I-25/Arapahoe Interchange

Environmental Assessment

Final Safety Assessment Summary

August 2011

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1 Crash History

A safety analysis was conducted as part of the overall Environmental Assessment (EA) for the Arapahoe Road/I-25 interchange. This effort considered three years of crash data within the study area. The study area encompasses mainline I-25 from mile point (MP) 195.63 to MP 198.83 which includes the interchanges at Dry Creek Road, Arapahoe Road and Orchard Road. In addition, seventeen intersections along Arapahoe Road, Yosemite Street and Clinton Street are included as part of the study area. The crash data used for the state highway roadways in this analysis were provided by CDOT's Safety and Traffic Engineering Office while the non-state highway roadways were provided by the City of Centennial and the City of Greenwood Village. When the crash data was compiled for this analysis, the available three year analysis period for the state highway roadways was January 2006 – December 2008 while the three year analysis period for the non-state highway roadways was January 2007 – December 2009. Of note, nearly all of the crash data for I-25 is for a time period after construction was complete for the T-REX project.

1.1 Interstate 25 Crash History

Along I-25 from just south of Dry Creek Road to just north of Orchard Road, there were 637 crashes during the three-year study period. This total includes mainline I-25 crashes and the ramp crashes but not the crashes that occurred at the ramp terminals. Of the crashes on this segment of I-25, there was one fatal crash and 81 injury crashes. The remaining 555 crashes were property damage (PDO) only crashes. **Table 1** shows the three interchanges within the study area and the crash totals for each interchange segment within the overall freeway study segment.

Table 1. Interchange Crash Totals

Interchange Segment	Mile Point To / From	Date To / From	AADT	% Trucks	Number of Crashes		
					PDO	Injury	Fatal
Dry Creek	195.63 – 196.66	01/06 – 12/08	153,100	7	130	18	0
Arapahoe	196.67 – 197.73	01/06 – 12/08	179,500	6	246	22	0
Orchard	197.74 – 198.83	01/06 – 12/08	201,900	5	179	41	1

AADT = Average Annual Daily Traffic
PDO = Property Damage Only

Figure 1 shows the Safety Performance Function (SPF) diagram for the three interchange areas along I-25. This diagram can be used to gauge a freeway's relative safety performance in comparison to similar roadway facilities. If the level of safety predicted by the SPF will represent a normal or expected number of crashes at a specific level of Average Annual Daily Traffic (AADT) along a highway segment, then the degree of deviation from the norm can be stratified to represent specific levels of safety.

