

TRB National Roundabout Conference  
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## SIGNALIZATION AND SAFETY



A Study of the Safety Effects of Signalizing Intersections  
on Colorado State Highways

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## ABSTRACT

### Safety and Signalization

#### Safety Effects of Signalizing Intersections on Colorado State Highways

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Presentation will discuss a systematic before and after accident history analysis for 112 intersections on the Colorado State Highway system which became signalized. Topics will include:

- Reasons for Signalization
- Site Selection
- Data Collection
- Description of the Analysis
- Safety Effects
  - Attributes Considered
  - Increase/Decreased/Unchanged Locations, by Attribute
  - Confidence Intervals
    - Attributes Improved
    - Attributes Made Worse
  - Consideration of Volume
    - Attributes Reduced Relative to Volume
    - Attributes Increased Relative to Volume

The presentation will discuss the general conclusions regarding the safety of signalization and recommendations for countermeasures and alternatives.

#### Biographical Information

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## 1. Introduction

Traffic Signals are ubiquitous. They've been in use seemingly forever and everybody knows why we have them: They improve safety and reduce delay by providing for the orderly flow of traffic. Or is it that they improve safety at the expense of some increased delay? Maybe they reduce delay . . . do they improve safety? This report investigates that question: "Does signalizing an intersection improve safety." Specifically this report considers the accident history at 112 intersections on Colorado State Highways before and after they became signalized.

## 2. Review of Extant Literature

The review of literature focused on studies of changes in crashes after installing signals and guidance concerning installing signals.

The ITE *Traffic Engineering Handbook*<sup>1</sup> has the following to say in the introduction of the Traffic Control Signals chapter,

The general public harbors many misunderstandings concerning the application of traffic signals and the likely results of their installation at a specific location. Traffic signals, which are seen by many people as the cure for every traffic problem, are believed to eliminate collisions and congestion, to reduce operation speeds, and to make every intersection a safe place for children to cross the street and for adults to drive. Politicians often see installation of a traffic signal as a means to keep the public happy, to generate votes, or to reward influential supporters.

Traffic Engineers know that a traffic signal is not a panacea and can actually contribute to collisions, congestion, delay, and speeding. Traffic Engineers must balance the potential benefits and drawbacks of signalization against often unreasonable public demands and emotions.

That's a good summary of the prevailing views.

The most recent study of change in crashes after installation of traffic signals discovered in the literature search was performed by Thomas and Smith of Iowa State University in 2001<sup>2</sup>. Among other things they reviewed 16 locations where signals were installed. They found that right-angle crashes decreased at all but one location. The fact that all 16 locations experienced "right angle" crashes in the 3 year before period suggests that the existence of right angle accidents might have been a criteria either for inclusion in the study or for installation of a signal. The study fails to address regression to mean. The study also found that rear end crashes increased on average, more than tripling from 7 to 23 at one location, and left turn crashes typically increased as well. They did find that the overall crash frequency decreased.

The *Manual on Uniform Traffic Control Devices*<sup>3</sup> (MUTCD) establishes criteria for the installation of traffic control signals, including 8 "warrants", at least one of which must be met before installation of a traffic signal. The MUTCD standard also cautions "The satisfaction of a traffic signal warrant or warrants shall not in itself require the installation of a traffic control signal."

Following are the titles and brief descriptions of the eight warrants.

#### Warrant 1, Eight-Hour Vehicular Volume

This warrant is applied when either there is a large volume of intersecting traffic (Condition A) or where the volume on a major street is so heavy that traffic on a minor intersecting street is unreasonably delayed or endangered when crossing or entering the major street (Condition B). There are tables of volumes for the major and minor approaches for each condition. If the volumes measured on the streets exceed the volumes in the tables for at least 8 individual hours (not necessarily 8 consecutive hours) for either condition then the warrant is met. In addition the warrant is met if the volumes measured exceed 80% of the volumes required to meet both Condition A and Condition B, even if neither

condition is met alone. Finally the traffic volumes required to meet the conditions of the warrant may be reduced to 70% of the original values if the major road speeds are over 40 MPH and/or the intersection is in a small town (less than 10,000 population).

#### Warrant 2. Four-Hour Vehicular Volume

This warrant is applied when a large volume of intersection traffic is the primary consideration. This warrant uses a graph with minor street hourly volume on one axis and major street hourly volume on the other. There are different curves plotted for different numbers of lanes on the major and minor streets. If the points representing four separate hours within a day fall above the appropriate curve the warrant is met. This warrant also has a second graph with the curves plotted at 70% of the volumes in the first graph. If the major road speed is over 40 MPH or the intersection is in a small town the second graph is used.

#### Warrant 3. Peak Hour

This warrant is applied at unusual locations where the minor street traffic experiences unacceptable delay crossing or entering the major street during at least one hour of a typical day. Examples of such locations would be adjacent to manufacturing plants or large office buildings which discharge or attract large volumes of traffic over a short period. There are two categories of criteria which may be met to satisfy this warrant. Category A requires that there be an average of at least 4 vehicles (5 vehicles for a 2-lane approach) waiting to enter or cross from one approach on the minor street for at least an hour, that the volume of traffic on that approach be at least 100 vehicles per hour (150 vph for 2-lane approach) and that the total number of vehicles using the intersection in the hour exceed 800 vehicles (650 vehicles for a "T" intersection). Category B uses a graph similar to the one described in Warrant 2 above, with higher volumes required for a point to be above the curve, but only one hour need to fall above the curve to meet the Category B requirement. Once again there is a second graph with lower volumes (70%) for speeds over 40 MPH or small towns. If either Category A or B criteria is met then the warrant is satisfied.

#### Warrant 4, Pedestrian Volume

This warrant is applied where the traffic volume on a major street causes unacceptable delay to pedestrians trying to cross the street. This warrant is met if there are at least 100 pedestrians per hour during at least four hours per day, or at least 190 pedestrians in any one hour of a typical day, and during the same time period (four hours or one hour) there are less than 60 gaps per hour in the traffic sufficient for the pedestrians to cross the street. If the average crossing speed of pedestrians at a location is less than 4 feet per second the pedestrian volume required to meet the warrant can be reduced by up to 50%. Pedestrian are expected to use existing signals if there are any within 300 feet along the major street.

#### Warrant 5, School Crossing

This warrant is applied when the primary reason for considering a signal is that school children cross the major street. The warrant is met when there is on average less than one adequate gap for students to cross the major street per minute during the time children are crossing, and there are at least 20 students crossing during an hour. Students are expected to use existing signals if there are any within 300 feet along the major street. Grade-separated (pedestrian overpass or tunnel) crossings and crossing guards are alternatives which must be considered before justifying a signal based on this warrant.

#### Warrant 6, Coordinated Signal System

Sometimes, to maintain "platooning" of vehicles so that progressive movement may be provided it is necessary to install a signal at a location where it would not otherwise be needed. This warrant is met where it can be shown that adjacent signals are too widely spaced to provide adequate platooning

### Warrant 7, Crash Experience

This warrant is applied where severity and frequency of crashes lead to consideration of a signal. For this warrant to be met all the following criteria must be satisfied: Alternatives must be tried with adequate enforcement and observation, and must fail to correct the crash frequency. Five or more broadside and/or pedestrian crashes must have occurred within a one year period. 80% of the volumes necessary to satisfy either Condition A or Condition B of Warrant 1 or 80% of the pedestrian volume necessary to satisfy Warrant 4 must be met.

### Warrant 8, Roadway Network

Sometimes it is desirable to install a traffic signal to encourage concentration and organization of traffic flow on a roadway network. This warrant is applied at the intersection of two major routes. A major route is one which is part of the principal roadway network for through traffic; or is a rural or suburban highway outside of, entering or traversing a city; or is designated as a major route on an official plan. Where two of these routes intersect the warrant is met if either the intersection has a total (existing or immediately projected) entering volume of 1,000 vehicles in the peak hour of a weekday and 5-year projected volumes that meet warrants 1, 2 or 3; or the intersection has a total (existing or immediately projected) entering volume of at least 1,000 vehicles per hour for at least 5 hours on Saturday or Sunday.

The MUTCD<sup>3</sup> also notes that, “A traffic signal should not be installed unless an engineering study indicates that installing a traffic signal will improve the overall safety and/or operation of the intersection.”, a not very subtle hint that signals do not always improve safety (or operations).

The ITE Traffic Control Devices Handbook<sup>4</sup>, issued by ITE to augment the MUTCD mentions the ability of signals to reduce certain types of crashes, especially right angle crashes, among the advantages of signals, but it also mentions, “Significant increase in the frequency of collisions (especially rear-end collisions).” can be a disadvantage

resulting from improper or unjustified signal control.

In a 1997 study, designed to establish accident reduction factors and expected benefit/cost ratios for a wide variety of safety project types, Voss, of the Kansas Department of Transportation Bureau of Traffic Engineering<sup>5</sup>, found by studying before and after crash data that new traffic signals could be expected to produce a 45% reduction in accidents.

Thus both the studies and the guidance suggest that signalization does improve safety by reducing crash frequency, but that some types of crashes may increase in frequency. The guidance uniformly suggests that safety be considered and that inappropriate or poorly executed signals can degrade safety.

### **3. Analysis Methodology**

The analysis made in this study was a simple comparison of the severity and types of accidents reported in three year periods before and after signalization at 112 locations on Colorado State Highways. The number of each crash type and severity at each location was obtained from the Colorado Department of Transportation (CDOT)'s extensive accident records database. The numbers from the 3 year before period were compared to those from the 3 year after period for each location and the change was calculated.

The data for all locations was aggregated and the total change was calculated for each crash type and severity in terms of numbers and percentages.

Counts were made for each crash type and severity showing the number of locations where the total number of crashes meeting a particular description (e.g. Injury or Broadside) increased, the number of locations where they decreased and the number of locations where they were unchanged.

Means were calculated for each crash type and severity for the before and after periods, and for the change. Standard deviation of the change was computed for each crash type and severity.

95% Confidence intervals were calculated for the mean change in number of crashes and the mean percent change of crashes of each type and severity.

Volume data for the State Highway at each location was also recorded for each period (Annualized Average Daily Traffic (AADT) from CDOT's data, for the central year of each three year period). The total percentage change in volume from the before period to the after period was calculated. Note that historic volume information for the crossroad was not available and whether the highway volume is a good surrogate is reasonably debatable. The highway volumes are the best available data so the assumption that the relative change in highway volume is representative of change in total entering volume is made.

Effect of change in volume is accounted for by comparing the percentage change confidence interval limits to the observed change in volume.

Regression to mean error (the tendency of a location where a high frequency of accidents is observed over a particular time period to display less accidents in a following period simply because the high frequency was above average, and not as a result of any particular action or lack thereof) is avoided (or at least minimized) by the selection process, which is explained in detail in the next chapter. Accident history did not contribute to the site selection process (except to the extent that some of the sites may have been signaled *because of* accident history).

## 4. Location Selection and Data Collection

A systematic approach was used in the attempt to include every location on the Colorado State Highway system where a signal was first installed after 1992 and for which 3 years of after accident history data are available in CDOT's database. The method consisted of reviewing the comprehensive video log of all Colorado Highways as recorded in 2000, to determine where traffic signals existed. Then the 1992 video log was reviewed to eliminate signals which existed at that time. The logs for the intervening years were consulted to determine when each particular new signal appeared, thus the "sample" is the entire population. The decision to proceed this way was made because CDOT project records fairly easily identified locations where "signal projects" had taken place, but identifying if the signal replaced an existing signal required looking through the plans for each location.

A video log of all Colorado Highways is created each year, primarily to document pavement condition. A limitation of this method of determining when a signal was installed is that it is only possible to determine that a signal was installed before a particular video was recorded and after the preceding video, but not when exactly. Of course since there are over 9,000 miles of State Highway in Colorado the log is recorded over a period of weeks or months. It is not necessarily done in the same order each year. For this reason it is possible (though unlikely) that for example one signal that first appears in the 1998 video log actually was installed after another that first appeared in the 1999 log. (The "1999" signal was installed in 1998 after its location was recorded, but before the 1998 signals location was recorded.) It is possible to say with certainty that any signal that doesn't appear in the 1998 log didn't exist on January 1, 1998, and any signal that does appear in the 1999 log did exist on January 1, 2000. Table 1 indicates in which year's video log each signal first appears.

**Table 1 - Locations**

<b>STUDIED SIGNAL LOCATIONS</b>				
<b>Site</b>	<b>Highw</b>	<b>MP</b>	<b>Video</b>	<b>Description</b>
<b>#</b>	<b>ay</b>		<b>Log</b>	
1	2B	11.10	1998	Hwy 2 (Hansen BV) at 64th Ave in Commerce City
2	2B	12.37	1998	Hwy 2 (Hansen BV) at 72nd Ave (and Railroad Crossing) in Commerce City
3	2C	15.61	1996	Hwy 2 at 96th Ave in Adams County
4	2C	16.96	1994	Hwy 2 at Hwy 44 (104th Ave) in Adams County
5	2D	0.58	1997	Hwy 2 (Sable Road) at Hwy 22 (124th Ave) in Brighton
6	6E	166.00	1995	Hwy 6 at I-70 Business Spur in Eagle County near Edwards
7	7A	0.34	1997	Hwy 7 (South Saint Vrain Ave) at Manford Dr. in Estes Park
8	7B	46.27	1998	Hwy 7 (Broadway) at Old Stage Road/Lee Hill Road in Boulder
9	7B	46.77	1998	Hwy 7 (Broadway) at Violet Avenue in Boulder
10	7B	48.64	1998	Hwy 7 (Broadway) at Cedar Avenue in Boulder
11	7B	48.97	1998	Hwy 7 (Broadway) at Portland Place/Bluff Street in Boulder
12	7B	50.53	1996	Hwy 7 (Canyon Boulevard) at 26th Avenue
13	7C	54.92	1998	Hwy 7 (Arapahoe Avenue) at Cherryvale Road in Boulder
14	7D	62.13	1998	Hwy 7 (Baseline Road) at Carr Avenue in Lafayette
15	7D	62.38	1998	Hwy 7 (Baseline Road) at 111th Street/Christopher Street in Lafayette
16	7D	63.22	1998	Hwy 7 (Baseline Road) at 119th Street in Lafayette
17	7D	77.59	1998	Hwy 7 (Bridge Street) at 8th Avenue in Brighton
18	9C	87.17	1998	Hwy 9 (Main Street) at ? near Breckenridge
19	9C	87.80	1998	Hwy 9 (Main Street) at Valley Brook Road/Bikeway near Breckenridge
20	9C	90.25	1998	Hwy 9 at Tiger Road in Summit County (near Frisco)
21	9C	92.89	1996	Hwy 9 at Swan Mountain Road/Bikeway in Summit County near Frisco
22	9C	95.61	1996	Hwy 9 (Summit Boulevard) at ? in Frisco
23	9C	96.70	1998	Hwy 9 (Summit Boulevard) at Ten Mile Road in Frisco
24	9C	97.01	1996	Hwy 9 (Summit Boulevard) at County Road 7 (Dillon Dam) in Frisco
25	13B	89.90	1994	Hwy 13 (Yampa Street) at 6th Street in Craig
26	13B	90.23	1994	Hwy 13 (Yampa Street) at 9th Street in Craig
27	14C	134.92	1994	Hwy 14 (Riverside) at Linden Street in Fort Collins
28	14C	135.13	1994	Hwy 14 (Riverside) at Mountain Ave in Fort Collins
29	14C	137.30	1999	Hwy 14 (Mulberry) at Timberline Road in Fort Collins
30	14C	137.62	1995	Hwy 14 (Mulberry) at Summit View Drive in Fort Collins
31	14C	235.68	1995	Hwy 14 (Main Street) at 13th Avenue in Sterling
32	14C	236.27	1995	Hwy 14 (Main Street) at 6th Avenue in Sterling
33	14C	236.55	1995	Hwy 14 (Main Street) at 3rd Avenue in Sterling
34	15A	0.00	1994	Hwy 15 (Broadway) at Hwy 160 and Hwy 285 in Monte Vista
35	15A	0.09	1996	Hwy 15 (Broadway) at 2nd Ave in Monte Vista
36	22A	0.00	1998	Hwy 22 (124th Avenue) at Hwy 2 (Sable Road)
37	24A	297.55	1995	Hwy 24 at Serpentine Road (Cave of the Winds Road) in Manitou Springs
38	24G	310.95	1995	Hwy 24 Bypass (Platte Avenue) at Amelia Street in Colorado Springs
39	30A	11.09	1998	Hwy 30 (6th Avenue) at Laredo Street in Arapahoe County
40	30A	12.59	1998	Hwy 30 (6th Avenue) at Tower Road in Arapahoe County
41	34A	92.60	1995	Hwy 34 (Eisenhower Boulevard) at Redwood Drive in Loveland
42	34A	92.76	1995	Hwy 34 (Eisenhower Boulevard) at Madison Avenue in Loveland
43	34A	93.81	1998	Hwy 34 (Eisenhower Boulevard) at Boyd Lake Road in Loveland
44	34B	164.46	1997	Hwy 34 (Platte Avenue) at Barlow Road in Fort Morgan
45	34D	5.61	1994	Hwy 34 Business Route (10th Street) at 59th Avenue in Greeley
46	34D	7.22	1997	Hwy 34 Business Route (10th Street) at 39th Avenue in Greeley
47	36B	35.26	1998	Hwy 36 (28th Street) at Glenwood Drive in Boulder
48	40A	133.28	1997	Hwy 40 (Lincoln Avenue) at Trafalgar Drive in Steamboat Springs
49	40A	135.12	1997	Hwy 40 (Lincoln Avenue) at Walton Creek Road in Steamboat Springs
50	40C	288.91	1993	Hwy 40 (Colfax Avenue) at Denver West Boulevard in Denver
51	40C	290.51	1993	Hwy 40 (Colfax Avenue) at Quail Street in Denver
52	40C	290.76	1993	Hwy 40 (Colfax Avenue) at Oak Street in Denver
53	40C	291.20	1993	Hwy 40 (Colfax Avenue) at Miller Street in Denver
54	42A	0.96	1993	Hwy 42 (95th Street) at Baseline Road in Louisville
55	42A	1.96	1993	Hwy 42 (95th Street) at South Boulder Road in Louisville

