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City of Albuquerque Yellow Light Timing Change and All-Red Clearance Interval Timing Change Effectiveness Study Final Report

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INTRODUCTION

The overall goal of this study is to report on the safety impact of a change in the yellow light interval timings at 18 intersections and changes in the all-red light clearance timings at 2 intersections in Albuquerque, New Mexico on traffic safety measured by changes in crashes and the type and severity of crashes. This Yellow Light Interval intervention (YLI) and All-Red Light Clearance Timing (ARL) study is a follow up to the red light camera (RLC) report completed in October 2010. In addition to automated red light enforcement, changes in the length of yellow light intervals and all-red light clearance intervals are two other principal methods to reduce red light running (Retting, et. al, 2008).

The 18 YLI and 2 ARL intersections chosen for this study were the former RLC camera intersections. In the introduction to the RLC report we noted the use of RLC systems is only one of several possible countermeasures available to impact the incidence of red light running related crashes. It was beyond the scope of that study to thoroughly review the different countermeasures, their use at the RLC intersections, and their effectiveness. The literature review in the RLC study report briefly described the variety of countermeasures and their effectiveness but focused on a review of RLC literature. This report provides a more complete review of intersection related interventions with a focus on yellow light interval timings and all-red light clearance intervals.

In an agreement with the New Mexico Department of Transportation (NMDOT) in April 2010 three RLC systems were shut off and beginning in May 2010 the City had 17 operational RLC systems. Based, at least partly, on the results of the RLC study red light cameras at 3 of the remaining 17 intersections were shut down in November 2010. In addition, at approximately the same time, at the remaining 14 RLC intersections speeding citations were discontinued and only red light running tickets were issued. In November 2010 the Albuquerque City Council voted to discontinue the RLC program and repeal the red light camera ordinance. In early December 2010 the City stopped processing violations and in late December 2010 the RLC system was turned off.

In December 2010 the City decided to implement several of the various countermeasures described in the RLC report. This includes the change in yellow light timings at 18 of the 20 previous RLC intersections and an increase in the all-red light phase timings at the 2 intersections where an all-red phase cycle was already in place. Both of these countermeasures were implemented January 1, 2011. The City did not add all-red light phase timings to any other intersections.

This study addresses the following questions:

1. What is the impact on crashes of increased yellow light time intervals on safety at signalized intersection approaches that were equipped with cameras?
2. What is the impact on crashes of a brief all-red light clearance interval on safety at the two signalized intersection approaches that were equipped with cameras?

The design of this study is based on similar methods used to conduct the RLC camera study completed in October 2010, but adapted for this study. Originally a 12-month before and after-time frame was considered based on the available post 12-month time period from January

2011 through December 2011 compared to the 12-month pre-time period of January 2010 through December 2010. Because complete crash data was not available for December 2011 we were only able to use an 11-month pre-study time period (January 2010 – November 2010) and an 11-month post-study time period (January 2011 – November 2011).

It is important to note the RLC system was in operation during calendar year 2010 at most of the study intersections and so the RLC system was in effect during most of the pre-study time frame at most of the study intersections that are part of this study. This is important given that pre-post-studies assumes the study group and comparison (or control) group are similar and that changes detected in the study group, but not the control group, were actually a result of the intervention. We are also not able to disentangle the possible safety effects of the RLC system in the post-time period. There is the possibility that the beneficial effect of the RLC system found in the RLC study extended beyond the end of the program. The study intersections and comparison intersections differ in this important way. For this reason it is difficult to attribute changes in crashes and crash rates solely to the increases in the yellow light time intervals and the all-red light clearance intervals. It is important to separate the effects of different improvements because studies have shown that treatments vary in their effectiveness. There is very little research that has studied the relative contribution of yellow light timing intervals and RLC systems on red light running and traffic crashes (Retting, et. al, 2008).