LOSS-I – Indicates low potential for crash reductions

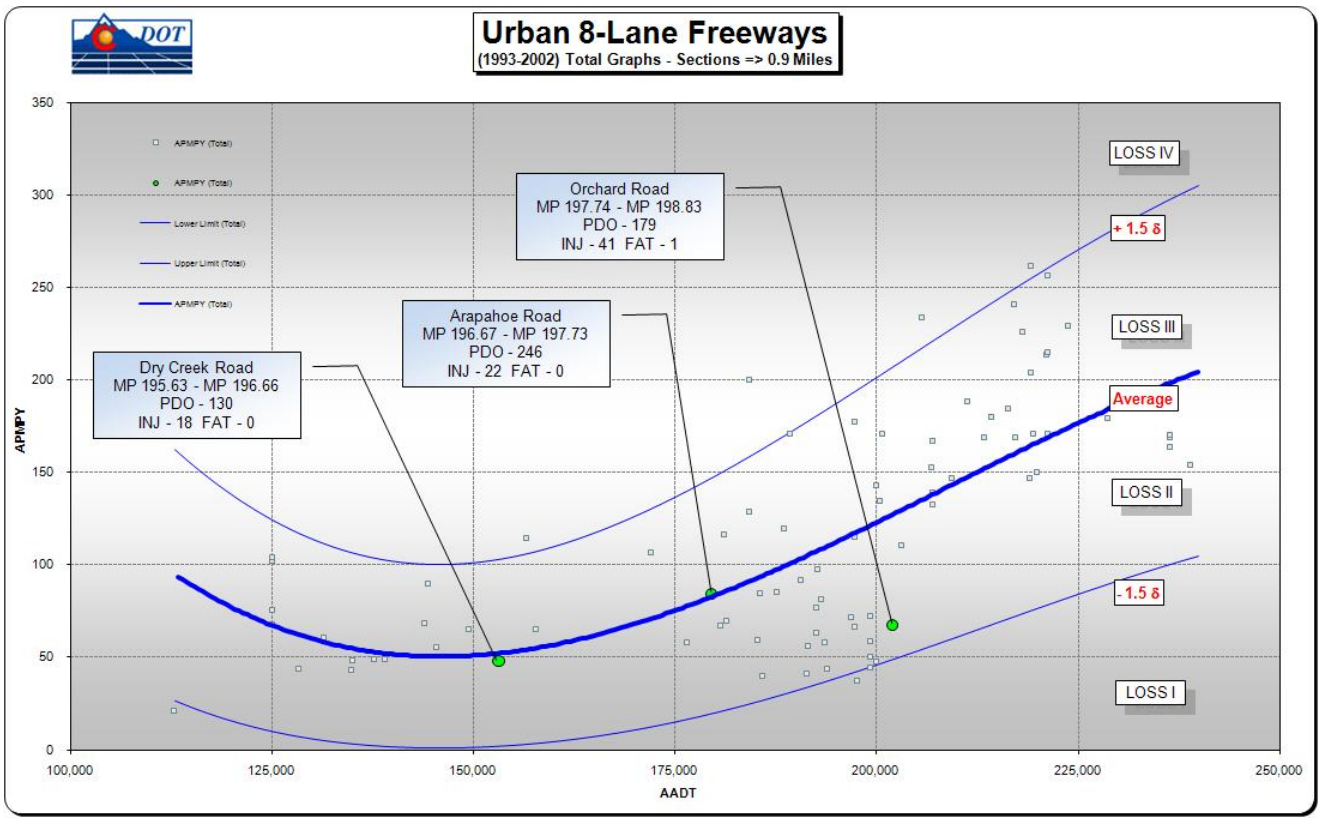
LOSS-II – Indicates better than expected safety performance

LOSS-III – Indicates less than expected safety performance

LOSS-IV – Indicates high potential for crash reduction

As this figure shows, all three interchange areas show average or better than expected safety performance when compared to similar facilities. Of note, CDOT has not developed a SPF for 10-lane freeways, so the 8-lane freeway SPF chart was used in this analysis.

Figure 1. Freeway Safety Performance Function Chart



1.2 Intersection Crash History

In addition to CDOT, the City of Centennial and the City of Greenwood Village provided detailed crash data for the individual arterial intersections in the study area. **Table 2** shows the crash data for each of the intersections evaluated in this study. A large enough crash data set is not yet available for the time period after the completion of the interim interchange improvements (completed in 2010) on Arapahoe Road to complete reliable safety analysis.

Table 2. Intersection Crash Totals

Intersection	Jurisdiction	Date To / From	Number of Crashes				Most Significant Type(s)
			PDO	Injury	Fatal	Total	
Arapahoe Road Intersections							
Arapahoe Rd. / Greenwood Plaza Blvd.	Greenwood Village	01/07 – 12/09	23	5	0	28	Sideswipe
Arapahoe Rd. / Yosemite St.	Greenwood Village	01/07 – 12/09	82	14	0	96	Broadside, Overtaking turn & Bicycle (1)
Arapahoe Rd. / Xanthia St.	Greenwood Village	01/07 – 12/09	1	0	0	1	None
Arapahoe Rd. / SB I-25 Ramp	CDOT	01/06 – 12/08	39	3	0	42	Sideswipe & curb
Arapahoe Rd. / NB I-25 Ramp	CDOT	01/06 – 12/08	73	6	0	79	Broadside, Overtaking turn, & Median barrier (2)
Arapahoe Rd. / Boston St.	CDOT	01/06 – 12/08	55	8	0	63	Rear end
Arapahoe Rd. / Clinton Ct.	CDOT	01/06 – 12/08	32	0	0	32	Rear end & Sideswipe
Arapahoe Rd. / Dayton St.	CDOT	01/06 – 12/08	70	9	0	79	Rear end & head on (3)
Yosemite Street Intersections							
Yosemite St. / Xanthia St.	Centennial	01/07 – 12/09	11	0	0	11	Other fixed objects
Yosemite St. / Briarwood Blvd.	Centennial	01/07 – 12/09	1	0	0	1	None
Yosemite St. / Davies Ave.	Centennial	01/07 – 12/09	3	0	0	3	None
Yosemite St. / Easter Pl.	Centennial	01/07 – 12/09	4	0	0	4	None
Yosemite St. / Alton Wy.	Centennial	01/07 – 12/09	5	1	0	6	Curb