56	42A	2.62	1993	Hwy 42 (95th Street) at Pine Street in Louisville
57	42A	4.86	1993	Hwy 42 at Hwy 287 in Boulder County near Louisville
58	44A	3.74	1998	Hwy 44 (104th Avenue) at McKay Road in Adams County near Thornton
59	44A	4.30	1994	Hwy 44 (104th Avenue) at Riverdale Road in Thornton
60	45A	4.27	1998	Hwy 45 (Pueblo Boulevard) at St. Clair Avenue/Plainview Street in Pueblo
61	50A	220.38	1998	Hwy 50 at County Road 111 in Chaffee County near Poncha Springs
62	50A	285.63	1998	Hwy 50 at County Road 67 in Fremont County near Canon City
63	50A	607.34	1998	Hwy 50 at McCulloch Boulevard in Pueblo County near Pueblo
64	52A	20.32	1995	Hwy 52 (1st Street) at McKinley Avenue in Fort Lupton
65	52B	86.64	1997	Hwy 52 (Main Street) at 7th Avenue in Fort Morgan
66	53A	0.65	1998	Hwy 53 (Broadway) at 62nd Avenue in Adams County near Denver
67	67B	15.07	1998	Hwy 67 at Hwy 50 in Fremont County near Florence
68	68A	0.27	1998	Hwy 68 (Harmony Road) at John F. Kennedy Parkway in Fort Collins
69	68A	0.63	1994	Hwy 68 (Harmony Road) at Boardwalk Drive in Fort Collins
70	68A	1.00	1994	Hwy 68 (Harmony Road) at LeMay Avenue in Fort Collins
71	68A	1.99	1994	Hwy 68 (Harmony Road) at Timberline Road in Fort Collins
72	68A	3.02	1994	Hwy 68 (Harmony Road) at Ziegler Road in Fort Collins
73	72A	3.47	1994	Hwy 72 (64th Avenue) at Gardenia in Arvada
74	74A	1.89	1996	Hwy 74 (Evergreen Parkway) at Soda Creek Road in Jefferson County near Bergen Park
75	74A	4.49	1993	Hwy 74 (Evergreen Parkway) at Lewis Ridge Road in Jefferson County near Bergen Park
76	74A	5.34	1996	Hwy 74 (Evergreen Parkway) at Stage Coach Boulevard in Jefferson County near Dedisse Park
77	82A	6.66	1995	Hwy 82 at County Road 114/County Road 154 in Garfield County near Glenwood Springs
78	82A	15.54	1997	Hwy 82 at (Garfield) County Road 100/Missouri Heights Road in Catherine
79	82A	19.07	1995	Hwy 82 at (Eagle) County Road 13 in El Jebel
80	82A	20.95	1995	Hwy 82 at Hwy 82 Business Route (Willits Lane/Two Rivers Road) in Basalt
81	82A	35.28	1997	Hwy 82 at Brush Creek Road in Pitkin County near Aspen
82	83A	56.86	1998	Hwy 83 at Stroh Road in Douglas County near Parker
83	83A	61.86	1998	Hwy 83 (Parker Road) at E-470 EB Ramps in Douglas County near Parker
84	83A	65.86	1998	Hwy 83 (Parker Road) at Caley Avenue in Arapahoe County near Aurora
85	83A	68.29	1995	Hwy 83 (Parker Road) at Temple Drive in Aurora
86	83A	69.39	1995	Hwy 83 (Parker Road) at Lehigh Ave in Aurora
87	83A	71.45	1998	Hwy 83 (Parker Road) at Lansing Way/Bethany Drive in Aurora
88	85B	185.12	1998	Hwy 85 at Meadows Parkway/Founders Parkway in Douglas County near Castle Rock
89	85B	187.25	1998	Hwy 85 at Happy Canyon Drive in Douglas County near Castle Rock
90	85B	200.55	1998	Hwy 85 (Sante Fe Drive) at Countyline Road in Littleton
91	86A	1.80	1993	Hwy 86 at Ridge Road in Castle Rock
92	86A	15.22	1998	Hwy 86 at Elizabeth Street in Elizabeth
93	88B	18.49	1998	Hwy 88 (Arapahoe Road) at Lima Street in Arapahoe County
94	90B	88.98	1998	Hwy 90 (Main Street) at Marine Drive in Montrose
95	119A	6.72	1996	Hwy 119 (Clear Creek Street) at Main Street in Black Hawk
96	119A	6.97	1998	Hwy 119 (Clear Creek Street) at Richman Street in Black Hawk
97	121A	23.03	1998	Hwy 121 (Wadsworth) at Independence Drive in Westminster
98	141B	160.95	1997	Hwy 141 (32 Road) at Grand Avenue in Grand Junction
99	145A	0.00	1998	Hwy 145 (State Street) at Hwy 160 (Main Street/Mancos Road) in Cortez
100	160A	35.19	1998	Hwy 160 at (Montezuma) County Road 24/County Road G (McElmo Junction) in Cortez
101	160A	40.30	1998	Hwy 160 (Mancos Road/Main Street) at Hwy 145 (State Street) in Cortez
102	285D	224.94	1998	Hwy 285 at County Road 72./County Road 43 in Park County near Pine Junction
103	287A	76.45	1994	Hwy 287 (Main Street) at Stuart Avenue in Lamar
104	287C	292.67	1997	Hwy 287 (Federal Boulevard) at 103rd Ave in Federal Heights
105	287C	301.83	1993	Hwy 287 at Hwy 42 in Boulder County near Louisville
106	287C	306.87	1997	Hwy 287 at Isabelle Road in Boulder County near Lafayette
107	287C	309.39	1997	Hwy 287 at Lookout Road in Boulder County near Lafayette
108	287C	311.42	1997	Hwy 287 at Niwot Road in Boulder County near Longmont
109	287C	336.27	1998	Hwy 287 (Garfield Avenue) at 45th Street in Loveland
110	287C	339.13	1998	Hwy 287 (College Avenue) at Carpenter Road in Fort Collins

111	287C	342.53	1994	Hwy 287 (College Avenue) at Troutman Parkway in Fort Collins
112	287C	342.81	1994	Hwy 287 (College Avenue) at Boardwalk Drive in Fort Collins

The before period for each location is three calendar years, from 4 years before the video log appearance to 2 years before, (e.g. location 1 appeared in 1998 → before period is January 1, 1994 - December 31, 1996). The after period is three calendar years beginning the year after the video log appearance (e.g. location 1 after period is January 1, 1999 - December 31, 2001). In this manner it is assured that the entire before period is prior to the signalization, the entire after period is with the signal operational and the two periods are of the same duration.

Data accrued along with all other Colorado reported accident data in CDOT’s Accident Records Database.

## 5. Analysis

The Appendix contains the entire Excel spreadsheet used in the analysis. The 65 crash types, severities and attributes listed in Table 2 were considered.

**Table 2 - Attributes**

Property Damage Only Crashes	Severity
Injury Crashes	
Fatal Crashes	
Persons Injured	
Persons Killed	
Single Vehicle Crashes	Number of Vehicles Involved
Two Vehicle Crashes	
Three or More Vehicle Crashes	
On Roadway	Location

Run Off the Road	
Overturning	Type of Crash
School Age Pedestrian	
Other Pedestrian	
Broadside	
Head On	
Rear End	
Sideswipe (Same Direction)	
Sideswipe (Opposite Direction)	
Approach Turn (Left Turning)	
Overtaking Turn	
Parked Vehicle	
Bicycle	
Wild Animal	
Fixed Object	
Daylight	
Dawn or Dusk	
Dark, Lighted	
Dark, Not Lighted	
Good Weather	Weather
Rain	
Snow, Sleet or Hail	
Fog	
Wind	
Dry	Road Condition
Wet	
Muddy	
Snowy	

Icy	Type of Vehicle at Fault
Slushy	
Passenger Car or Van	
Passenger Car or Van with Trailer	
Pickup Truck or Utility Van	
Pickup Truck or Utility Van with Trailer	
Self Contained Truck Under 10,000 Lbs.	
Truck Over 10,000 Lbs. or Bus over 15 Passengers	
Motor Home	
Motorcycle	
Bicycle	
Hit and Run (Vehicle Unknown)	
None Apparent	
Asleep	
Illness	
Inexperience	
Fatigue	
Preoccupied	
Unfamiliar with Area	
Emotionally Upset	
Evading Law Enforcement	
Physical Disability	
Unimpaired	Driver Impairment
Alcohol	
Prescription Drugs or Medication	
Illegal Drugs	
Alcohol and Drugs	
<b>Total Crashes</b>	

There are other attributes recorded in CDOT’s database (e.g. Domestic Animal) but if no crashes involving a particular attribute occurred in the study then that attribute has been excluded from this report.

Once the data was assembled and the columns totaled it was quickly discovered that while the prevailing literature finds crashes decrease after signalization, with a few exceptions, here in Colorado quite the opposite appeared to hold true. In terms of pure total numbers only 14 of 65 attributes showed any decrease.

**Table 3 - Attributes Reduced in Total Occurrence After Signalization**

Fatal Crashes
Persons Killed
School Age Pedestrian
Broadside
Overtaking Turn
Bicycle
Dark, Not Lighted
Motor Home
Motorcycle
Emotionally Upset
Evading Law Enforcement
Physical Disability
Prescription Drugs or Medication
Alcohol and Drugs

Only two attributes (Bicycle as At Fault Vehicle and Driver under Influence of Illegal Drugs) had an unchanged number of occurrences. The remaining 49 attributes experienced an increased total number of occurrences after signalization.

Next consideration was given to determining whether more locations had experienced an increase or decrease of crashes with each attribute. In the spreadsheet the cells for the after period are color coded as follows: Red if there were more crashes with that attribute at that location in the after period. Green if there were less. Yellow if the number was unchanged. The red (increased), yellow (unchanged) and green (decreased) cells were tallied for each attribute. Then the number of locations where accidents decrease was subtracted from the number of locations where the accidents increased to determine if more locations experienced an increase or a decrease for each attribute. The list of attributes for which more locations experienced a decrease is the same as the list in Table 3, except that Wild Animal crashes replace Bicycle crashes. Locations experiencing increases and decreases were also tallied separately for Urban and Rural locations, in hopes that enlightening differences would appear, but that did not prove to be the case. Several pie-charts were created showing the increased/decreased/unchanged proportions for various attributes and they are also included in the appendix. These are helpful in providing at a glance a general feeling for the effectiveness of signalization as related to a particular accident type.

Figure 1 shows that the locations where the total number of broadside crashes decreased is larger than the number of locations where they increased, but that the number of broadsides was unchanged at a similar proportion of the intersections. This reflects the fact that a significant portion of the locations didn't experience any broadsides in either period.

**Figure 1** Change in Broadside Accidents by Location

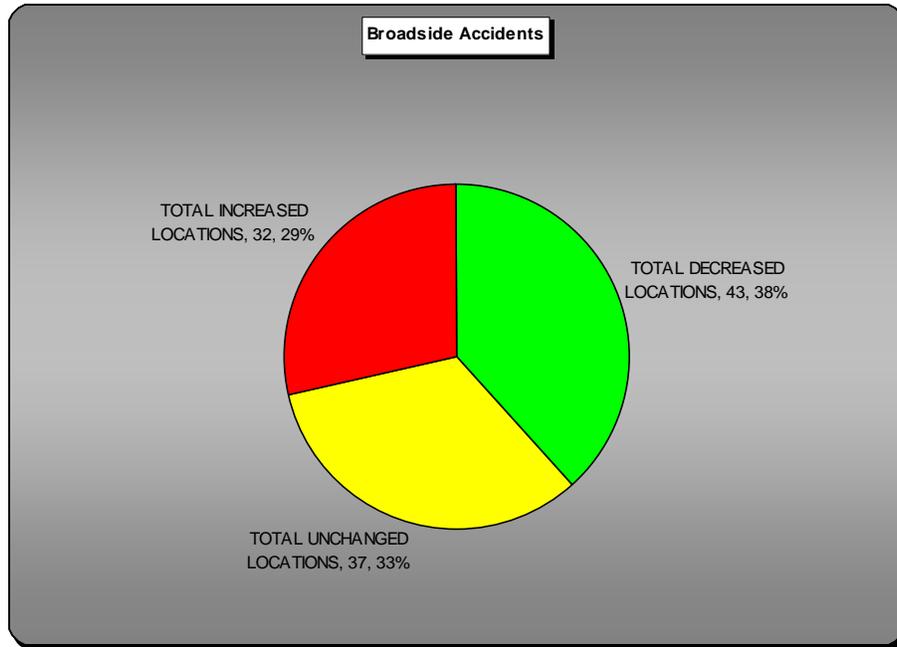
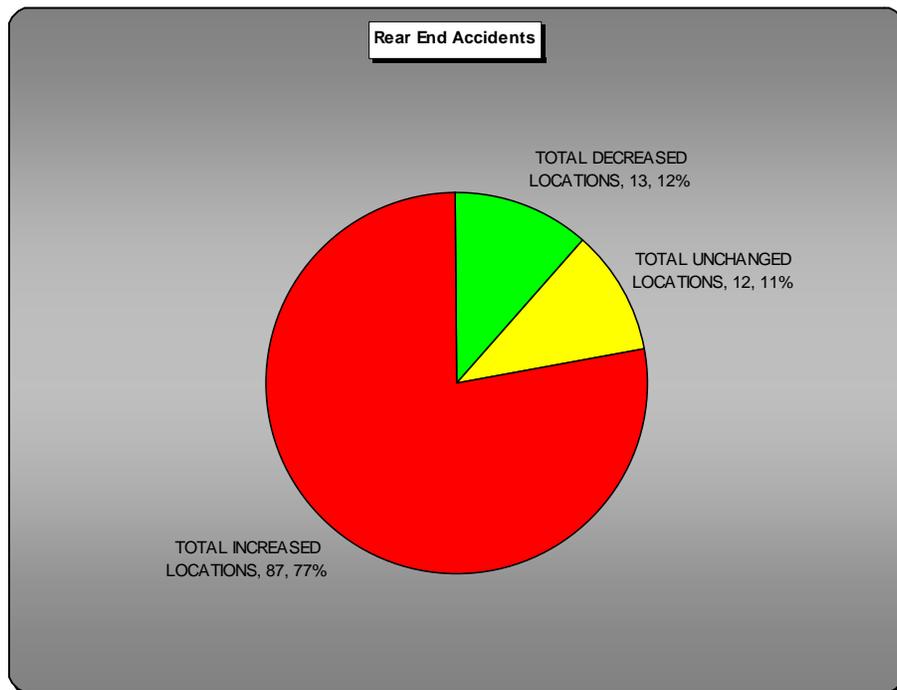


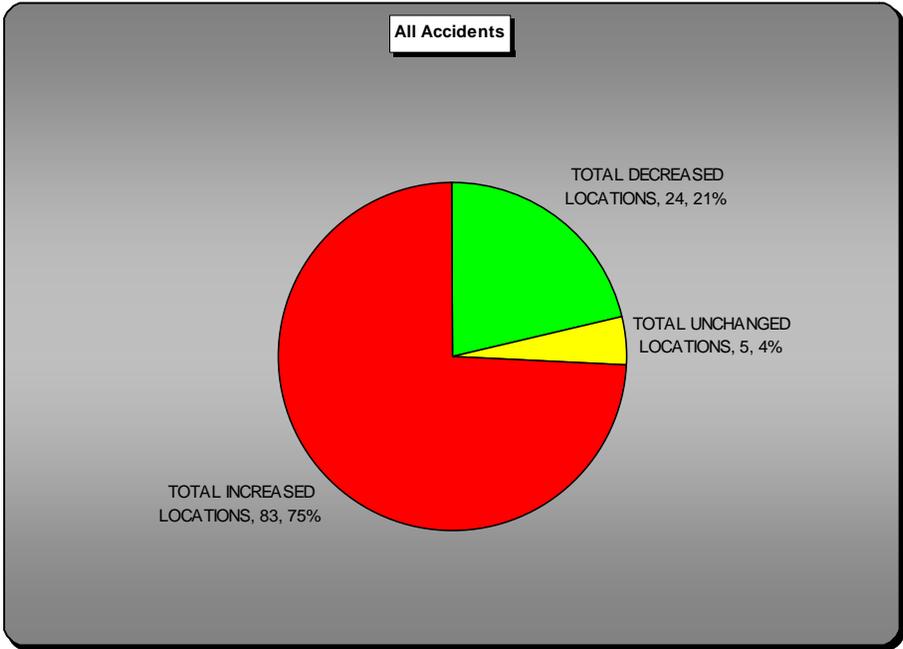
Figure 2 shows that rear end crashes were much more likely to increase than to decrease or remain unchanged.

**Figure 2** Change in Rear End Crashes by Location



Finally, Figure 3 shows that the total number of reported crashes increased at three quarters of the locations.