Similar to the RLC study, data was primarily acquired from two sources. We obtained traffic volume count information from the Mid-Region Council of Governments of New Mexico (MRCOG). As one of its many tasks the MRCOG provides metropolitan and rural transportation planning for a four-county area, which includes the City of Albuquerque. This includes extensive data collection for traffic monitoring, analysis of current conditions, and traffic forecasts of future conditions. After receiving this information from MRCOG we were able to calculate average annual daily traffic (AADT) counts for each travel direction from calendar year 2010 through calendar year 2011. This information is used in this study to measure traffic flow and to calculate crash rates per million entering vehicles (MEV) in study intersections (previous RLC intersections) and comparison group intersections. During the red light camera study period (January 2000 – December 2008), following a national trend, traffic volume counts at both RLC and comparison group intersections declined.

Crash data for the RLC study was provided by the New Mexico Department of Transportation (DOT) through the University of New Mexico's Division of Government Research (DGR). For this review, to maintain consistency, crash data for the two year study period was provided by DOT via DGR. DGR maintains a comprehensive traffic crash database for the state of New Mexico. The database contains information on every crash that occurs in New Mexico with property damage over $500 and that occurs on public property. Information needed to complete this type of study is included in the database. This includes: the date and time of the accident, the severity of the accident, the type of accident (i.e. intersection, non-intersection, intersection related), the street name, contributing factors (i.e. excessive speed, failed to yield, improper overtaking, driver inattention, under influence of alcohol), the highest contributing factor, number of occupants, number killed, number of injuries by seriousness, and number not injured.

City of Albuquerque Municipal Development staff was very helpful in providing us 2010 and 2011 official yellow light timings for the YLI intersections and the comparison intersections used in this study. During calendar year 2010 and calendar year 2011 and earlier City of Albuquerque determined yellow light intervals based on the Institute of Transportation Engineers (ITE) Formula method and the posted speed limit. Through the use of this method citywide, the City implemented a 'rule of thumb' practice for how yellow light intervals were timed. The City has historically made exceptions based on the geometry of the roadway and intersection.

With the proposed data a variety of analyses can be conducted all of which are similar to those used in the RLC study. Analyses were conducted on two levels. First, all 20 intersections, both the 18 YLI intersections and 2 ARL intersections, were included using the methods described below. Second, the 2 ARL intersections were removed and the three methods were applied to the 18 YLI intersections. This was done in order to study the effect and the difference in crashes on YLI intersections. Because there are only two ARL intersections it was not possible to separately study the effects of the all-red light clearance timing intervention on crashes at the two intersections.

A simple before and after study. This method focuses on the comparison of the frequency and rate of crashes by total, type of crash (rear-end and right-angle), and crash severity (fatal, injury, and property damage only) for a period of time before the change in timings to intersections with YLIs and ARL timings and for a similar period of time after the intervention. This method assumes *no changes* other than the installation of YLIs and ARL timings has occurred from the before to the after periods. This simple (or naïve) method assumes that if nothing has changed the crash frequency and rate before the two interventions is a good estimate of what would have happened during the after period without the interventions. The assumption of no change is questionable but this analysis serves as a starting point and a baseline measure for comparison. With this method, the effect of the interventions is determined by the difference between the number of crashes before and the number of crashes after the two interventions was implemented.

Before and after study with a correction for traffic flow. This method adjusts the impact of the interventions on safety from the before to after study periods by correcting for traffic volumes. Traffic volume is an important factor that is influential on travel safety. Numerous factors may affect safety such as changes in traffic volume, changes in the geometry of the intersection (i.e. increase/decrease in the number of travel lanes, change in speed limits, the use of protected left turn lanes as compared to permitted left turn lanes, etc.), weather, surrounding land uses, and the driving population. With this method, the effect of the interventions is determined by the difference between the crash rate in million entering vehicles before and the crash rate in million entering vehicles after the interventions was implemented.

Before and after study using comparison intersections. This study uses comparison intersections in order to consider the effects of unrecognized factors. This type of study allows the comparison of intersections without the interventions with YLI and ARL intersections. Comparison intersections are defined as intersections that are similar in crash rates, traffic volume, and geographic characteristics. The crash data at the comparison group sites can be used to compare against the crashes that occurred at the study intersection sites if the YLI and ARL timings had not been implemented.