Intersection	Jurisdiction	Date To / From	Number of Crashes				Most Significant Type(s)
			PDO	Injury	Fatal	Total	
Clinton Street Intersections							
Clinton St. / Clinton Ct.	Greenwood Village	01/07 – 12/09	2	0	0	2	None
Clinton St. / Costilla Ave.	Greenwood Village	01/07 – 12/09	3	2	0	5	Approach turn
Clinton St. / Easter Ave.	Centennial	01/07 – 12/09	3	0	0	3	None
Clinton St. / Geddes Ave.	Centennial	01/07 – 12/09	1	0	0	1	None

(1) 2 bicycle crashes at Arapahoe/Yosemite

(2) 3 median barrier crashes at Arapahoe/NB ramp

(3) 2 head-on crashes at Arapahoe/Dayton

This table shows that the highest crash totals are at intersections along Arapahoe Road. Several crash types, including rear end, broadside, sideswipe, overtaking turn and median barrier, have been identified as the most significant crash types at more than one intersection along Arapahoe Road. This signifies the need for measures to be taken in order to reduce the occurrence of these crash types.

Figure 2 shows both the freeway and intersection analyses completed for this study as well as how the segment or intersection is performing based on the available crash data. This figure also shows the crash rates for the freeway and arterial segments and how they compare to statewide average crash rates.

Arapahoe Road through and east of the I-25 interchange has a crash rate higher than the statewide average for property damage only crashes. All interstate crash rates in the study area are lower than the statewide average rates.