**Figure 3** Change in Overall Crashes by Location



At this point the analysis begins to focus on consideration of whether these changes are meaningful, or if they might be random. This process begins with determining the mean number of crashes with a particular attribute per location in the before period, the after period and the mean change. These were determined simply by dividing the totals determined earlier by 112 (the number of locations). Next the standard deviation of the population (since the sample is believed to be the entire population) was determined for the change at all locations for each attribute, using the following formula:

$$\sigma = \sqrt{\frac{\sum (x - \bar{x})^2}{n}}$$

Where sigma = standard deviation, x = population mean and n = the number of locations in the population. Once standard deviation is known a confidence interval can be

constructed. If zero is outside the 95% confidence interval for change in a given attribute then the hypothesis that there is no significant change from the before to the after period is rejected. The confidence limits are stated both in terms of change in the number of crashes from before to after and as a percentage increase (decrease shown as negative) from the before period.

**Table 4 - Attributes which Decreased (95% Confidence) After Signalization**

<b>Attribute</b>	<b>Upper Confidence Limit (minimum decrease)</b>	<b>UCL %</b>
Broadside	-0.07 crashes per location	-2.1%
Overtaking Turn	-0.02 crashes per location	-8.5%
Prescription Drugs or Medication	-0.11 crashes per location	-26.3%

**Table 5 Attributes which Increased (95% Confidence) After Signalization**

<b>Attribute</b>	<b>Lower Confidence Limit (minimum increase)</b>	<b>LCL %</b>
Property Damage Only	3.22 crashes per location	54.5%
Injury Crashes	1.38 crashes per location	41.3%
Persons Injured	1.59 persons per location	27.3%
Single Vehicle	0.04 crashes per location	6.1%
Two Vehicles	3.88 crashes per location	49.9%
Three or More Vehicles	0.52 crashes per location	66.3%
On Roadway	4.56 crashes per location	51.8%
Run Off the Road	0.05 crashes per location	8.8%
Rear End	3.39 crashes per location	125.7%
Sideswipe (Same Direction)	0.03 crashes per location	7.7%
Approach Turn (Left Turning)	1.62 crashes per location	101.1%
Fixed Object	0.04 crashes per location	8.4%
Daylight	3.33 crashes per location	45.8%
Dawn or Dusk	0.07 crashes per location	20.4%

Dark, Lighted	0.79 crashes per location	61.6%
Good Weather	3.67 crashes per location	44.9%
Rain	0.15 crashes per location	38.8%
Snow, Sleet or Hail	0.14 crashes per location	23.3%
Dry Road	3.37 crashes per location	43.9%
Wet Road	0.30 crashes per location	34.4%
Muddy Road	0.02 crashes per location	Undefined, zero before
Passenger Car or Van at Fault	2.67 crashes per location	39.7%
Pickup or Utility Van at Fault	1.03 crashes per location	63.1%
Heavy Truck or Bus at Fault	0.11 crashes per location	51.3%
Hit and Run (Unknown Vehicle at Fault)	0.15 crashes per location	68.4%
No Apparent Human Factor	2.13 crashes per location	33.5%
Driver Inexperience	0.28 crashes per location	60.4%
Driver Preoccupied	0.59 crashes per location	47.7%
Driver Apparently Unimpaired	3.74 crashes per location	48.8%
Driver Impaired by Alcohol	0.01 crashes per location	2.5%
Total Crashes	4.85 crashes per location	52.1%

To this point the effect of increasing traffic over time has been neglected. Traffic volume data (AADT) was included in the CDOT data base and the volumes from the middle year of each before and after period was recorder for this report. The totals for all locations were aggregated and the mean change, in terms of numbers and as a percentage of the before volume was determined. The growth in the highway traffic volumes from the middle of the before period to the middle of the after period averaged 19.30%.

Lacking information for crossroad volumes, the assumption that the frequency of accidents can be expected to be directly proportional to traffic volume (The underlying premiss of all “accident rate” calculations) is presumed to be valid and is used for this report. This leads to the observation that any attribute whose Upper Confidence Limit expressed as

a percentage is less than 19.3% can be said to have increased at a less than expected rate, or to have decreased in frequency relative to traffic volume.

Similarly, only those attributes whose Lower Confidence Limit expressed as a percentage is greater than 19.3% can be said to have experienced an increase in frequency greater than that predicted by increasing traffic volume alone.

Table 6 lists the attributes which fall into each of the above categories.

**Table 6 - Attributes Effected by Signalization (Considering Traffic Growth)**

Attributes Significantly Reduced Relative to Highway AADT After Signalization	Attributes Significantly Increased Beyond Highway AADT Growth After Signalization
School Aged Pedestrian	Property Damage Only Crashes
Broadside	Injury Crashes
Overtaking Turn	Persons Injured
Motor Home at Fault	2 Vehicles
Driver Impaired by Prescription Drugs or Medication	3 or More Vehicles
	On Roadway
	Rear End
	Approach Turn (Left Turning)
	Daylight
	Dawn or Dusk
	Dark, Lighted
	Good Weather
	Rain
	Snow, Sleet or Hail
	Dry Road
	Wet Road
	Muddy Road
	Passenger Car or Van at Fault
	Pickup or Utility Van at Fault
	Heavy Truck or Bus at Fault
	Hit and Run (Unknown) at Fault
	No Apparent Human Factor
	Driver Inexperience
	Driver Preoccupied
	Driver Apparently Unimpaired
	Total Number of Crashes

## 6. Conclusions and Recommendations

It bears repeating that, according to the MUTCD<sup>3</sup> **“The satisfaction of a traffic signal warrant or warrants shall not in itself require the installation of a traffic control signal.”**

All of the signals in the study satisfied a warrant or warrants, yet the total number of accidents increased at 75% of the locations, and the total number of accidents at all locations increased by 74.6%.

It is apparent that overall, installing a traffic signal is not likely to improve safety. There are a few accident types which are generally improved such as Broadside and Overtaking Turn, but the total number of crashes and Injury crashes are apparently increased, even when additional traffic volume is accounted for. In the study there was a significant increase in 26 of the 65 investigated attributes, while only 5 attributes clearly decreased relative to traffic volume. What is certain is that the signals were installed and the frequencies of occurrence crashes with the various attributes changed. While it doesn't necessarily follow that installing the signals caused the significant changes, absent any other compelling arguments, this does seem to be the most likely explanation. This is mostly bad news.

There is a kernel of good news however; the two accident types which account for the largest increases in total numbers are Rear End and Approach Turn. These two types account for more than 2/3 of the accidents in the after period. These two types together increased by a total of 765 crashes, equaling more than 98% of the increase in the total number of crashes (778). The good news is, very effective and relatively inexpensive (relative to the cost of a traffic signal) countermeasures exist for both types of crashes at signalized intersections. In CDOT's experience approach turn accidents can be reduced 90% or more by implementation of protected-only left turns, which could be added to a

planned signal for only a few hundred dollars. CDOT is currently in the midst of a research project, in conjunction with the University of Colorado at Denver and the Insurance Institute for Highway Safety, investigating the effectiveness of advanced detection with dilemma prevention for reducing rear end accidents. Such detection adds about \$10,000 to the cost of a signal, but preliminary results indicate that the accident reduction may approach 50%. Good signal design, including using 12" LED faces, mast arms in lieu of span wires, back plates to improve observability, and signal heads centered over lanes, can also be expected to reduce rear end crash frequency. In locations where advanced detection is inappropriate, due to close spacing of signals, good signal coordination to produce progression can reduce rear ends.

If approach turn accidents in the after period were reduced 90% and rear ends in the after period were reduced 50% there would have been 801 less total accidents in the after period . . .for a net change of -23 accidents compared to the before period. That's pure speculation, and assumes that none of the locations incorporated any countermeasures to those crash types, but it serves to illustrate the point that the tools are available fix the observed tendency of safety to decline when an intersection on a Colorado State Highway is signalized.

MUTCD<sup>3</sup> recommends that an engineering study should show that safety and/or operation will be improved by the proposed signal. Traffic Engineers must weigh any hoped for operational benefit against the knowledge that in most cases the signal will not improve safety. Traffic Engineers should also explicitly consider all of the methods available to mitigate the undesirable safety effects of proposed signals, including consideration of the possibility that a modern roundabout may be more appropriate. Furthermore, Traffic Engineers should monitor the safety performance of newly signalized intersections and address any problems identified.

## REFERENCES

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2. Thomas, G.V. and D.J. Smith, *Effectiveness of Roadway Safety Improvements*, Center for Transportation Research and Education, Iowa State University, (March 2001)
3. *Manual on Uniform Traffic Control Devices (MUTCD), 2003 Edition*, Federal Highway Administration, United States Department of Transportation, Washington, DC, (2003)
4. *Traffic Control Devices Handbook*, J. Pline, Editor, Institute of Transportation Engineers, Washington, DC, (2001)
5. Voss, L.G., *Accident Reduction Factors*, Kansas Department of Transportation Bureau of Traffic Engineering, Topeka, KS, (May 1997)

## APPENDIX

## STUDIED SIGNAL LOCATIONS

Site #	Highway	MP	Video Log	Description
1	2B	11.10	1998	Hwy 2 (Hansen BV) at 64th Ave in Commerce City
2	2B	12.37	1998	Hwy 2 (Hansen BV) at 72nd Ave (and Railroad Crossing) in Commerce City
3	2C	15.61	1996	Hwy 2 at 96th Ave in Adams County
4	2C	16.96	1994	Hwy 2 at Hwy 44 (104th Ave) in Adams County
5	2D	0.58	1997	Hwy 2 (Sable Road) at Hwy 22 (124th Ave) in Brighton
6	6E	166.00	1995	Hwy 6 at I-70 Business Spur in Eagle County near Edwards
7	7A	0.34	1997	Hwy 7 (South Saint Vrain Ave) at Manford Dr. in Estes Park
8	7B	46.27	1998	Hwy 7 (Broadway) at Old Stage Road/Lee Hill Road in Boulder
9	7B	46.77	1998	Hwy 7 (Broadway) at Violet Avenue in Boulder
10	7B	48.64	1998	Hwy 7 (Broadway) at Cedar Avenue in Boulder
11	7B	48.97	1998	Hwy 7 (Broadway) at Portland Place/Bluff Street in Boulder
12	7B	50.53	1996	Hwy 7 (Canyon Boulevard) at 26th Avenue
13	7C	54.92	1998	Hwy 7 (Arapahoe Avenue) at Cherryvale Road in Boulder
14	7D	62.13	1998	Hwy 7 (Baseline Road) at Carr Avenue in Lafayette
15	7D	62.38	1998	Hwy 7 (Baseline Road) at 111th Street/Christopher Street in Lafayette
16	7D	63.22	1998	Hwy 7 (Baseline Road) at 119th Street in Lafayette
17	7D	77.59	1998	Hwy 7 (Bridge Street) at 8th Avenue in Brighton
18	9C	87.17	1998	Hwy 9 (Main Street) at ? near Breckenridge
19	9C	87.80	1998	Hwy 9 (Main Street) at Valley Brook Road/Bikeway near Breckenridge
20	9C	90.25	1998	Hwy 9 at Tiger Road in Summit County (near Frisco)
21	9C	92.89	1996	Hwy 9 at Swan Mountain Road/Bikeway in Summit County near Frisco
22	9C	95.61	1996	Hwy 9 (Summit Boulevard) at ? in Frisco
23	9C	96.70	1998	Hwy 9 (Summit Boulevard) at Ten Mile Road in Frisco
24	9C	97.01	1996	Hwy 9 (Summit Boulevard) at County Road 7 (Dillon Dam) in Frisco
25	13B	89.90	1994	Hwy 13 (Yampa Street) at 6th Street in Craig
26	13B	90.23	1994	Hwy 13 (Yampa Street) at 9th Street in Craig
27	14C	134.92	1994	Hwy 14 (Riverside) at Linden Street in Fort Collins
28	14C	135.13	1994	Hwy 14 (Riverside) at Mountain Ave in Fort Collins
29	14C	137.30	1999	Hwy 14 (Mulberry) at Timberline Road in Fort Collins
30	14C	137.62	1995	Hwy 14 (Mulberry) at Summit View Drive in Fort Collins
31	14C	235.68	1995	Hwy 14 (Main Street) at 13th Avenue in Sterling
32	14C	236.27	1995	Hwy 14 (Main Street) at 6th Avenue in Sterling
33	14C	236.55	1995	Hwy 14 (Main Street) at 3rd Avenue in Sterling
34	15A	0.00	1994	Hwy 15 (Broadway) at Hwy 160 and Hwy 285 in Monte Vista
35	15A	0.09	1996	Hwy 15 (Broadway) at 2nd Ave in Monte Vista
36	22A	0.00	1998	Hwy 22 (124th Avenue) at Hwy 2 (Sable Road)
37	24A	297.55	1995	Hwy 24 at Serpentine Road (Cave of the Winds Road) in Manitou Springs
38	24G	310.95	1995	Hwy 24 Bypass (Platte Avenue) at Amelia Street in Colorado Springs
39	30A	11.09	1998	Hwy 30 (6th Avenue) at Laredo Street in Arapahoe County
40	30A	12.59	1998	Hwy 30 (6th Avenue) at Tower Road in Arapahoe County
41	34A	92.60	1995	Hwy 34 (Eisenhower Boulevard) at Redwood Drive in Loveland
42	34A	92.76	1995	Hwy 34 (Eisenhower Boulevard) at Madison Avenue in Loveland
43	34A	93.81	1998	Hwy 34 (Eisenhower Boulevard) at Boyd Lake Road in Loveland
44	34B	164.46	1997	Hwy 34 (Platte Avenue) at Barlow Road in Fort Morgan
45	34D	5.61	1994	Hwy 34 Business Route (10th Street) at 59th Avenue in Greeley
46	34D	7.22	1997	Hwy 34 Business Route (10th Street) at 39th Avenue in Greeley
47	36B	35.26	1998	Hwy 36 (28th Steet) at Glenwood Drive in Boulder
48	40A	133.28	1997	Hwy 40 (Lincoln Avenue) at Trafalger Drive in Steamboat Springs
49	40A	135.12	1997	Hwy 40 (Lincoln Avenue) at Walton Creek Road in Steamboat Springs
50	40C	288.91	1993	Hwy 40 (Colfax Avenue) at Denver West Boulevard in Denver
51	40C	290.51	1993	Hwy 40 (Colfax Avenue) at Quail Street in Denver
52	40C	290.76	1993	Hwy 40 (Colfax Avenue) at Oak Street in Denver
53	40C	291.20	1993	Hwy 40 (Colfax Avenue) at Miller Street in Denver
54	42A	0.96	1993	Hwy 42 (95th Street) at Baseline Road in Louisville
55	42A	1.96	1993	Hwy 42 (95th Street) at South Boulder Road in Louisville
56	42A	2.62	1993	Hwy 42 (95th Street) at Pine Street in Louisville
57	42A	4.86	1993	Hwy 42 at Hwy 287 in Boulder County near Louisville
58	44A	3.74	1998	Hwy 44 (104th Avenue) at McKay Road in Adams County near Thornton
59	44A	4.30	1994	Hwy 44 (104th Avenue) at Riverdale Road in Thornton
60	45A	4.27	1998	Hwy 45 (Pueblo Boulevard) at St. Clair Avenue/Plainview Street in Pueblo
61	50A	220.38	1998	Hwy 50 at County Road 111 in Chaffee County near Poncha Springs
62	50A	285.63	1998	Hwy 50 at County Road 67 in Fremont County near Canon City
63	50A	607.34	1998	Hwy 50 at McCulloch Boulevard in Pueblo County near Pueblo
64	52A	20.32	1995	Hwy 52 (1st Street) at McKinley Avenue in Fort Lupton
65	52B	86.64	1997	Hwy 52 (Main Street) at 7th Avenue in Fort Morgan
66	53A	0.65	1998	Hwy 53 (Broadway) at 62nd Avenue in Adams County near Denver
67	67B	15.07	1998	Hwy 67 at Hwy 50 in Fremont County near Florence

