the large percentage of single vehicle road departure crashes. We know that ½ of those crashes occur on a curve and its important to identify options for improvement in this area.

2013 Focus:

Single Vehicle Road Departure Crashes.

Roadway safety is a vital component of local government. The traffic safety program is expected have a continuing substantial and lasting positive impact on the citizens of Larimer County.