Cost analysis. This study includes a cost analysis that translates the change in observed crashes by severity from the pre-time period to the post-time period to a dollar impact. This is different than what was done in the RLC study. In that study we used the results from the Empirical Bayes (EB) method to conduct the cost analysis. Because EB corrects for the regression to the mean (RTM) problem it is a better method for this type of study and cost analysis. An EB analysis was not available for this study.

The proposed review does not include a before and after study using the Empirical Bayes (EB) method which were used in the RLC study. EB is not used because the City considered that the three proposed methods are sufficient for the purpose of this review. In addition, the completion of this type of analysis takes longer, requires additional resources, and a longer study period, which were not available for this study. Most importantly, the length of the study period (11-months) is short and longer time periods are recommended for EB. Longer time periods are relevant for considering regression to the mean effects as well as sample size considerations. The Empirical Bayes (EB) method has been designed to adjust for the regression to the mean (RTM) problem, which is a serious problem associated with before and after traffic safety studies. Regression to the mean is a problem that occurs in this type of study because intersections are chosen for interventions, like adjustments in yellow intervals and all-red light clearance intervals, because they are thought to have a relatively high rate of crashes. They are 'hotspots' for crashes and sites that need to be treated to reduce the frequency and severity of crashes. Because these intersections were chosen because they were 'hotspots' we could conclude the intersections would drop normally from previous high levels in spite of the introduction of treatments – high accident frequencies may tend to move to the average over the long term. As a result, the application of the comparison group method may tend to over-estimate the treatment effect, since it fails to correct the RTM problem. EB is a much more complex design, but is also more robust.

Yellow Light Signal Timings and All-Red Light Clearance Interval Timings

To confirm the new official yellow light timings at 18 of the 20 former RLC intersections that began January 1, 2011 provided by the city, ISR staff traveled to each of the YLI intersections and comparison intersections, sometimes more than once, to collect yellow light timings. ISR staff also travelled to the 2 ARL intersections to collect red-light timings. General information on each intersection (i.e. number of travel lanes by direction, presence of dedicated left turn lanes, pedestrian crossing signals, the presence of solid medians, presence of crosswalk, presence of red light camera signs, and rumble strips), and a general description of the intersection including a map of the intersection was not collected because this was done in the previous RLC study. Appendix A includes a copy of the intersection data collection instrument.

The list of comparison intersections used in the previous study was also used in this study. The list of potential comparison intersections was based on average total crashes, average crashes by type (rear-end and angle), by type of injury (fatal, injury, and property damage only), and traffic volume. From this list various criteria were used to select comparison intersections including total crashes, the crash rate, and daily traffic. After extracting intersections that for a variety of reasons did not meet our criteria for inclusion as a comparison intersection we created a sample of 37 comparison intersections. We followed an identical process of collecting information at comparison group intersections.

LITERATURE REVIEW

Numerous countermeasures exist for impacting crashes at signalized intersections, which can generally be divided into either engineering or enforcement countermeasures. This section reviews existing research focused on enforcement countermeasures and more specifically YLI and ARL research.

According to the National Highway Traffic Safety Administration's (NHTSA) (2011), in 2009 approximately 2,210,000 crashes occurred at intersections or were intersection related. Of these crashes an estimated 1,158,000 crashes occurred at signalized intersections. Approximately 2,299 crashes at the signalized intersections resulted in fatalities, another estimated 370,000 resulted in injuries, and approximately 785,000 were deemed property-damage only crashes. According to the National Safety Council (NSC) (2011), in 2009 approximately 699 fatal crashes plus an estimated 87,100 non-fatal injury crashes occurred at intersections or were intersection related due to a red light running violation.

A red light violation occurs when a vehicle enters an intersection some time after the signal light has turned red. Vehicles inadvertently in an intersection when the signal changes to red (i.e. waiting to turn left) are not red light runners (Q&As: Red Light Cameras http://www.iihs.org/research/qanda/rlr.html). A nationwide study of fatal crashes at traffic signals in 1999 and 2000 estimated that 20 percent of drivers fail to obey traffic signals (Q&As: Red Light Cameras http://www.iihs.org/research/qanda/rlr.html).