68	68A	0.27	1998	Hwy 68 (Harmony Road) at John F. Kennedy Parkway in Fort Collins
69	68A	0.63	1994	Hwy 68 (Harmony Road) at Boardwalk Drive in Fort Collins
70	68A	1.00	1994	Hwy 68 (Harmony Road) at LeMay Avenue in Fort Collins
71	68A	1.99	1994	Hwy 68 (Harmony Road) at Timberline Road in Fort Collins
72	68A	3.02	1994	Hwy 68 (Harmony Road) at Ziegler Road in Fort Collins
73	72A	3.47	1994	Hwy 72 (64th Avenue) at Gardenia in Arvada
74	74A	1.89	1996	Hwy 74 (Evergreen Parkway) at Soda Creek Road in Jefferson County near Bergen Park
75	74A	4.49	1993	Hwy 74 (Evergreen Parkway) at Lewis Ridge Road in Jefferson County near Bergen Park
76	74A	5.34	1996	Hwy 74 (Evergreen Parkway) at Stage Coach Boulevard in Jefferson County near Dedisse Park
77	82A	6.66	1995	Hwy 82 at County Road 114/County Road 154 in Garfield County near Glenwood Springs
78	82A	15.54	1997	Hwy 82 at (Garfield) County Road 100/Missouri Heights Road in Cathrine
79	82A	19.07	1995	Hwy 82 at (Eagle) County Road 13 in El Jebel
80	82A	20.95	1995	Hwy 82 at Hwy 82 Business Route (Willits Lane/Two Rivers Road) in Basalt
81	82A	35.28	1997	Hwy 82 at Brush Creek Road in Pitkin County near Aspen
82	83A	56.86	1998	Hwy 83 at Stroh Road in Douglas County near Parker
83	83A	61.86	1998	Hwy 83 (Parker Road) at E-470 EB Ramps in Douglas County near Parker
84	83A	65.86	1998	Hwy 83 (Parker Road) at Caley Avenue in Arapahoe County near Aurora
85	83A	68.29	1995	Hwy 83 (Parker Road) at Temple Drive in Aurora
86	83A	69.39	1995	Hwy 83 (Parker Road) at Lehigh Ave in Aurora
87	83A	71.45	1998	Hwy 83 (Parker Road) at Lansing Way/Bethany Drive in Aurora
88	85B	185.12	1998	Hwy 85 at Meadows Parkway/Founders Parkway in Douglas County near Castle Rock
89	85B	187.25	1998	Hwy 85 at Happy Canyon Drive in Douglas County near Castle Rock
90	85B	200.55	1998	Hwy 85 (Sante Fe Drive) at Countyline Road in Littleton
91	86A	1.80	1993	Hwy 86 at Ridge Road in Castle Rock
92	86A	15.22	1998	Hwy 86 at Elizabeth Street in Elizabeth
93	88B	18.49	1998	Hwy 88 (Arapahoe Road) at Lima Street in Arapahoe County
94	90B	88.98	1998	Hwy 90 (Main Street) at Marine Drive in Montrose
95	119A	6.72	1996	Hwy 119 (Clear Creek Street) at Main Street in Black Hawk
96	119A	6.97	1998	Hwy 119 (Clear Creek Street) at Richman Street in Black Hawk
97	121A	23.03	1998	Hwy 121 (Wadsworth) at Independence Drive in Westminster
98	141B	160.95	1997	Hwy 141 (32 Road) at Grand Avenue in Grand Junction
99	145A	0.00	1998	Hwy 145 (State Street) at Hwy 160 (Main Street/Mancos Road)) in Cortez
100	160A	35.19	1998	Hwy 160 at (Montezuma) County Road 24/County Road G (McElmo Junction) in Cortez
101	160A	40.30	1998	Hwy 160 (Mancos Road/Main Street) at Hwy 145 (State Street) in Cortez
102	285D	224.94	1998	Hwy 285 at County Road 72./County Road 43 in Park County near Pine Junction
103	287A	76.45	1994	Hwy 287 (Main Street) at Stuart Avenue in Lamar
104	287C	292.67	1997	Hwy 287 (Federal Boulevard) at 103rd Ave in Federal Heights
105	287C	301.83	1993	Hwy 287 at Hwy 42 in Boulder County near Louisville
106	287C	306.87	1997	Hwy 287 at Isabelle Road in Boulder County near Lafayette
107	287C	309.39	1997	Hwy 287 at Lookout Road in Boulder County near Lafayette
108	287C	311.42	1997	Hwy 287 at Niwot Road in Boulder County near Longmont
109	287C	336.27	1998	Hwy 287 (Garfield Avenue) at 45th Street in Loveland
110	287C	339.13	1998	Hwy 287 (College Avenue) at Carpenter Road in Fort Collins
111	287C	342.53	1994	Hwy 287 (College Avenue) at Troutman Parkway in Fort Collins
112	287C	342.81	1994	Hwy 287 (College Avenue) at Boardwalk Drive in Fort Collins



Site #	Notes	ROAD CONDITION									AT FAULT VEHICLE TYPE											HUMAN FACTORS							DRIVER IMPAIRMENT				Total Crashes	CDOT Region	aadt				
		Wind	Dry	Wet	Muddy	Snowy	Icy	Slushy	Passenger Car or Van	Car or Van w/Trailer	Pickup/Utility Van	Pickup/Utility Van w/Trailer	Truck, U/J, 000#	Heavy Truck or Bus (15+pass)	Motorhome	Motorcycle	Bicycle	Hlt and Run (Unknow)	None Apparent	Asleep	Illness	Distracted by Passenger	Inexperience	Fatigue	Preoccupied	Unfamiliar w/Area	Emotional Upset	Evasion Law Enforcement	Physical Disability	Unimpaired	Alcohol	RX Drugs/Meds				Illegal Drugs	Alcohol and Drugs		
1	Before Signalization - Urban	0	15	0	0	0	0	0	12	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	6	9384		
1	After Signalization - Urban	0	11	1	0	0	0	0	8	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	6	10568		
1	Change (After-Before)	0	-4	1	0	0	0	0	-4	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-2	0	1184		
2	Before Signalization - Urban	0	27	2	0	1	0	0	15	0	3	1	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	30	6	8925	
2	After Signalization - Urban	1	23	3	0	0	0	0	18	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	27	6	11578	
2	Change (After-Before)	1	-4	1	0	-1	0	0	3	0	0	-1	-1	-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	-3	2653		
3	Before Signalization - Urban	0	15	1	0	1	0	0	6	1	5	0	1	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	6	8169	
3	After Signalization - Urban	0	6	1	0	0	0	0	3	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	6	6673	
3	Change (After-Before)	0	-9	0	0	-1	0	0	-3	-1	-1	0	-1	-5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-11	0	-1496		
4	Before Signalization - Urban	0	14	0	0	0	0	0	13	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	6	5030		
4	After Signalization - Urban	0	4	0	0	0	0	0	3	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	6	5411	
4	Change (After-Before)	0	-10	0	0	0	0	0	-10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-9	0	381		
5	Before Signalization - Urban	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	6	6985	
5	After Signalization - Urban	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	6	7262	
5	Change (After-Before)	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	277	
6	Before Signalization - Rural	0	14	2	0	1	1	0	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	3	9631		
6	After Signalization - Rural	0	21	3	0	3	2	0	22	0	9	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	38	3	11261	
6	Change (After-Before)	0	7	1	0	2	1	0	4	0	9	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	16	1630		
7	Before Signalization - Rural	0	6	1	0	0	0	0	3	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	4	9750		
7	After Signalization - Rural	1	6	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	4	10485	
7	Change (After-Before)	1	0	-1	0	0	0	0	2	0	-2	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	735	
8	Before Signalization - Urban	0	11	3	0	0	0	0	12	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	4	8152		
8	After Signalization - Urban	0	5	3	0	0	0	0	5	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	4	9175	
8	Change (After-Before)	0	-6	0	0	0	0	0	-7	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-5	0	1023		
9	Before Signalization - Urban	0	3	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	4	10342	
9	After Signalization - Urban	0	2	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	4	12319	
9	Change (After-Before)	0	-1	0	0	0	0	0	-3	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1977	
10	Before Signalization - Urban	0	2	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	4	24519		
10	After Signalization - Urban	0	3	1	0	0	0	0	3	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	4	26957	
10	Change (After-Before)	0	1	1	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2438		
11	Before Signalization - Urban	0	5	0	0	1	1	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	4	22703	
11	After Signalization - Urban	0	7	0	0	1	0	0	7	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	4	27933	
11	Change (After-Before)	0	2	0	0	1	-1	-1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	5230	
12	Before Signalization - Urban	0	30	1	0	0	2	0	27	0	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	33	4	22000	
12	After Signalization - Urban	0	16	4	0	0	0	0	17	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	4	28392	
12	Change (After-Before)	0	-14	3	0	0	-2	0	-10	0	1	0	0	-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-13	0	6392	
13	Before Signalization - Urban	0	7	5	0	0	0	0	10	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	4	21104	
13	After Signalization - Urban	0	8	0	0	0	0	0	6	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	8	4	23004
13	Change (After-Before)	0	1	-5	0	0	0	0	-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-4	0	1900	
14	Before Signalization - Urban	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	15000	
14	After Signalization - Urban	0	2	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	4	13740	
14	Change (After-Before)	0	2	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	-1260	
15	Before Signalization - Urban	0	12	4	0	1	0	0	12	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	2	15000	
15	After Signalization - Urban	0	20	2	0	0	0	0	15	0	4	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17	4	13059	
15	Change (After-Before)	0	8	-2	0	1	0	0	3	0	2	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	-1941	
16	Before Signalization - Urban	1	19	3	0	1	0	0	19	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	23	6	9951	
16	After Signalization - Urban	0	20	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	21	6	14559
16	Change (After-Before)	-1	1	-3	0	-1	0	0	-12	0	4	0	2	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-2	0	4608	
17	Before Signalization - Urban	0	9	1	0	0	0	0	8	0	2																												





site #	notes	Highway section	from milepoint	to milepoint	from date	to date	SEVERITY			# of VEHICLES			CRASH TYPE														LIGHT		WEATHER										
							Property Damage Only	Injury Crash	Fatal Crash	Injured	Killed	1 car	2 cars	3+ cars	On Road	Off Road	OverTurn	School Age Pedestrian	Other Pedestrian	Broadside	Head On	Rear End	Sidewipe (Same Direction)	Sidewipe (Opposite Dir)	Approach Turn (Left Turn)	Overtaking Turn	Parked Vehicle	Bicycle	Wild Animal	Fixed Object	Daylight	Dawn or Dusk	Dark, Lighted	Dark, Unlighted	Good Weather	Rain	Snow, Sleet or Hail	Fog	
54	After Signalization - Urban	42	A	0.94	0.98	1/1/1994	12/31/1996	13	6	1	9	1	3	15	2	18	2	0	0	0	0	0	0	0	0	0	0	0	2	13	1	4	2	17	2	1	0	0	
54	Change (After-Before)	42	A	0.94	0.98			4	4	0	5	0	3	2	6	2	0	0	0	-1	1	2	0	0	0	0	0	2	6	-1	4	-1	6	2	0	0	0		
55	Before Signalization - Urban	42	A	1.94	1.98	1/1/1989	12/31/1991	19	9	0	12	0	2	26	0	27	1	0	0	6	0	13	2	0	0	0	0	1	19	4	5	0	26	1	1	0	0		
55	After Signalization - Urban	42	A	1.94	1.98	1/1/1994	12/31/1996	36	13	0	22	0	7	38	4	46	3	0	0	0	0	19	6	0	0	0	0	1	4	36	4	9	0	38	5	4	1	0	
55	Change (After-Before)	42	A	1.94	1.98			17	4	0	10	0	5	12	4	19	2	0	0	-2	0	6	4	0	0	0	0	3	17	0	4	0	12	4	3	1	0		
56	Before Signalization - Urban	42	A	2.6	2.64	1/1/1989	12/31/1991	4	2	0	4	0	1	5	0	6	0	1	0	0	1	0	2	1	0	0	0	0	6	0	0	0	6	0	0	0	0	0	
56	After Signalization - Urban	42	A	2.6	2.64	1/1/1994	12/31/1996	13	4	0	4	0	3	12	2	15	2	0	0	0	1	3	0	0	0	0	0	2	12	1	2	1	11	1	4	0	0		
56	Change (After-Before)	42	A	2.6	2.64			9	2	0	0	0	2	7	2	9	2	-1	0	1	2	0	0	0	0	0	0	2	6	1	2	1	5	1	4	0	0		
57	Before Signalization - Urban	42	A	4.86	4.9	1/1/1989	12/31/1991	13	4	0	4	0	0	17	0	17	0	0	0	0	0	14	1	0	0	0	0	0	14	1	2	0	14	1	1	0	0	0	
57	After Signalization - Urban	42	A	4.86	4.9	1/1/1994	12/31/1996	26	11	0	15	0	4	31	2	35	2	0	0	0	1	3	0	0	0	0	0	3	30	0	4	3	36	0	1	0	0	0	
57	Change (After-Before)	42	A	4.86	4.9			13	7	0	11	0	4	14	2	18	2	0	0	0	1	3	0	0	0	0	0	3	16	-1	2	3	22	-1	0	0	0		
58	Before Signalization - Urban	44	A	3.72	3.76	1/1/1994	12/31/1996	3	5	0	7	0	1	4	3	7	1	0	0	0	2	0	5	0	0	0	0	0	1	7	0	1	0	7	0	1	0	0	
58	After Signalization - Urban	44	A	3.72	3.76	1/1/1999	12/31/2001	10	4	0	6	0	0	12	2	14	0	0	0	0	0	2	0	0	0	0	0	0	0	11	0	2	0	12	0	0	0	0	
58	Change (After-Before)	44	A	3.72	3.76			7	-1	0	-1	0	-1	8	-1	7	-1	0	0	0	0	0	0	0	0	0	0	-1	4	0	1	0	5	0	-1	0	0		
59	Before Signalization - Urban	44	A	4.28	4.32	1/1/1990	12/31/1992	6	6	0	11	0	1	11	0	11	1	0	0	0	0	2	2	0	0	0	0	1	9	0	3	0	10	1	1	0	0	0	
59	After Signalization - Urban	44	A	4.28	4.32	1/1/1999	12/31/1997	13	5	0	9	0	1	17	0	17	1	0	0	0	0	6	0	4	0	0	0	0	1	13	0	4	1	16	0	2	0	0	
59	Change (After-Before)	44	A	4.28	4.32			7	-1	0	-2	0	0	6	0	6	0	0	0	0	0	0	-2	0	0	0	0	0	4	0	1	1	6	-1	1	0	0		
60	Before Signalization - Urban	45	A	4.25	4.29	1/1/1994	12/31/1996	12	9	0	14	0	3	16	2	18	3	1	0	0	10	0	3	1	0	0	0	3	14	0	6	0	16	2	0	0	0	0	
60	After Signalization - Urban	45	A	4.25	4.29	1/1/1999	12/31/2001	13	11	0	18	0	0	20	4	24	0	0	0	0	0	2	0	15	2	0	0	0	0	21	1	1	0	22	0	1	0	0	
60	Change (After-Before)	45	A	4.25	4.29			1	2	0	4	0	-3	4	2	6	-3	-1	0	0	-8	0	12	1	0	0	0	-3	7	1	-5	0	6	-2	1	0	0		
61	Before Signalization - Rural	50	A	220.36	220.4	1/1/1994	12/31/1996	3	1	0	4	0	1	3	0	4	0	0	0	0	0	0	1	0	0	0	0	1	1	0	0	2	4	0	0	0	0	0	
61	After Signalization - Rural	50	A	220.36	220.4	1/1/1999	12/31/2001	0	2	0	6	0	0	2	0	2	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	
61	Change (After-Before)	50	A	220.36	220.4			-3	1	0	2	0	-1	-1	0	-2	0	0	0	0	0	0	-1	0	0	0	-1	0	-1	0	-1	-2	-3	0	0	0	0	0	
62	Before Signalization - Rural	50	A	285.61	285.65	1/1/1994	12/31/1996	6	6	2	14	2	1	12	1	13	1	0	0	0	11	0	1	0	0	0	0	1	12	1	0	1	14	0	0	0	0	0	
62	After Signalization - Rural	50	A	285.61	285.65	1/1/1999	12/31/2001	5	6	0	9	0	0	11	0	10	0	0	0	0	0	4	0	3	0	0	0	0	0	7	0	3	0	10	0	0	0	0	
62	Change (After-Before)	50	A	285.61	285.65			-1	0	-2	-5	-2	-1	-1	-3	-1	0	0	0	0	-7	0	2	0	0	0	0	-1	-5	-1	3	-1	-4	0	0	0	0		
63	Before Signalization - Rural	50	A	307.32	307.36	1/1/1994	12/31/1996	6	12	0	28	0	0	15	3	18	0	0	0	0	9	0	3	0	0	0	0	0	16	1	0	1	15	1	1	1	1	1	
63	After Signalization - Rural	50	A	307.32	307.36	1/1/1999	12/31/2001	13	10	2	18	2	1	17	7	24	1	1	0	0	0	1	0	15	2	0	0	0	6	0	0	0	0	22	0	0	2	0	0
63	Change (After-Before)	50	A	307.32	307.36			7	-2	2	-10	2	1	2	4	6	1	1	0	0	-8	0	12	2	0	0	0	0	6	0	2	-1	7	-1	1	0	0		
64	Before Signalization - Urban	52	A	20.3	20.34	1/1/1991	12/31/1993	4	0	0	0	0	4	0	4	0	0	0	0	0	0	0	2	1	0	0	0	0	0	3	0	1	0	4	0	0	0	0	
64	After Signalization - Urban	52	A	20.3	20.34	1/1/1996	12/31/1998	1	2	0	4	0	0	2	1	3	0	0	0	0	0	1	0	2	0	0	0	0	0	2	0	1	0	3	0	0	0	0	
64	Change (After-Before)	52	A	20.3	20.34			-3	2	0	4	0	0	-2	1	-1	0	0	0	0	1	0	0	-1	0	0	0	-1	0	0	0	-1	0	0	0	0	0		
65	Before Signalization - Urban	52	B	86.62	86.66	1/1/1993	12/31/1995	4	6	0	6	0	1	8	1	10	0	0	0	0	5	0	2	1	0	0	0	0	6	0	4	0	8	0	1	0	0	0	
65	After Signalization - Urban	52	B	86.62	86.66	1/1/1998	12/31/2000	4	4	0	6	0	1	6	0	8	0	0	0	0	1	1	0	0	0	0	0	0	7	0	1	0	8	0	0	0	0		
65	Change (After-Before)	52	B	86.62	86.66			0	-2	0	0	0	0	-2	-1	-2	0	0	0	0	-4	0	-1	0	0	0	1	0	-3	0	0	-1	-1	0	0	0			
66	Before Signalization - Urban	53	A	0.63	0.67	1/1/1994	12/31/1996	2	0	0	0	0	0	2	0	2	0	0	0	0	1	0	1	0	0	0	0	0	2	0	0	0	2	0	0	0	0	0	
66	After Signalization - Urban	53	A	0.63	0.67	1/1/1999	12/31/2001	8	3	0	7	0	0	10	1	8	0	0	0	0	0	3	0	4	0	0	0	0	6	0	1	0	6	1	0	0	0	0	
66	Change (After-Before)	53	A	0.63	0.67			6	3	0	7	0	0	8	1	6	0	0	0	0	2	0	3	0	0	0	0	0	4	0	1	0	4	1	0	0	0		
67	Before Signalization - Rural	67	B	15.05	15.09	1/1/1994	12/31/1996	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
67	After Signalization - Rural	67	B	15.05	15.09	1/1/1999	12/31/2001	3	1	0	1	0	1	3	0	3																							