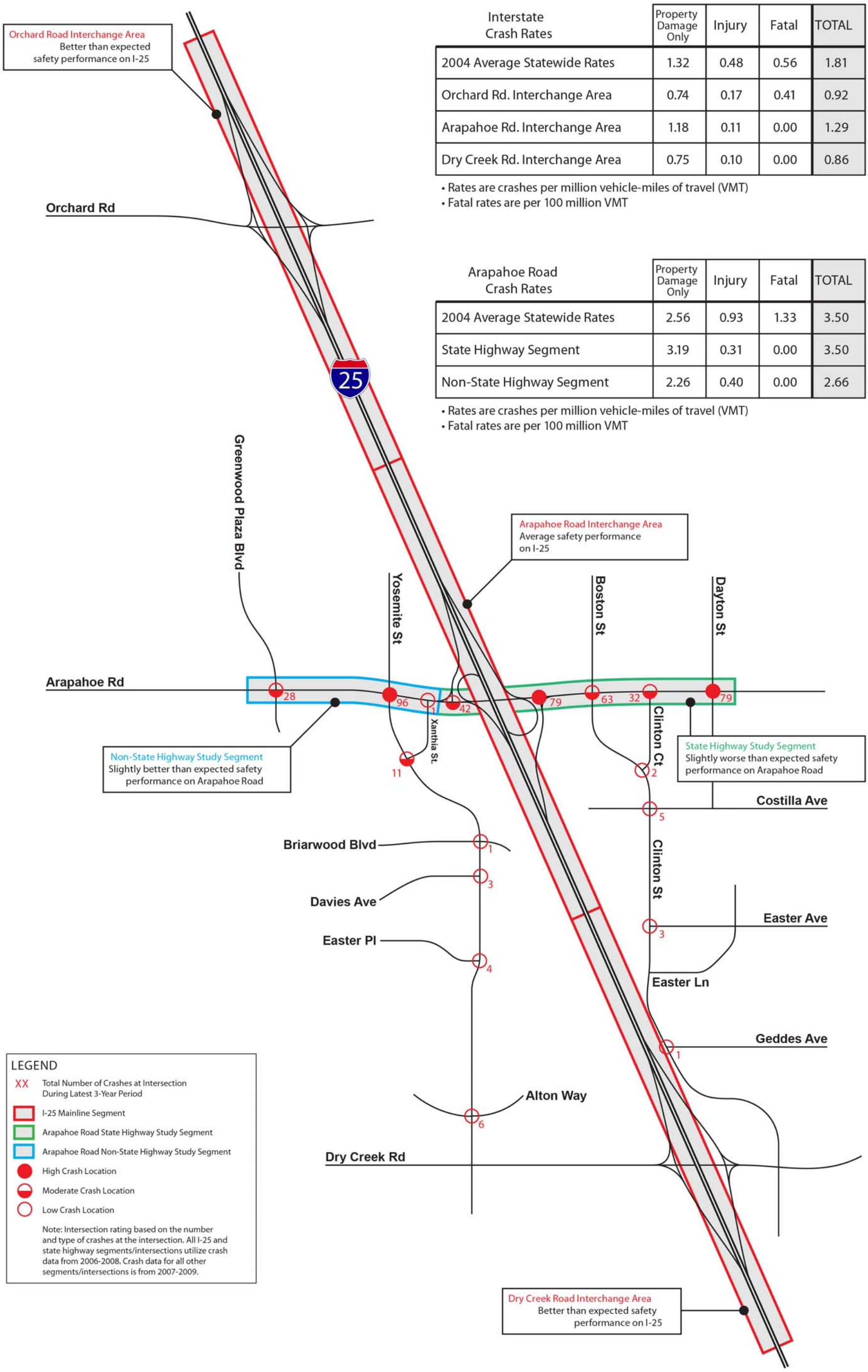
Figure 2. Crash History

Interstate Crash Rates	Property Damage Only	Injury	Fatal	TOTAL
2004 Average Statewide Rates	1.32	0.48	0.56	1.81
Orchard Rd. Interchange Area	0.74	0.17	0.41	0.92
Arapahoe Rd. Interchange Area	1.18	0.11	0.00	1.29
Dry Creek Rd. Interchange Area	0.75	0.10	0.00	0.86

- Rates are crashes per million vehicle-miles of travel (VMT)
- Fatal rates are per 100 million VMT

Arapahoe Road Crash Rates	Property Damage Only	Injury	Fatal	TOTAL
2004 Average Statewide Rates	2.56	0.93	1.33	3.50
State Highway Segment	3.19	0.31	0.00	3.50
Non-State Highway Segment	2.26	0.40	0.00	2.66

- Rates are crashes per million vehicle-miles of travel (VMT)
- Fatal rates are per 100 million VMT



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2 Future Freeway and Street Safety

Four different future interchange alternatives were analyzed for the Arapahoe/I-25 interchange. These alternatives include:

- No Action
- Improved Partial Cloverleaf
- Improved Partial Cloverleaf with Costilla Crossing
- Three Level Partial Cloverleaf

Each of these alternatives was evaluated with regard to safety and crash totals were predicted to compare and contrast each of the alternatives. Forecasted traffic volumes for 2035 were utilized in the prediction of crashes for each of the alternatives.

2.1 Interstate 25 Crash Predictions

The mainline freeway configuration and 2035 traffic volumes are the same for all four alternatives and therefore the expected freeway crash totals are the same for all four alternatives. Safety projections along the mainline freeways in the study area were completed using a variation of the Safety Performance Function (SPF) procedures developed by the CDOT Traffic and Safety Engineering department. CDOT's SPF charts were used to estimate the future number of crashes on I-25 in the vicinity of the Arapahoe Road interchange based on historic crash data, existing traffic volumes and projected future 2035 traffic volumes. Using this methodology, there are expected to be approximately 205 to 225 crashes per year in 2035 on mainline I-25 in the vicinity of the Arapahoe/I-25 interchange. This compares to approximately 85 crashes per year during the current study period (January 2006 – December 2008).