Red light running is complex and there is no single reason to explain why drivers run red lights. Broadly, reasons fall into demographic, human behavioral, vehicle, and interaction characteristics categories (Burkey and Obeng, 2004). Demographic characteristics include age and gender. Drivers between 18 to 25 years of age and males are more likely to run red lights (FHWA, 2009). According to an Institute for Transportation Engineers (ITE) (2003) study red light runners tend to be less than 30 years old, have a record of moving violations, are driving without a valid license, and have consumed alcohol. Human behavioral factors include driver inattention that may be caused by numerous factors including: drowsiness, eating, using a cell phone or other hand held device, and talking with passengers. Speeding and aggressive driving are other factors. Intersection characteristics include traffic volumes, time of day (violations are higher during a.m. and p.m. peak travel hours) approach grade, and frequency of signal cycles. Motorists are more likely to be injured in urban crashes involving red light running than in other type of urban crashes. A study of urban crashes conducted by the Insurance Institute for Highway Safety found that running red lights and other traffic controls was the most common cause of all accidents (22 percent) and those injuries are prevalent within this category of crashes. According to the study, injuries occurred in 39 percent of crashes involving the running of a traffic control, the highest proportion of any type of crash (Retting et al., 1999). In general, red light running violations and crashes are negatively associated with approach flow rates, negatively associated with yellow indication duration, positively associated with approaching speeds, and negatively associated with clearance path length (i.e., the width of the intersection). A study by Bonneson and Zimmerman (2004A) on the effect of yellow light interval timing on the frequency of red light running at urban intersections found that an increase of 0.5 to 1.5 seconds in the yellow light interval (as long as the total time did not exceed 5.5 seconds) decreased red light running by 50%. The authors also found that while drivers adjust to the longer yellow light interval, the increase in time did not 'undo' the benefit of an increased yellow interval.

Numerous counter measures exist to reduce the number of crashes and red light runners at signalized intersections. Red light running countermeasures fall into one of two categories: enforcement countermeasures and engineering countermeasures (Bonneson and Zimmerman, 2004A). Enforcement countermeasures encourage compliance through the threat of a citation and a possible fine. These countermeasures require the use of either a police officer or an automated system to identify red light violators. Engineering countermeasures aim to reduce the incidences of red light running by improving driver awareness of the signal light or by reducing the number of incidences in which drivers are put in the position of having to decide whether or not to run the red light (Bonneson and Zimmerman, 2004A). Engineering countermeasures usually fall into four broad categories, including countermeasures that:

- Increase the visibility from a sufficient distance to capture the driver's attention (visibility and conspicuity).
- Increase the likelihood of stopping for the red signal when seen.
- Address intentional violators.
- Eliminate the need to stop altogether. (Institute of Transportation Engineers, 2003 and FHWA, 2009)

Some intersection characteristics including the design and configuration characteristics can increase the incidence of red light running. This includes the road grade approaching intersections, sight distance, roadside obstructions (i.e. trees, billboards, and traffic control devices), and approach traffic volumes,

Specific engineering countermeasures recommended by the Federal Highway Administration (2009) to reduce red light running include:

- Set appropriate yellow light time intervals that allow vehicles to clear the intersection or safely stop that is consistent with the speed limit, road grade and intersection width.
- Add a brief all-red light clearance interval to allow traffic in the intersection to clear prior to releasing cross traffic.
- Improve signal head visibility by increasing size or adding signal heads where one signal head is used for multiple lanes and may be blocked from view.
- Address east-west roads where sun angles silhouette the traffic signal head and add back plates to enhance visibility.
- Add intersection warning signs or advanced yellow flashing lights or reduce the approach speed to the intersection.
- Coordinate traffic signals to optimize traffic flow, eliminating interruptions.
- Remove on-site parking near intersections to increase visibility of pedestrians and cross traffic.
- Repair malfunctioning lights and avoid unnecessarily long cycle timings.

While several studies have shown that RLC programs reduce the number and rate of red light running violations (Retting et al., 1999) including the Albuquerque RLC study completed in 2010 there are other available countermeasures. The next section focuses on the two interventions that are part of this study: yellow light time intervals and brief all-red light clearance intervals.