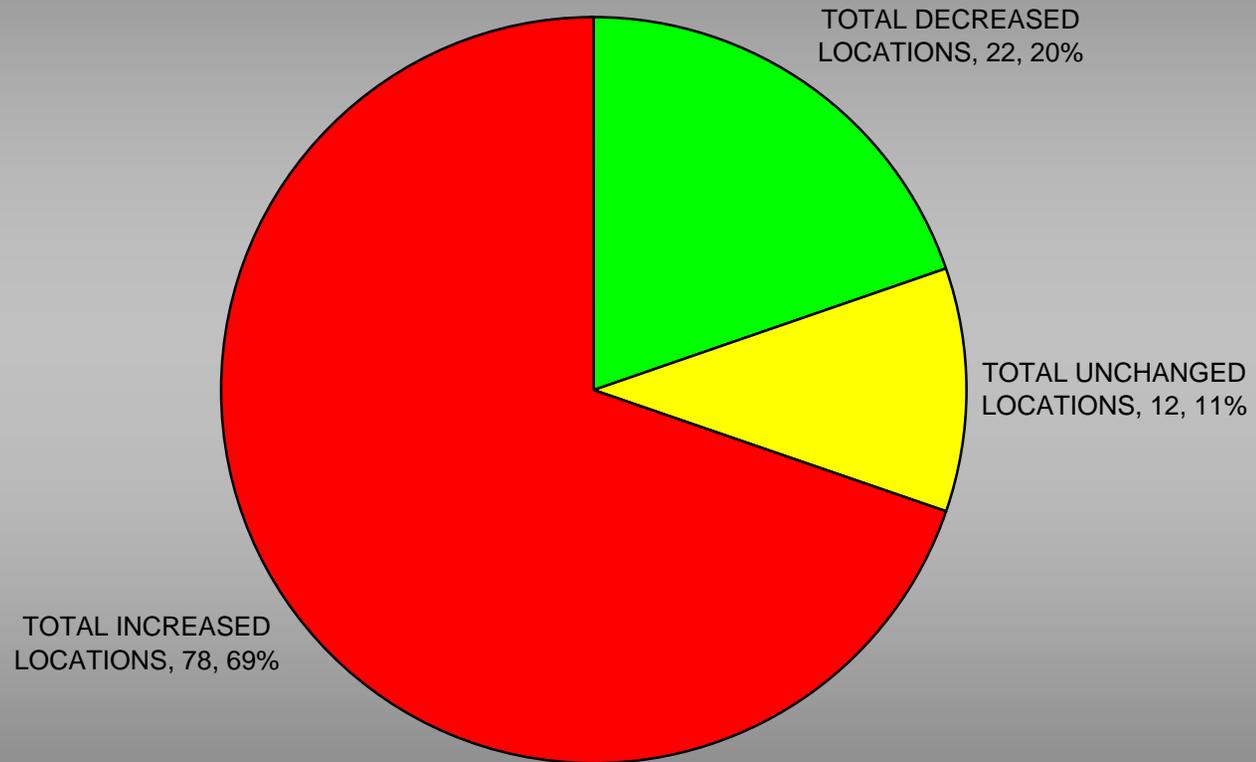
site #	notes	Highway section	from milepoint	to milepoint	from date	to date	SEVERITY			# of VEHICLES			CRASH TYPE													LIGHT		WEATHER									
							Property Damage Only	Injury Crash	Fatal Crash	Injured	Killed	1 car	2 cars	3+ cars	On Road	Off Road	Overturn	School Age Pedestrian	Other Pedestrian	Broadside	Head On	Rear End	Sideways (Same Direction)	Sideways (Opposite Dir)	Approach Turn (Left Turn)	Overtaking Turn	Parked Vehicle	Bicycle	Wild Animal	Fixed Object	Daylight	Dawn or Dusk	Dark, Lighted	Dark, Unlighted	Good Weather	Rain	Snow, Sleet or Hail
81	Before Signalization - Rural	82	A	35.26	35.3	1/1/1993	12/31/1995	12	4	0	6	0	1	12	3	16	0	0	0	0	0	0	0	0	0	0	12	1	2	1	12	0	4	0			
81	After Signalization - Rural	82	A	35.26	35.3	1/1/1998	12/31/2000	27	7	0	11	0	2	26	5	32	2	0	0	1	2	0	0	0	0	0	25	0	8	0	25	0	9	0			
81	Change (After-Before)	82	A	35.26	35.3			15	3	0	5	0	1	14	2	16	2	0	0	1	0	0	0	0	0	0	13	-1	6	-1	13	0	5	0			
82	Before Signalization - Urban	83	A	56.84	56.88	1/1/1994	12/31/1996	3	1	0	1	0	0	4	0	4	0	0	0	0	0	0	0	0	0	0	2	1	1	0	4	0	0	0			
82	After Signalization - Urban	83	A	56.84	56.88	1/1/1999	12/31/2001	27	7	0	9	0	5	27	2	32	1	0	0	5	0	10	2	0	0	0	1	25	0	7	0	32	0	0			
82	Change (After-Before)	83	A	56.84	56.88			24	6	0	8	0	5	23	2	28	1	0	0	4	-1	8	2	0	0	0	1	23	-1	6	0	28	0	0			
83	Before Signalization - Urban	83	A	61.84	61.88	1/1/1994	12/31/1996	11	1	0	1	0	1	9	2	11	1	0	0	1	0	10	0	0	0	0	1	11	0	1	0	11	1	0	0		
83	After Signalization - Urban	83	A	61.84	61.88	1/1/1999	12/31/2001	19	2	0	3	0	6	14	1	19	2	0	0	1	0	13	1	0	0	0	1	3	20	1	0	16	1	2	0		
83	Change (After-Before)	83	A	61.84	61.88			8	1	0	2	0	5	5	-1	8	1	0	0	0	0	3	1	0	0	0	1	2	9	1	-1	0	5	0	2		
84	Before Signalization - Urban	83	A	65.84	65.88	1/1/1994	12/31/1996	6	1	0	1	0	0	6	1	7	0	0	0	2	0	5	0	0	0	0	0	6	0	1	0	6	1	0	0		
84	After Signalization - Urban	83	A	65.84	65.88	1/1/1999	12/31/2001	27	15	0	32	0	1	30	11	42	0	1	0	2	0	27	0	0	0	0	0	31	0	9	2	41	1	0	0		
84	Change (After-Before)	83	A	65.84	65.88			21	14	0	31	0	1	24	10	35	0	1	0	0	0	22	0	0	0	0	0	25	0	8	2	35	0	0	0		
85	Before Signalization - Urban	83	A	68.27	68.31	1/1/1991	12/31/1993	2	3	0	7	0	2	3	2	0	0	0	0	1	0	1	0	0	0	0	2	2	0	2	1	4	0	1	0		
85	After Signalization - Urban	83	A	68.27	68.31	1/1/1996	12/31/1998	11	8	0	14	0	5	10	4	14	5	0	0	4	0	7	1	0	0	1	0	5	13	4	2	0	17	1	1	0	
85	Change (After-Before)	83	A	68.27	68.31			9	5	0	7	0	3	7	4	11	3	0	0	3	0	6	1	0	0	0	0	3	11	4	0	-1	13	1	0		
86	Before Signalization - Urban	83	A	69.37	69.41	1/1/1991	12/31/1993	14	7	0	10	0	1	18	2	20	1	0	0	1	0	13	2	0	0	0	1	18	0	2	1	18	1	2	0		
86	After Signalization - Urban	83	A	69.37	69.41	1/1/1996	12/31/1998	33	28	0	46	0	4	51	6	57	4	0	0	5	0	28	3	0	0	0	0	4	48	0	11	0	57	0	1	0	
86	Change (After-Before)	83	A	69.37	69.41			19	21	0	36	0	3	33	4	37	3	0	0	4	0	15	1	0	0	0	0	3	30	0	9	-1	39	-1	-1	0	
87	Before Signalization - Urban	83	A	71.43	71.47	1/1/1994	12/31/1996	6	6	0	17	0	0	10	2	12	0	0	0	3	2	3	0	0	1	2	0	1	0	0	10	1	1	10	1	1	0
87	After Signalization - Urban	83	A	71.43	71.47	1/1/1999	12/31/2001	10	5	0	9	0	2	13	0	14	1	0	0	0	4	1	5	0	0	0	0	1	12	0	2	1	14	1	0	0	
87	Change (After-Before)	83	A	71.43	71.47			4	-1	0	-8	0	2	3	-2	2	1	0	0	0	1	-1	2	0	-1	2	0	1	2	0	1	0	4	0	-1	0	
88	Before Signalization - Urban	85	B	185.1	185.14	1/1/1994	12/31/1996	7	3	0	6	0	1	7	1	9	1	0	0	5	0	2	0	0	0	1	1	0	1	1	1	7	1	2	0		
88	After Signalization - Urban	85	B	185.1	185.14	1/1/1999	12/31/2001	12	5	0	9	0	0	17	0	17	0	0	0	6	1	6	1	0	0	0	0	10	0	3	3	15	1	0	0		
88	Change (After-Before)	85	B	185.1	185.14			5	2	0	3	0	-1	10	-1	8	-1	0	0	1	1	4	1	0	0	0	-1	3	-1	2	2	8	0	-2	0		
89	Before Signalization - Rural	85	B	187.23	187.27	1/1/1994	12/31/1996	4	0	0	0	0	0	1	4	0	0	0	0	2	0	2	0	0	0	0	0	0	4	0	0	0	4	0	0	0	
89	After Signalization - Rural	85	B	187.23	187.27	1/1/1999	12/31/2001	5	2	0	3	0	0	6	1	7	0	0	0	3	0	4	0	0	0	0	0	6	1	0	0	6	1	0	0		
89	Change (After-Before)	85	B	187.23	187.27			1	2	0	3	0	0	3	0	3	0	0	0	1	0	2	0	0	0	0	0	0	2	1	0	0	2	1	0	0	
90	Before Signalization - Urban	85	B	200.53	200.57	1/1/1994	12/31/1996	7	2	0	4	0	1	7	1	8	1	0	0	3	1	3	0	0	0	1	0	0	1	8	0	0	1	9	0	0	
90	After Signalization - Urban	85	B	200.53	200.57	1/1/1999	12/31/2001	18	5	0	7	0	0	19	4	23	0	0	0	2	0	9	0	0	0	0	0	0	19	2	2	0	23	0	0	0	
90	Change (After-Before)	85	B	200.53	200.57			11	3	0	3	0	-1	12	3	15	-1	0	0	-1	-1	6	0	0	0	0	0	-1	11	2	2	-1	14	0	0	0	
91	Before Signalization - Urban	86	A	1.78	1.82	1/1/1989	12/31/1991	4	0	0	0	0	1	3	0	4	0	0	0	2	0	0	0	0	0	0	0	1	0	3	0	0	1	4	0	0	
91	After Signalization - Urban	86	A	1.78	1.82	1/1/1994	12/31/1996	2	1	0	1	0	0	3	0	3	0	0	0	1	0	2	0	0	0	0	0	0	3	0	0	0	2	1	0	0	
91	Change (After-Before)	86	A	1.78	1.82			-2	1	0	1	0	-1	0	0	-1	0	0	0	-1	0	2	0	0	0	0	0	-1	0	0	0	-1	-2	1	0		
92	Before Signalization - Rural	86	A	15.2	15.24	1/1/1994	12/31/1996	6	2	1	1	1	7	0	8	1	0	0	0	8	0	0	0	0	0	0	0	1	9	0	0	0	9	0	0		
92	After Signalization - Rural	86	A	15.2	15.24	1/1/1999	12/31/2001	5	5	0	6	0	0	8	2	10	0	1	0	1	0	6	0	0	0	0	0	0	8	0	2	0	10	0	0	0	
92	Change (After-Before)	86	A	15.2	15.24			-1	3	-1	3	-1	-1	1	2	2	-1	1	0	-7	0	6	0	0	0	0	0	-1	0	0	2	0	1	0	0		
93	Before Signalization - Urban	88	B	18.47	18.51	1/1/1994	12/31/1996	7	6	0	12	0	0	11	2	13	0	0	0	5	1	5	1	0	0	1	0	0	0	0	0	3	11	0	2	0	
93	After Signalization - Urban	88	B	18.47	18.51	1/1/1999	12/31/2001	44	12	0	16	0	0	50	6	54	1	0	0	7	0	30	2	0	0	0	0	1	41	4	1	4	47	2	1	0	
93	Change (After-Before)	88	B	18.47	18.51			37	6	0	4	0	0	39	4	41	1	0	0	2	-1	25	1	0	0	0	0	1	31	4	1	1	36	2	-1	0	
94	Before Signalization - Urban	90	B	88.96	89	1/1/1994	12/31/1996	6	3	0	8	0	3	6	0	6	3	2	0	1	0	3	0	1	0	0	0	2	5	1	1	2	7	1	1	0	
94	After Signalization - Urban	90	B	88.96	89	1/1/1999	12/31/2001	4	0	0	0	0	0	4	0	4	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	2	4	0	0	0	
94	Change (After-Before)	90	B	88.96	89			-2	-3	0	-8	0	-3	-2	0	-2																					