2.2 Intersection Crash Predictions

Safety projections for the seventeen intersections within the study area were completed using the intersection SPFs that have been developed by CDOT. These SPF charts utilize historic crash data as well as the daily traffic volumes on the main roadway and the side street to estimate the number of crashes at each intersection. CDOT has developed SPF charts for various laneage, traffic control and the number of legs for each intersection configuration. Once the intersection crash totals were predicted using the SPF charts, crash modification factors (CMFs) from the Highway Safety Manual (AASHTO, 2010) were utilized to adjust the SPF predicted crash totals to account for some of the unique geometric conditions at the interchange. A CMF is a numeric value that either adjusts a crash total up or down based on a specific geometric or traffic control condition. For example, removal or relocation of a fixed object was one of the CMFs used for the two ramp terminal intersections on Arapahoe Road at I-25. This was used to account for the removal of the existing concrete barrier under I-25 on Arapahoe Road.

Table 3 shows the results of the intersection crash estimate analyses for each of the four alternatives. The numbers shown are the total number of crashes expected to occur at all seventeen intersections over the course of a year.

Table 3. Intersection Crash Predictions

Alternative	Observed or Predicted Crash Totals (per year)
Existing	152
No Action	255 – 275
Improved Partial Cloverleaf	230 – 250
Improved Partial Cloverleaf with Costilla Crossing	230 – 250
Three Level Partial Cloverleaf	220 – 240

As can be seen in this table, each of the interchange alternatives is expected to reduce the number of intersection crashes within the study area when compared to the No Action alternative. The following provides a summary of the findings.

- The Improved Partial Cloverleaf alternatives are expected to be better than No Action due to the removal of the existing concrete barrier between the through travel lanes on Arapahoe Road. In addition, both of the Partial Cloverleaf alternatives are expected to only have about 10 more crashes per year than the three level interchange alternative.

- The Three Level Partial Cloverleaf interchange is expected to have the least number of intersection crashes. This is because through traffic on Arapahoe Road through each of the signalized intersections in the interchange is expected to decrease with the addition of the tunnel for through traffic. This reduction in the traffic volume through the interchange intersections reduces the amount of exposure at each intersection and therefore the expected number of crashes.

- The overall crash totals for the two Partial Cloverleaf alternatives is the same. However, with the Costilla Crossing alternative, the number of crashes at the intersections on Arapahoe Road is expected to decrease by about 5 crashes per year while the number of crashes along Costilla Avenue is expected to increase by the about same amount.

3 Conclusions

The safety analyses included in this analysis were completed as part of the EA analyses for the Arapahoe/I-25 interchange. The freeway mainline crash history was reviewed, but the proposed interchange alternatives will primarily impact intersection related crashes along Arapahoe Road. Based on a review of the most recent crash data provided for the study area (January 2006 – December 2008 for state highways and January 2007 – December 2009 for non-state highways), the most significant intersection crash types (rear ends, sideswipes and broadsides) are primarily related to congestion. There are also several median barrier related crashes due to the existing concrete barrier on Arapahoe Road under I-25. In addition to the 2035 No Action alternative, there are three other alternatives that were analyzed with regard to safety which include an Improved Partial Cloverleaf, an Improved Partial Cloverleaf with Costilla Crossing and a Three Level Partial Cloverleaf.

For mainline I-25, all of the future condition alternatives are the same from a geometric and traffic volume standpoint. Due to this, the expected number of crashes per year is the same for No Action and each of the alternatives.

With regard to intersection crashes along Arapahoe Road, Yosemite Street and Clinton Street, all three proposed interchange alternatives are expected to experience fewer intersection crashes than the No Action alternative. This is primarily due to the removal of the existing concrete barrier between the through travel lanes on Arapahoe Road. As can be seen in **Table 3** of this analysis, the intersections within the study area in all three alternatives are expected to have similar crash experiences. Therefore, it is expected that all three of these alternatives should help to reduce the number of congestion related crash types (i.e. rear end, sideswipe and broadside) at the intersections in the vicinity of the Arapahoe Road/I-25 interchange.