All-Red Light Timing Clearance Interval

The goal of implementing an all-red light timing clearance interval is to allow vehicles in the intersection when the light turns from green to yellow to red time to clear the intersection by holding all lights red for a limited time. Although this does not affect the act of running red lights, it has been proven to reduce the number of right-angle crashes at intersections, thereby increasing safety for motorists (ITE, 2003). Of 76 city traffic engineers who responded to a survey regarding use of all-red clearance intervals at intersections within their cities approximately 80% reported use of all-red clearance intervals at ALL intersections within their cities and the remaining 20% disclosed using all-red clearance intervals at some of their signalized intersections (ITE, 2003). Standard red light clearance intervals range from 0.5 to 2.0 seconds. A study by Datta, et al. (2000) showed all-red clearance intervals ranging from 1.5 to 2.0 seconds in length helped to reduce both right angle crashes and injuries at implemented intersections in Detroit.

Yellow Light Interval

The Federal Highway Administration (FHA) requires all green signalized lights to be followed by a yellow signal cautioning drivers the pass through of the intersection is ending and a red signal to stop is imminent (FHA, 2001). Although yellow lights are required there is not a set national practice for setting the length of the yellow light (ITE, 2003). However, many studies recognize the equation devised by ITE (1999) as one of the surest methods for computing an appropriate yellow light interval for an intersection:

$$\mathrm{CP} = t + \frac{V}{2a + 64.4g} + \frac{W + L}{\mathrm{V}}$$

t = perception-reaction time of the motorist (typically 1 second)
V = speed of the approaching vehicle expressed in ft./sec.
α = comfortable deceleration rate of a vehicle (typically 10 ft./sec.)
W = width of intersection
L = length of vehicle (typically 20 ft.)
g = grade of the intersection approach in percent divided by 100 (downhill is negative)

The FHA provides guidelines to yellow light timings of 3 to 6 seconds depending on the approach speed to the intersection, with the greater length of time going to the intersections with greater approach speeds (FHA, 2001). Appropriate yellow light timings ascertained by traffic engineers is crucial for intersection safety, and due diligence to safety at the individual intersections must be taken into account at all times when enhancing the yellow light interval (NCSRLR, 2009).

The purpose of increasing the yellow light interval is to allow drivers greater reaction time to the changing light, allow vehicles more time to clear the intersection, and to decrease the number of red light runners. The practice of enhancing the yellow light interval in an effort to decrease the number of red light runners has shown promising results from a number of studies.

A study by Bonneson and Zimmerman (2004A) on the effect of yellow light interval timing on the frequency of red light running at urban intersections found an increase of 0.5 to 1.5 seconds in the yellow light interval (as long as the total time did not exceed 5.5 seconds) decreased red light running by 50%. The authors also found that while drivers adjust to the longer yellow light interval, the increase in time did not 'undo' the benefit of an increased yellow interval. A subsequent study by Bonneson and Zimmerman (2004B) found yellow light intervals should be between 3.2 and 5.4 seconds for approaching speeds ranging from 30 to 60 mph. Red light running was shown to increase when yellow light intervals were less than 3.2 seconds and greater than 5.4 seconds.

Another study by Van der Horst and Wilmink (1986) found a 50% decrease in red light running when yellow light intervals were increased by 1 second (3 seconds increased to 4 seconds and 4 seconds increased to 5 seconds in rural areas). Retting and Green (1997) reported lengthening yellow light intervals provides red light compliance and sustained safety benefits resulting from fewer crashes. Driver habituation to the yellow light interval change did not appear to occur and reduce the effect on lengthening the interval of the yellow light.

Retting el al. (2008) revealed a 36% overall decrease of red light running at experimental sites where the yellow light interval was increased by 1 second at 6 approaches at two intersections. However, results from 3 comparison sites were inconsistent. Two of the comparison sites also experienced a decrease of red light running by 23% and 27%, while the third comparison intersection had a 60% increase in red light running violations.