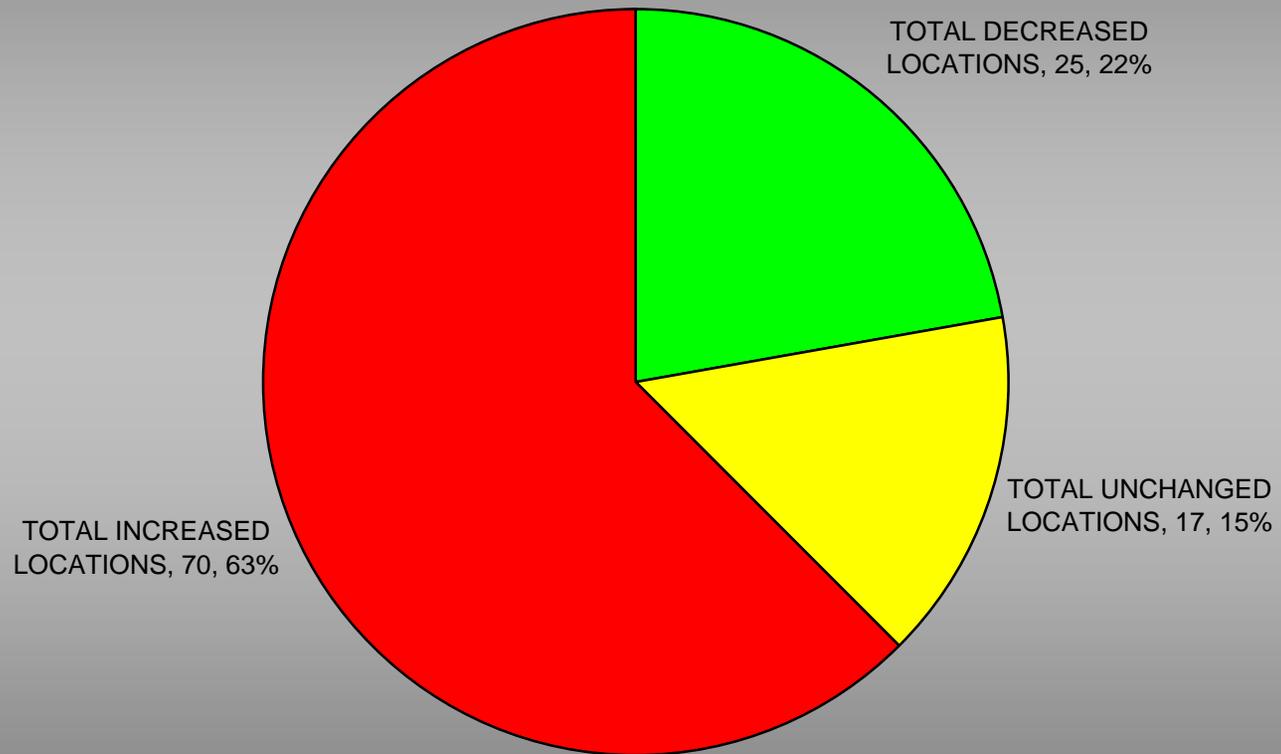




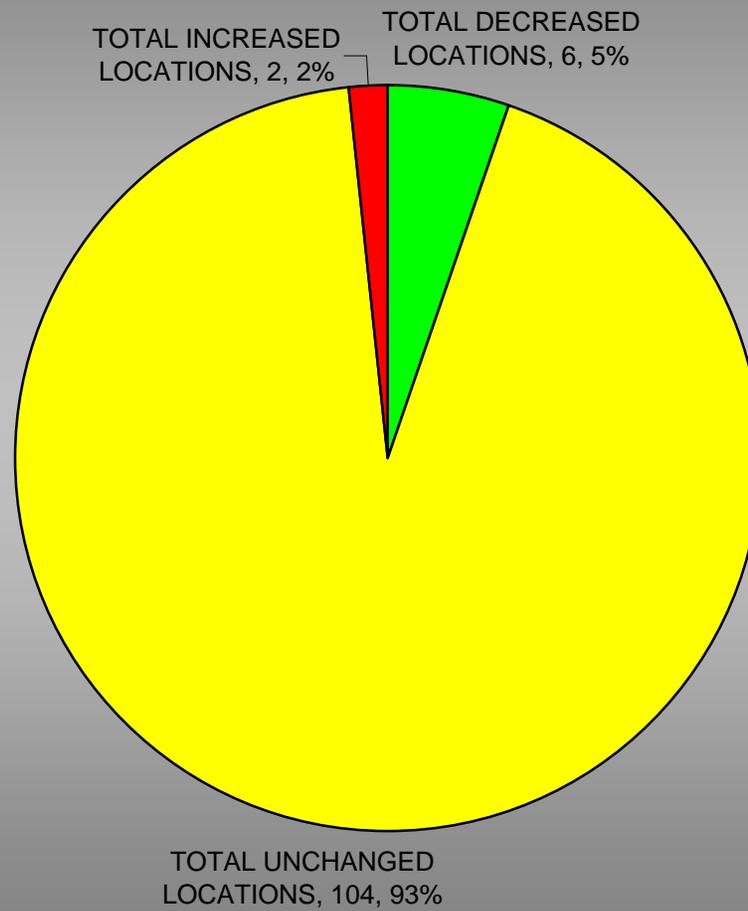
## Property Damage Accidents



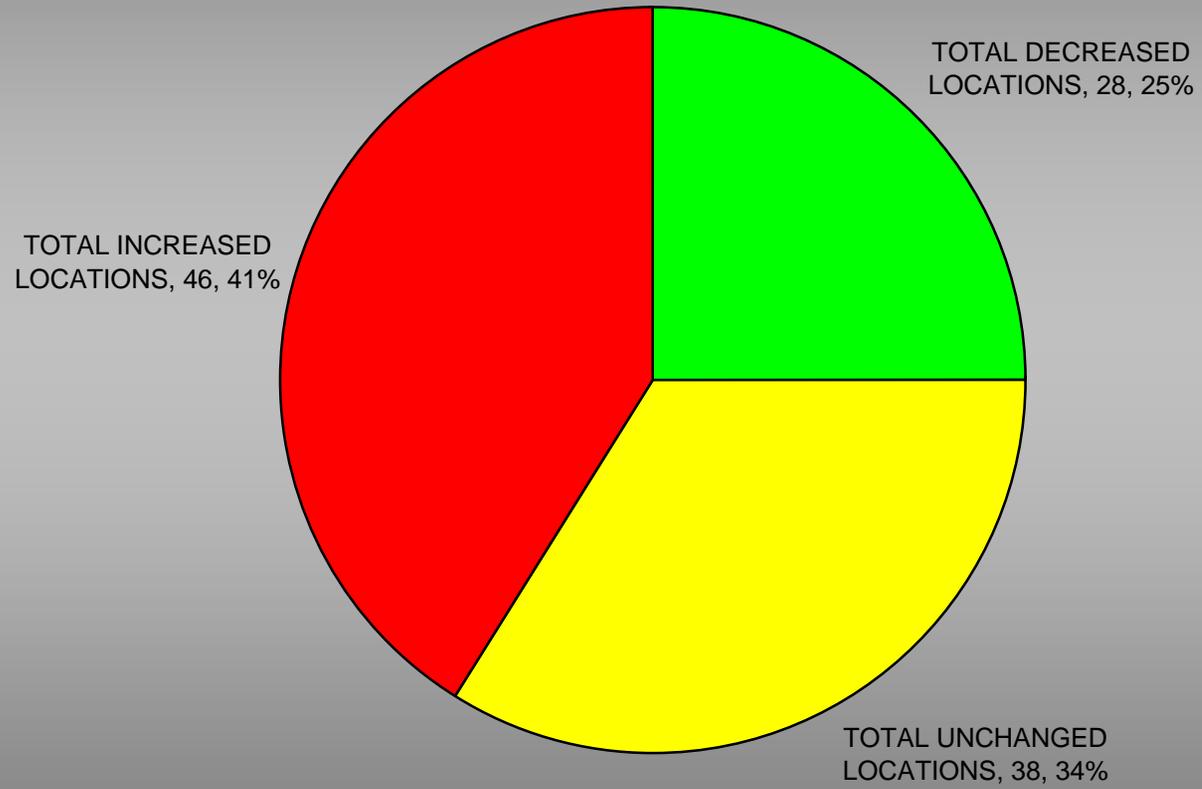
## Injury Accidents



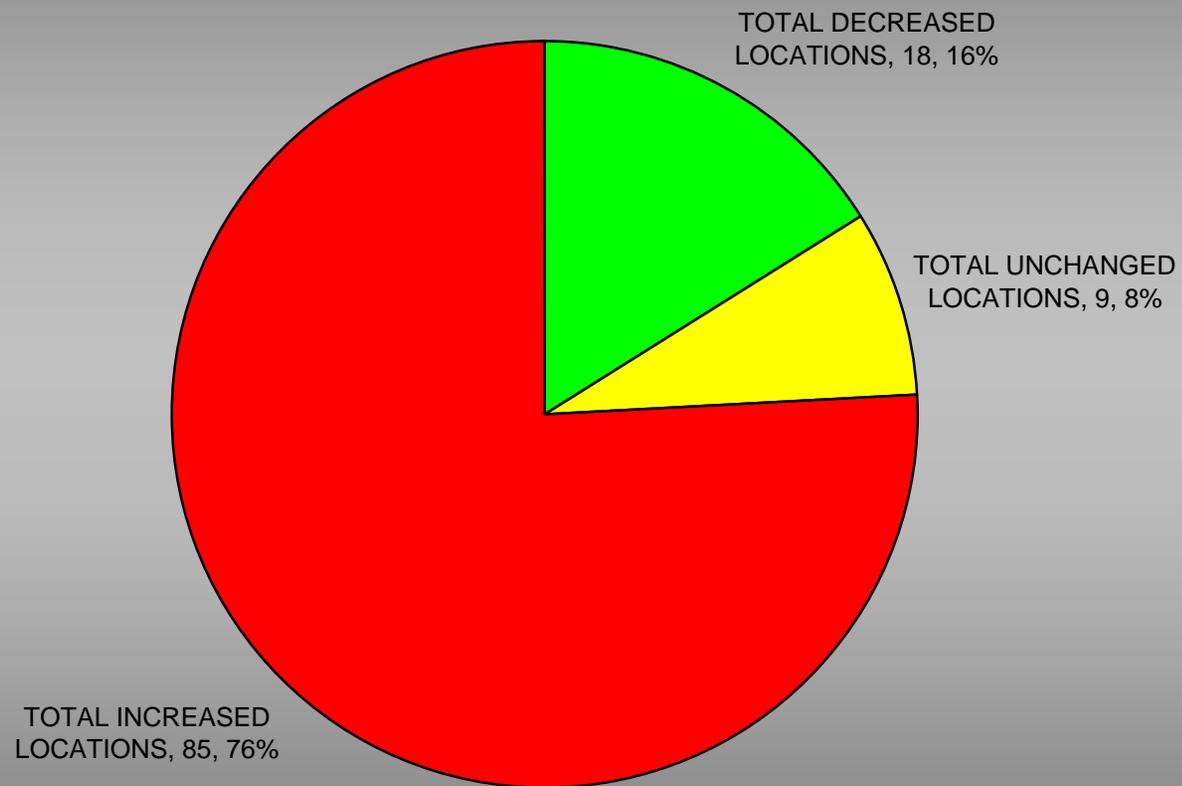
## Fatal Accidents



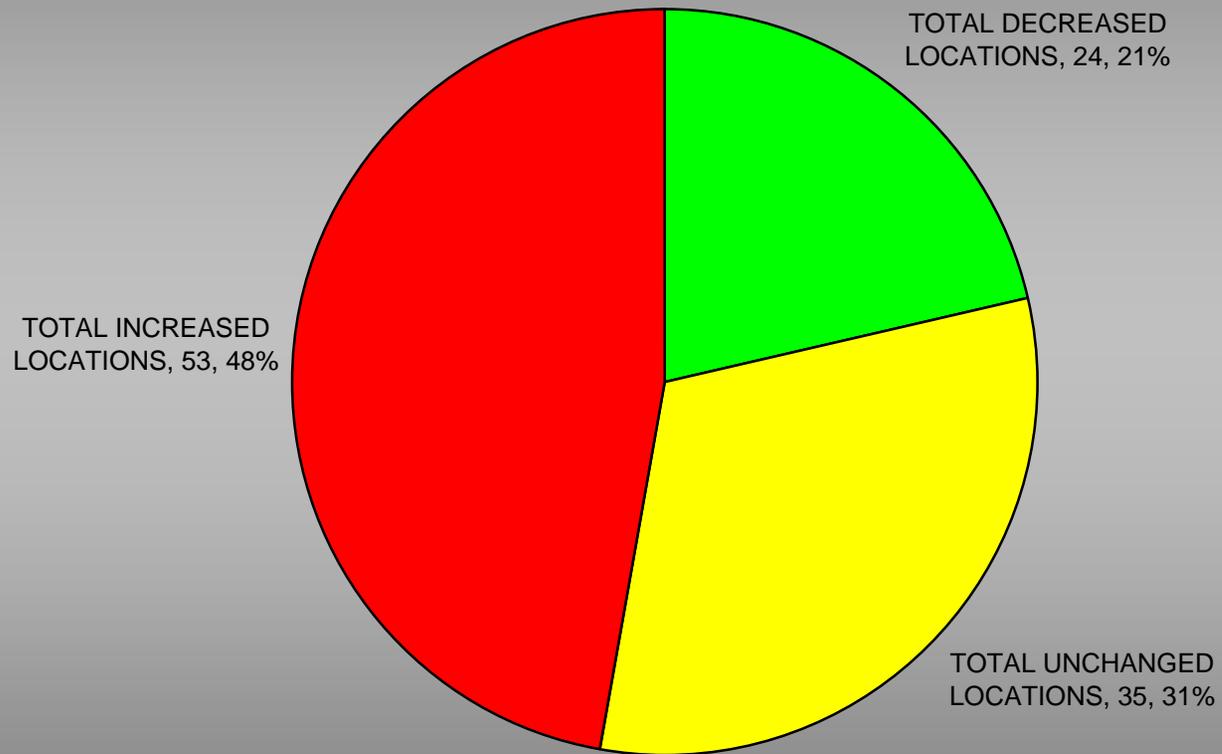
### Single Vehicle Accidents



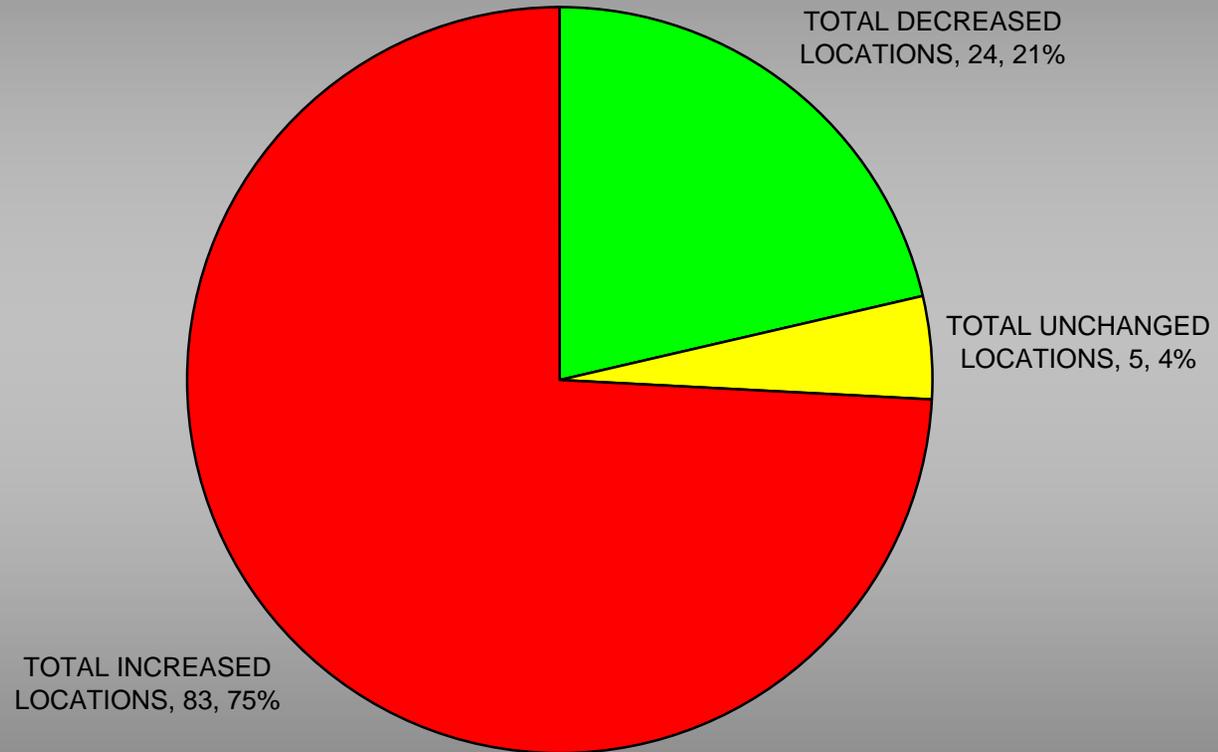