Habituation to the increased yellow light interval is a potential side effect (ITE, 2003). The time for one signal cycle to complete is lengthened when the yellow light interval is lengthened. This causes drivers and pedestrians to have to wait longer for their turn to go through the intersection. If the cycle is too long, drivers may habituate to the lengthened signal and enter the intersection later in the cycle in order to avoid having to stop at the excessively long light (ITE, 2003). This would decrease the potential benefits increasing the yellow light interval could bring. Bonneson and Zimmerman (2004A) reported yellow light intervals should not exceed 5.5 seconds as longer intervals correlate with a decrease in potential benefits as drivers would begin entering the intersection later in the cycle.

There are numerous treatments to help reduce red light running and increase the safety of signalized intersections. Implementations of both all-red clearances and lengthening yellow light intervals have proven to increase safety at signalized intersections. Enhancing the yellow light intervals has shown to decrease red light running as well. Responsible measures should be taken, such as having traffic engineers study an intersection, before treatment measures are implemented (NCSRLR, 2009). Yellow light intervals should not be lengthened beyond 5.5 seconds as the benefits of increasing the yellow light interval will diminish (Bonneson and Zimmerman, 2004A).

Calculating the Economic Benefit of Intersection Related Crash Reduction Measures

Calculating the cost of traffic crashes can be complex and generally two approaches are used to assign monetary costs. Economic costs, also called human capital costs, measure the cost of crashes that have occurred and don't measure the total cost to society that includes losses in the quality of life. The second approach is referred to as comprehensive costs and this approach includes the sum of economic costs plus an estimate of quality of life costs. Quality of life costs include physical and mental suffering, quality of life, and permanent cosmetic damage (Hanley, 2004).

The use of economic costs only is useful for measuring the cost of past motor vehicle crashes and should not be used to estimate the dollar value of future benefits due to traffic safety measures. The comprehensive cost approach which combines economic costs with quality of life costs can be used to estimate future benefits. The National Safety Council (NSC) (NSC, 2011) suggests that whenever possible this calculation should be used for cost benefit analyses.

The following briefly describes the two primary sources that have been used to estimate the costs of motor vehicle crashes (Hanley, 2004). First, the National Highway and Traffic Safety Administration (NHTSA) examined the cost of motor vehicle crashes in 1996 and 2000 (Blincoe et al., 2002). In both reports the Abbreviated Injury Scale (AIS) was used as the basis for stratifying costs by injury severity. AIS codes are mainly directed toward the immediate threat to life resulting from an injury and are estimated shortly after a crash occurs. The AIS, developed in 1969, ranks injuries on a scale of 1 (minor) to 6 (un-survivable). Because some motor vehicle crashes result in longer term injuries with more expensive outcomes, the AIS is not always an accurate predictor.

Various costs are associated with motor vehicle crashes including costs associated with programs designed to improve safety, in this study yellow light timings. Economic costs are comprised of a number of separate categories including: medical costs, property damage costs, legal costs, workplace costs, insurance administration costs, household productivity costs, emergency services costs, and travel delay costs. Other types of costs that is not economic such as physical pain and emotional anguish can be more difficult to estimate. NHTSA has focused on the economic impact of motor vehicle crashes and using these costs alone does not produce the most accurate cost-benefit ratio and so produces conservative estimates. The largest cost components are property damage, market productivity, and medical, which together accounted for approximately 66% of the cost of a crash. According to NHTSA (2011) the value of fatal risk reduction per life saved falls in the range of $2-5 million.

Second, the National Safety Council (NSC) publishes an annual bulletin (NSC, 2011) which estimates the costs of motor vehicle injuries. The NSC estimates includes wage and productivity losses, medical expenses, administrative expenses, vehicle damage, and employer's uninsured costs. The cost of all these items is calculated for each fatality, injury and property damage crash. The most recent NSC publication reflects 2008 data. NSC also calculates the comprehensive costs of motor vehicle crashes which focus on measures of the value of the lost quality of life. NSC reports crash severity using the KABCO injury scale established by the American National Standards Institute (ANSI). This injury scale is designed for law enforcement coding of motor vehicle crashes and is the scale used in the New Mexico Uniform Crash Report. The KABCO injury scale measures fatalities (K), incapacitating injuries (A), non-incapacitating injuries (B), possible injuries (C), and property damage only (O).

Tables 1 and 2 separately show the NHTSA 2009 and NSC 2008 estimated costs. Because the two reporting systems are different the values are not directly comparable. As noted above, NHTSA reports crash severity based on the Abbreviated Injury Scale (AIS) while the NSC reports crash severity using the KABCO injury scale.

Because NHTSA used the AIS which do not directly match the KABCO scale used by many law enforcement agencies in their crash reports it has been necessary to map AIS categories to traffic crash reports generated by law enforcement agencies (Council et al., 2005).

Table 1. NHTSA Cost per Person

Crash Type	2001 Dollars
Unsurvivable	$1,000,977
Critical	$1,122,824
Severe	$356,600
Serious	$190,624
Moderate	$68,445
Minor	$10,819
Property Damage Only	$2,593

Table 2. NSC Total Cost per Person

Crash Type	2008 Dollars	
	Economic Cost	Comprehensive Cost
Fatal (K)	$1,300,000	$4,200,000
Incapacitating (A)	$67,200	$214,200
Non-Incapacitating (B)	$21,800	$54,700
Possible (C)	$12,300	$26,000
Property Damage Only (O)	$2,400	$2,400

Due to the low frequency at which fatalities (K) and incapacitating injuries (A) occur, fatalities and incapacitating injuries are often combined into a single category - K+A (Council et al., 2005; Washington & Shin, 2005). In a number of previous RLC studies when possible injuries (C) were compared to non-incapacitating injuries (B) the cost level of C was higher than B. Because injuries should have a higher cost than possible injuries this finding is counterintuitive. One possible reason why this may occur is that sometimes crash reports record minor injuries as C which later turns out to be more costly whiplash injuries (Council et al., 2005). Due to the high cost and infrequency of K+A, and the difficulty in coding non-incapacitating injuries and possible injuries all injuries have been grouped together in previous studies. Crashes with no injuries (Property Damage Only – PDO) become a second category, which creates cost groups: all injury related crashes K+A+B+C, and PDO crashes (Council et al., 2005; Washington & Shin, 2005). The analysis of injury related crashes and PDO crashes are important to measure the cost benefit of red light running reduction and other traffic crash safety systems.

RESEARCH DESIGN

As noted earlier this study uses three methods to study the effectiveness of the two interventions – YLI and ARL. These three methods are common in the traffic safety literature (Ozbay et al., 2009). Our study uses these methods with some slight modifications. In the second and third method we calculate crashes per million entering vehicles (MEV). In addition we conduct a cost analysis of the benefits of the interventions. These methods are:

A simple before and after study. This method focuses on the comparison of the frequency and rate of crashes by total and type of crash (rear-end and right-angle) for a period of time before the change in timings to intersections with YLIs and ARL and for a similar period of time after the intervention. This method assumes no changes other than the installation of two interventions has occurred from the before to the after periods. This simple (or naïve) method assumes that if nothing has changed the crash frequency and rate before the interventions is a good estimate of what would have happened during the after period without the interventions. The assumption of no change is questionable but this analysis serves as a starting point and a baseline measure for comparison. With this method, the effect of the interventions is determined by the difference between the number of crashes before and the number of crashes after the interventions was implemented.

Before and after study with a correction for traffic flow. This method adjusts the impact of the interventions safety from the before to after study periods by correcting for traffic volumes. Traffic volume is an important factor that is influential on travel safety. Numerous factors may affect safety such as changes in traffic volume, changes in the geometry of the intersection (i.e. increase/decrease in the number of travel lanes, change in speed limits, the use of protected left turn lanes as compared to permitted left turn lanes, etc.), weather, surrounding land uses, and the driving population. With this method, the effect of the interventions is determined by the difference between the crash rate in million entering vehicles before and the crash rate in million entering vehicles after the interventions were implemented.

Before and after study using comparison intersections. This study uses comparison intersections in order to consider the effects of unrecognized factors. This type of study allows the comparison of intersections without the interventions with intervention intersections. Comparison intersections are defined as intersections that are similar in crash rates, traffic volume, and geographic characteristics. The crash data at the comparison group sites can be used to help estimate the crashes that would have occurred at the intervention site intersections if the interventions had not been implemented.