## Two Vehicle Accidents



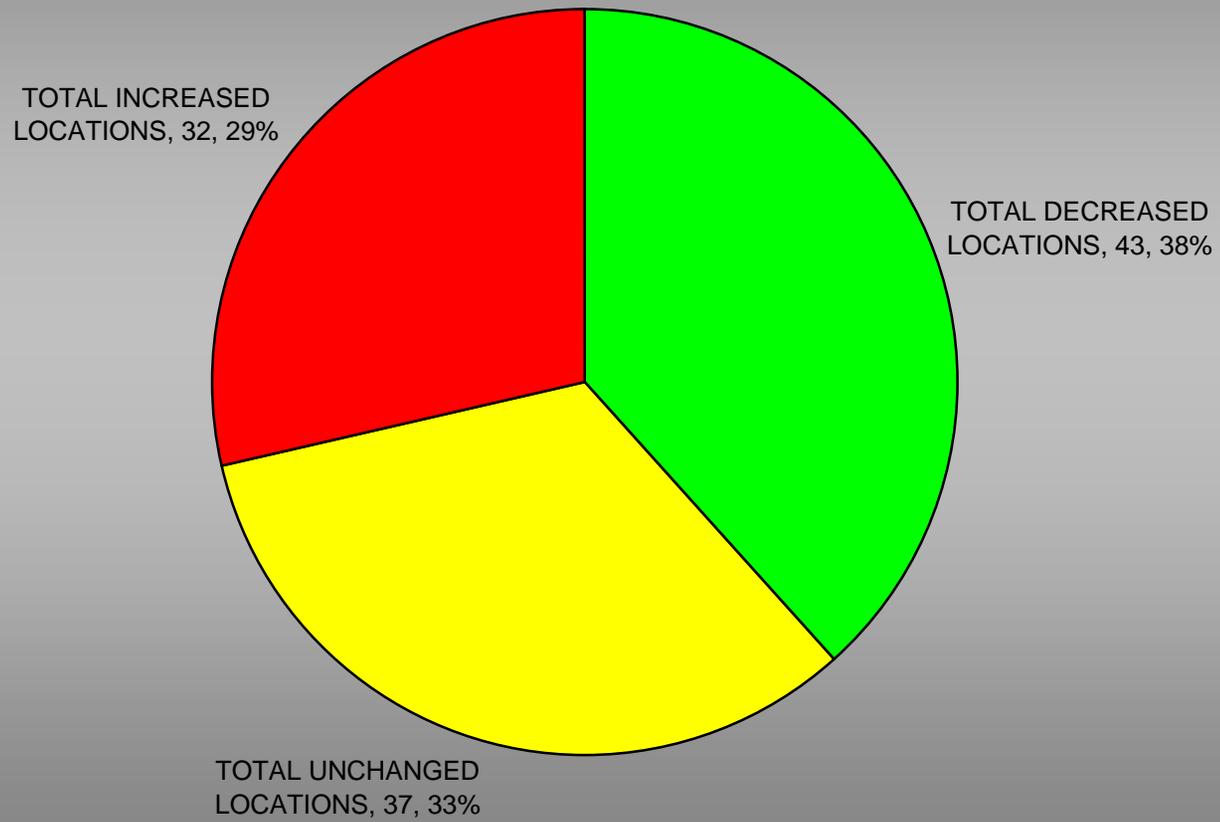
### Three or More Vehicle Accidents



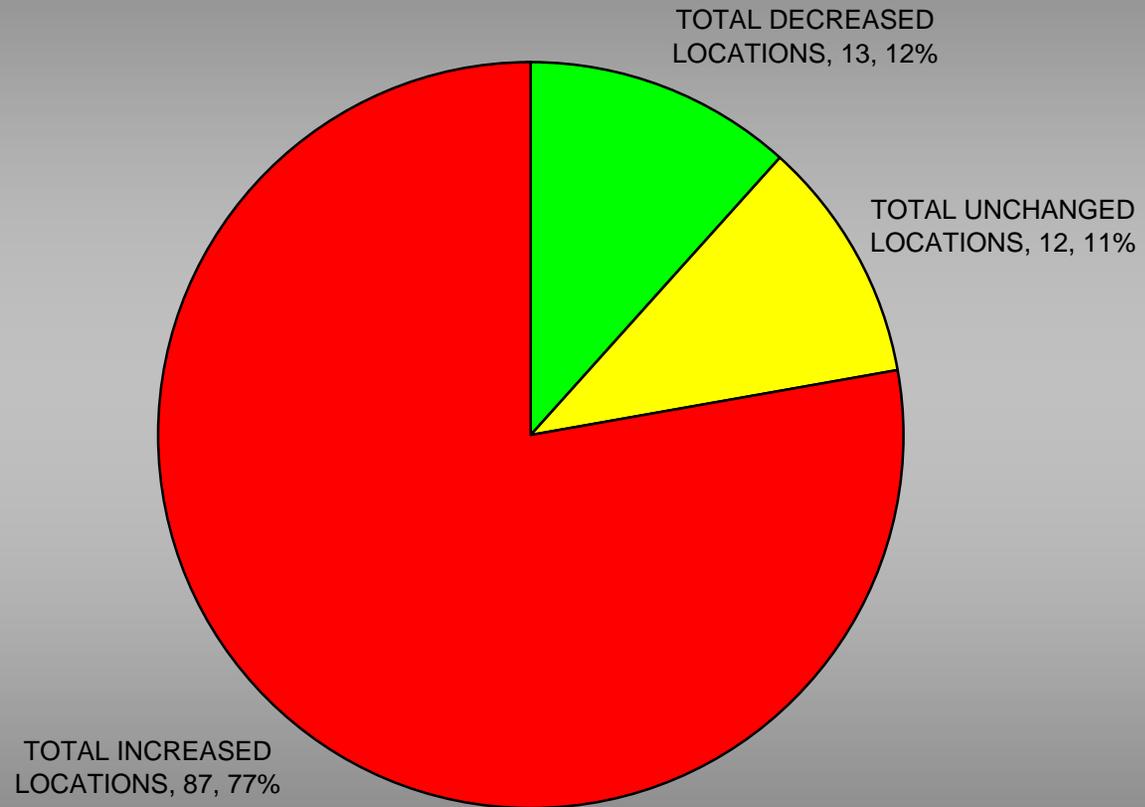
## On Road Accidents



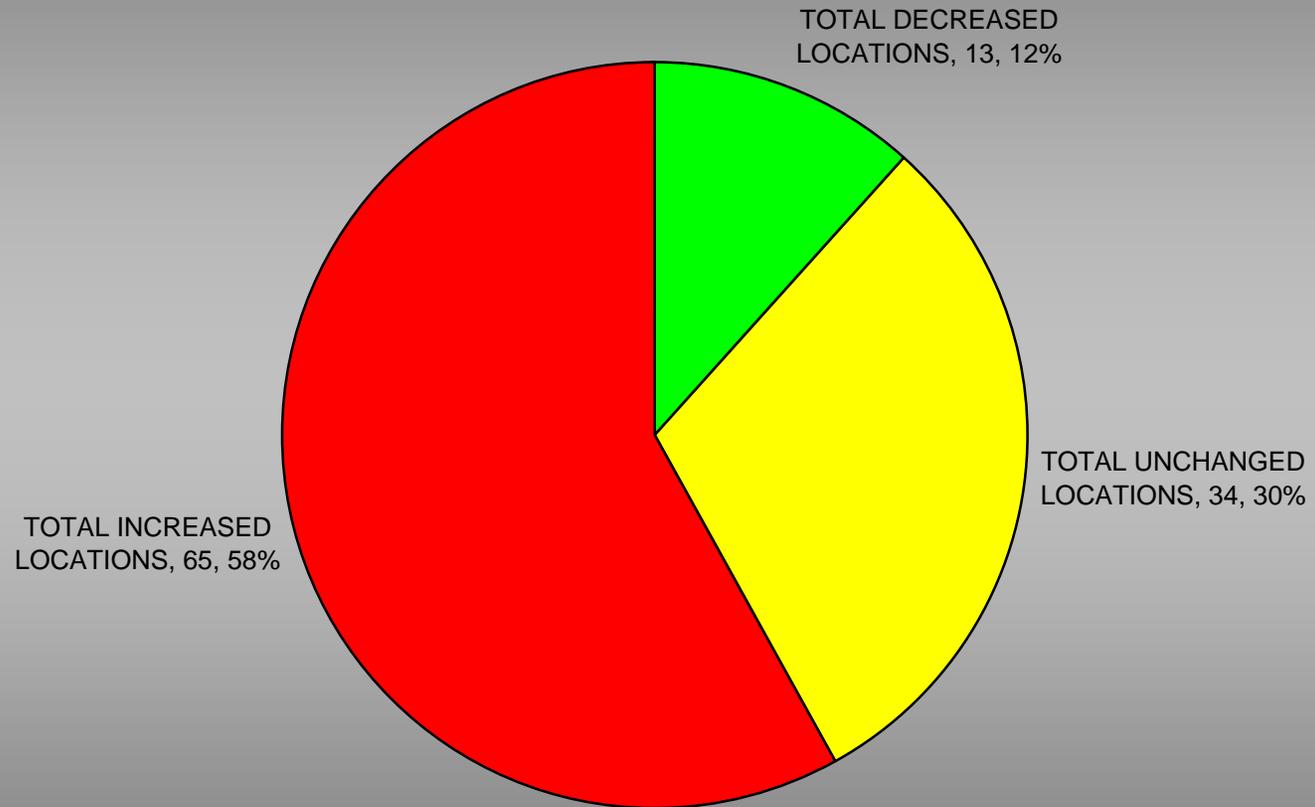
## Broadside Accidents



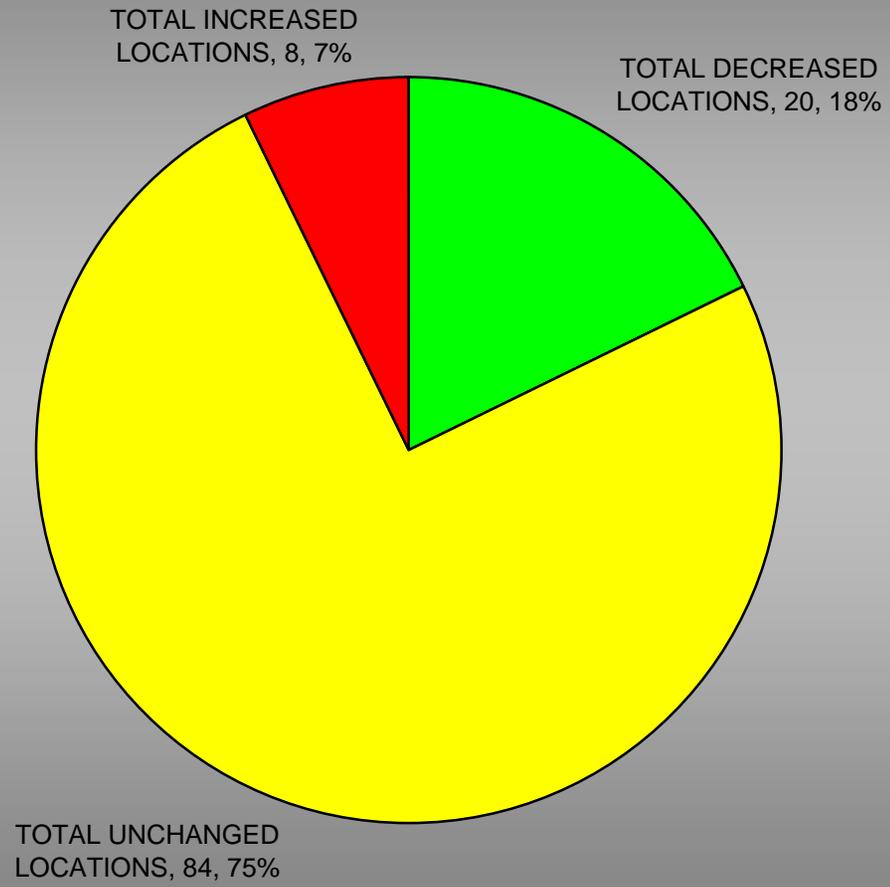
## Rear End Accidents



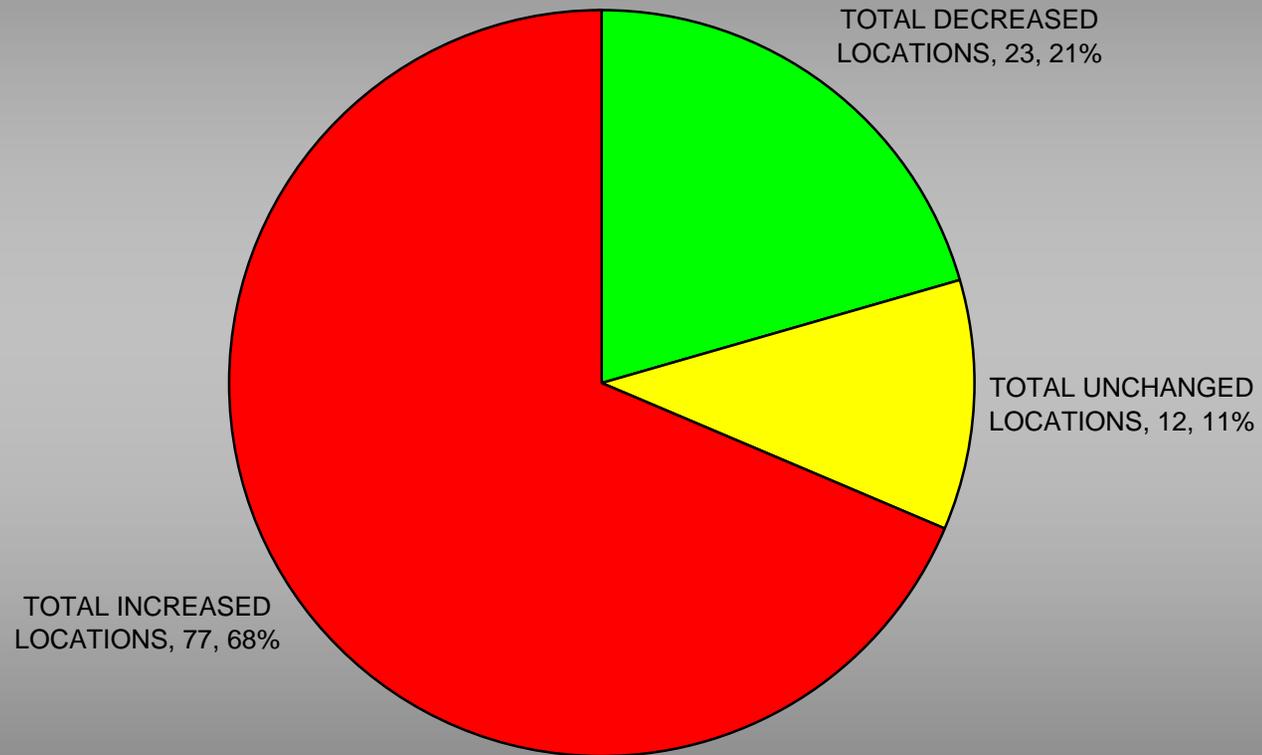
### Approach Turn (Left Turning) Accidents



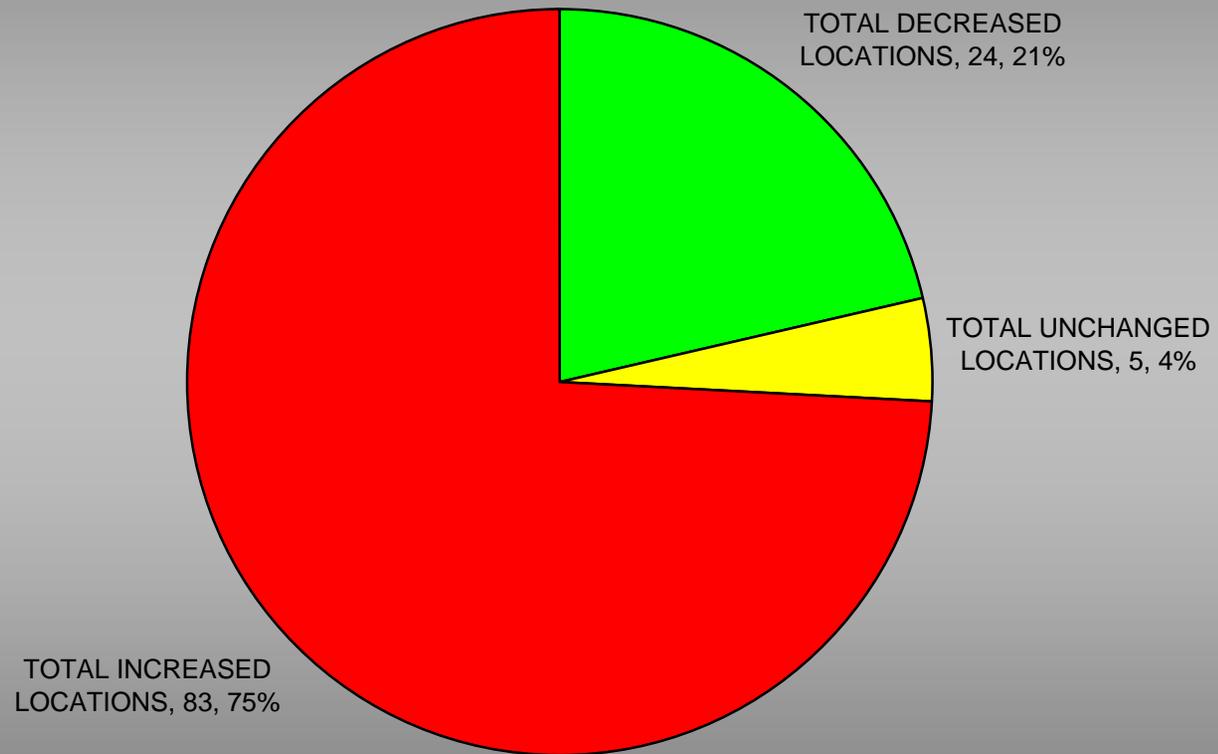
## Overtaking Turn Accidents



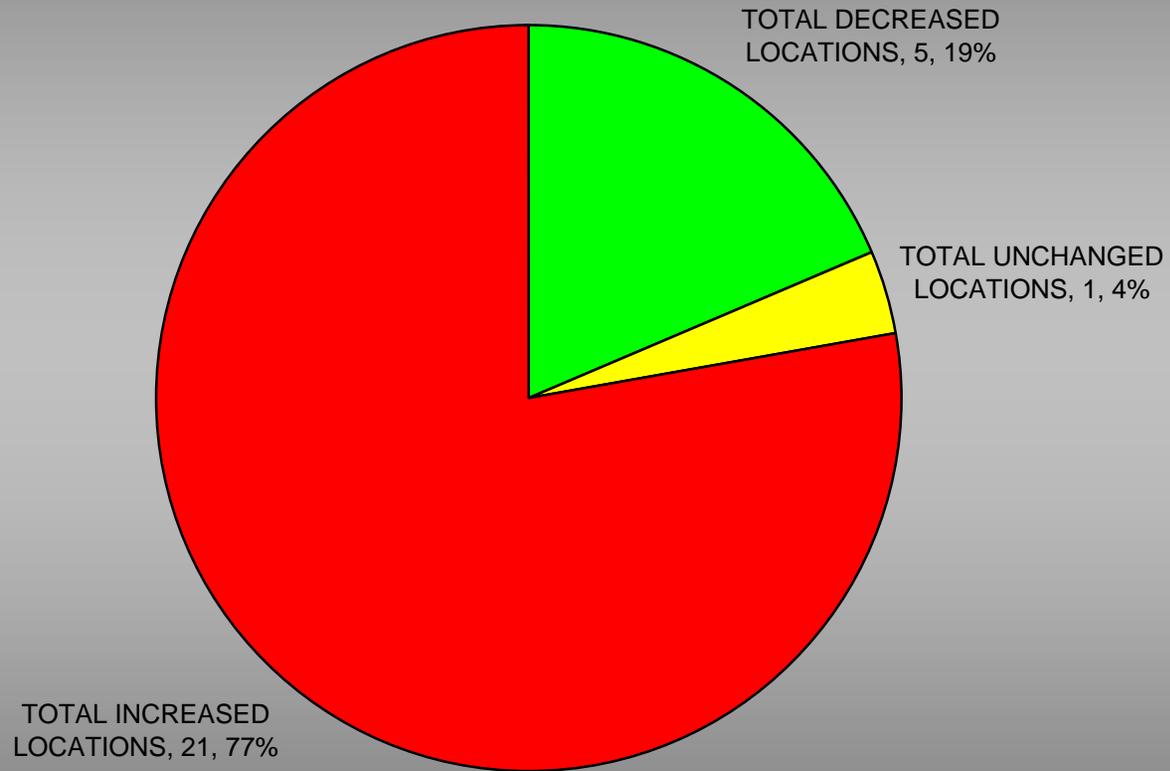
## Daylight Accidents



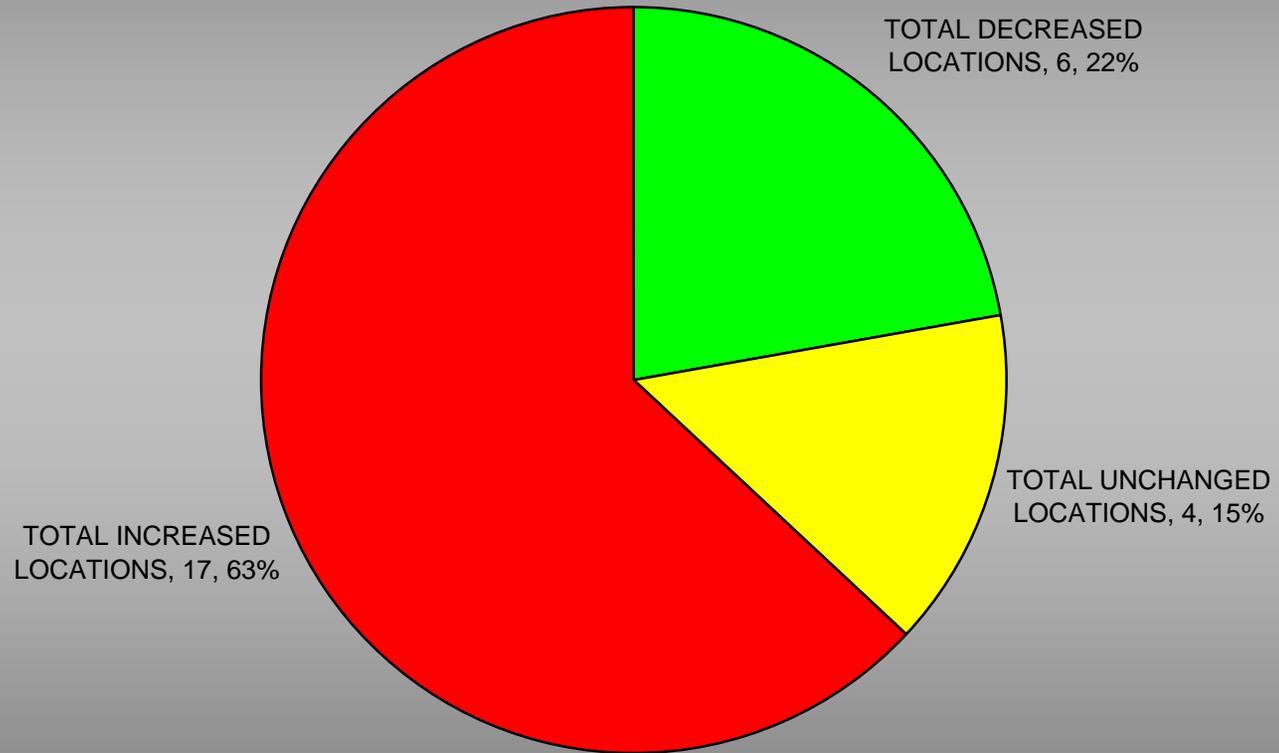
# All Accidents



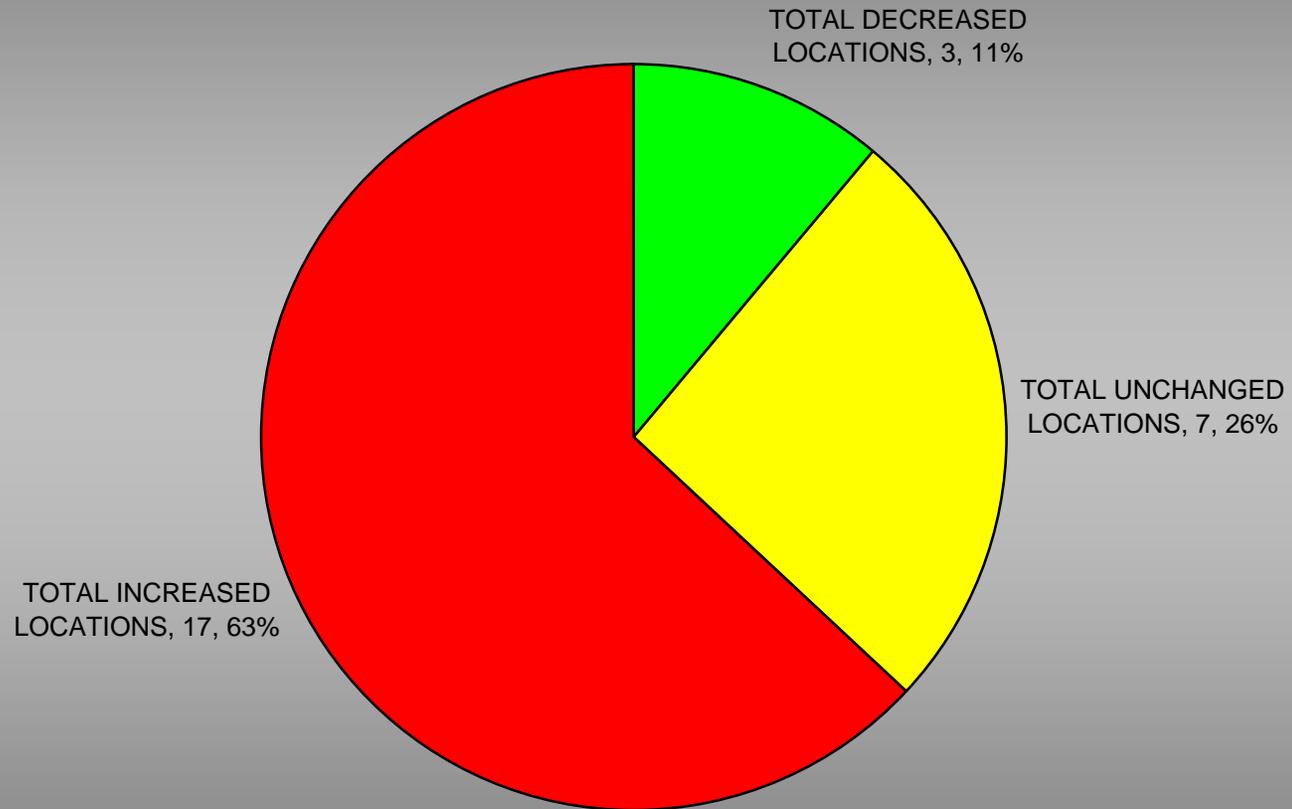
Rural, All Accidents



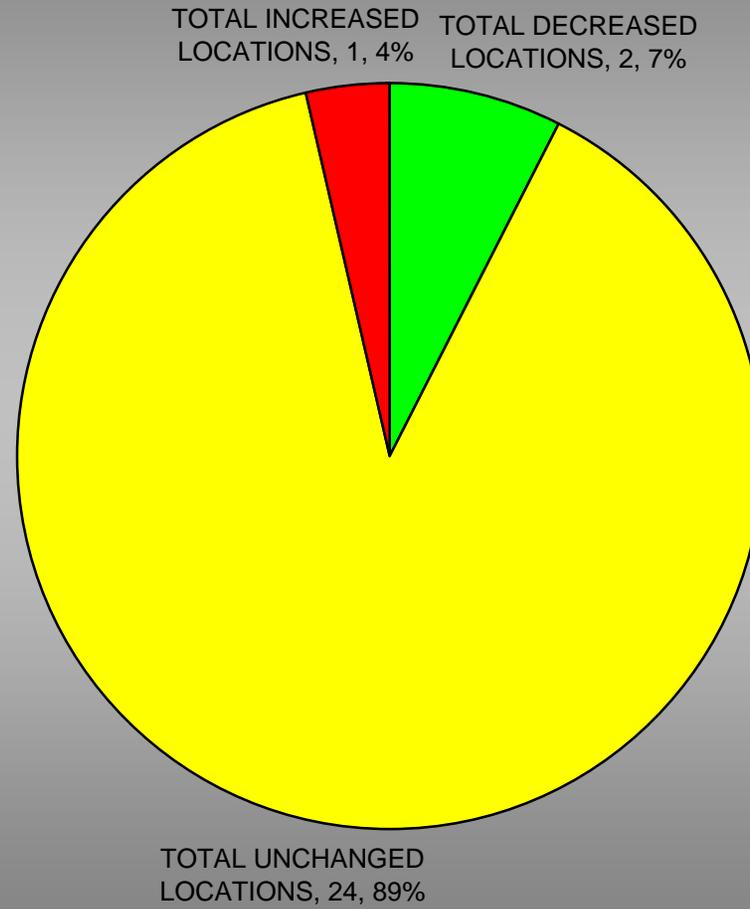
### Rural, PDO Accidents



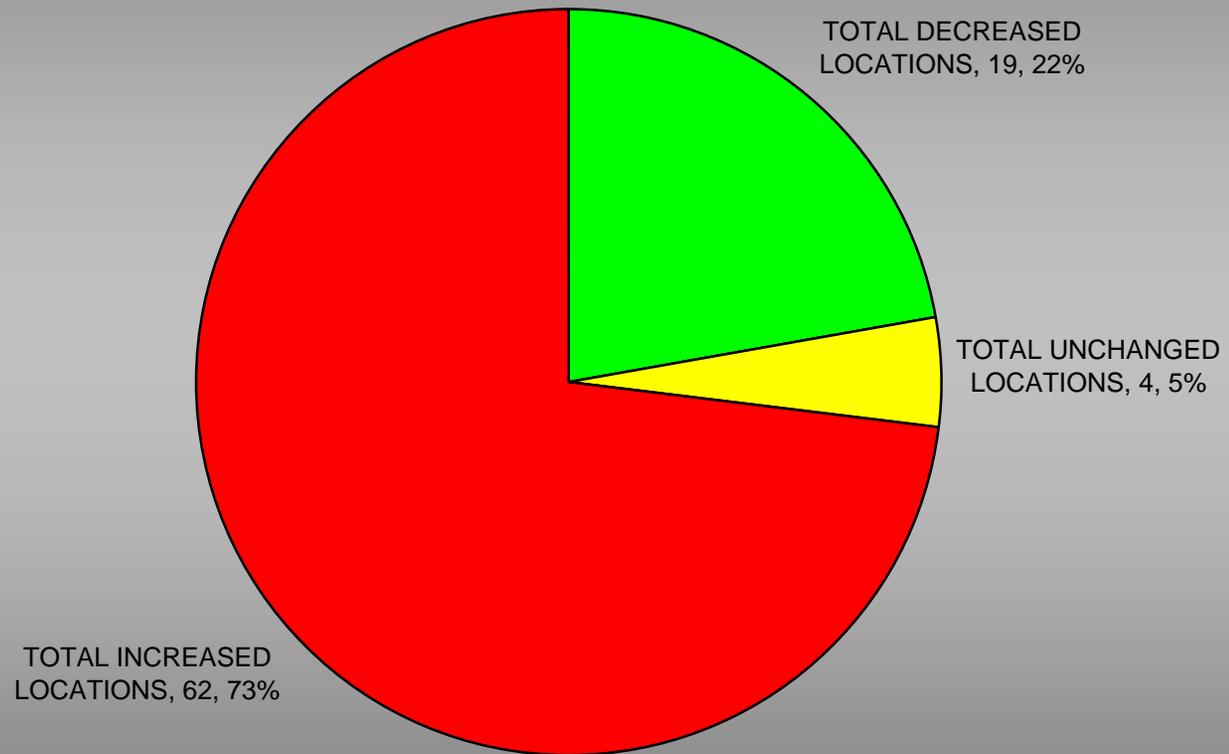
### Rural INJ Accidents



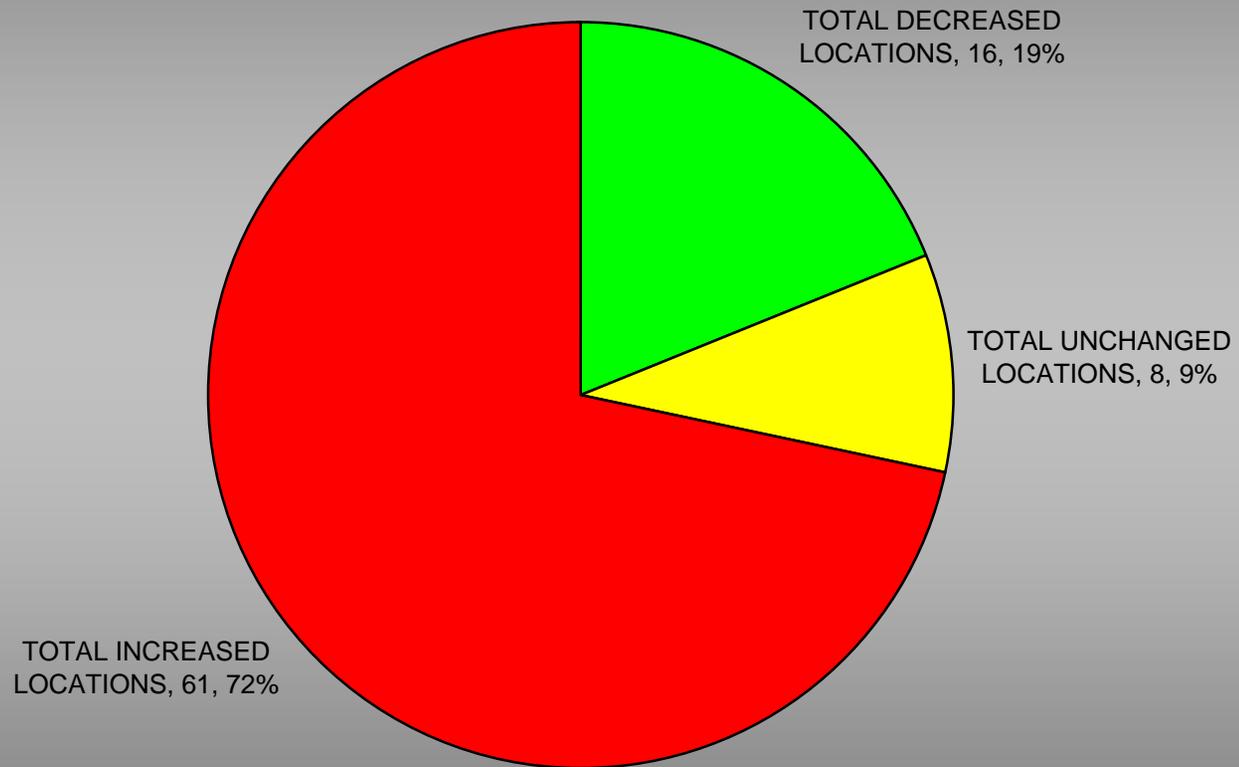
## Rural FAT Accidents



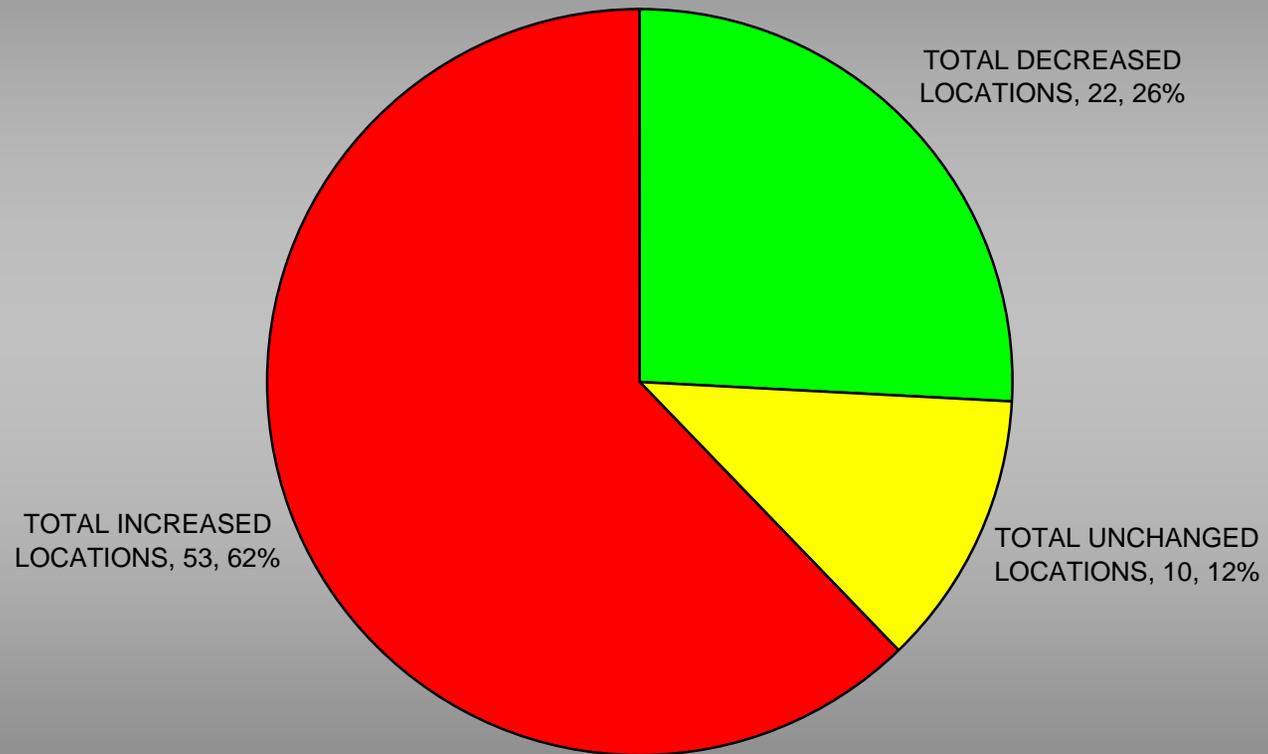
Urban, All Accidents



### Urban, PDO Accidents



### Urban, INJ Accidents



### Urban, INJ Accidents