Paired Samples T-Test

The Paired Samples T-Test is used in the simple before and after study, the before and after study with a correction for traffic flow and the before and after study using comparison intersections to measure the difference in crashes before and after the implementation of the yellow light interval intervention and all-red light clearance intervention. The Paired Samples T-Test compares the means of two variables. It computes the difference between the two variables for each case, and tests to see if the average difference is significantly different from zero. This is a "repeated measures" test and requires a sufficient sample size to statistically measure significant differences before and after a treatment; in this study the effect of the implementation of the yellow light interval intervention at 18 intersections and the all-red light clearance intervention at two intersections is assessed. The sample size of two all-red light clearance intersections is not large enough to conduct a paired samples t-test. For this reason we are not able to statistically detect differences in the all-red light clearance intersections alone. These two intersections are combined with the 18 YLI intersections to create a sample of 20 intersections. In addition, the 18 YLI are also analyzed separately so as to isolate that effect. We also report differences in crash counts and million entering vehicle crash rates before and after the implementation of the intervention by study intersection.

Cost Analysis

This study includes a cost analysis that translates the observed changes in the frequency of crashes to a dollar impact. This analysis relies on the use of the observed number of crashes in the pre-time and the observed number of crashes in the post-time period. The difference in the total crashes and type/severity of crashes is used along with the cost information provided in

Table 2 as described above. This is different than what was done in the RLC study. In that study we used the results from the Empirical Bayes (EB) method to conduct the cost analysis. Because EB corrects for the regression to the mean (RTM) problem it is a better method for this type of study and cost analysis. An EB analysis was not completed for this study.

This analysis is conducted using cost data available from the National Safety Council (NSC). Other studies have used cost data developed by the National Highway Traffic Safety Administration (NHTSA) (Council et al., 2005). The NSC estimate we use includes economic costs (i.e. wage and productivity losses, medical expenses, administrative expenses, vehicle damage, and employer's uninsured costs) and comprehensive costs that focus on lost quality of life. The cost of all these items is calculated for each fatality, injury and property damage crash. NSC uses the KABCO injury scale established by the American National Standards Institute (ANSI). This injury scale is designed for law enforcement coding of motor vehicle crashes and is the scale used in the New Mexico Uniform Crash Report. The KABCO injury scale measures fatalities (K), incapacitating injuries (A), non-incapacitating injuries (B), possible injuries (C), and property damage only (O). Due to the high cost and infrequency of K+A, and the difficulty in coding non-incapacitating injuries and possible injuries all injuries have been grouped together in previous studies. Crashes with no injuries (Property Damage Only – PDO) become a second category, which creates cost groups: all injury related crashes K+A+B+C, and PDO crashes (Council et al., 2005; Washington & Shin, 2005). The analysis of injury related crashes and PDO crashes are important to measure the cost benefit of RLC systems. Using this method the estimated dollar impact is conservative. This occurs for several reasons. First, the NTHSA calculated costs for possible injuries which have been used in other studies (Council et al., 2005; Washington & Shin, 2005) uses a possible injury cost that is at least 25% higher than the NSC estimate of $26,000. Similarly, the NHTSA property damage only costs are higher by a minimum of 360%. Second, the estimated cost we use for injury crashes is for possible injury crashes. This means we include fatal injuries, incapacitating injuries, and non-incapacitating injuries, which have higher cost estimates into a lower cost estimate. This is done because fatal crashes and incapacitating injuries are relatively rare and it was not possible in this study because of time and cost considerations to separate out this level of detail. Third, our calculations are done by crash and not injury or number of vehicles involved in the crash. For example, some crashes involve multiple vehicles and multiple injuries. Again, because of time and cost considerations this study does not include this level of analysis.

SITE DESCRIPTION

Albuquerque, New Mexico is the largest city in New Mexico with a 2010 estimated population of 535,239 (http://www.cabq.gov/econdev/whyabqquickfacts.html). Albuquerque covers an area of 188.8 square miles and in early 2010 had slightly more than 600 signalized intersections.

Beginning in May 2005 and through December 2010 the City of Albuquerque had a maximum of 20 RLC intersections with 40 total monitored approaches. All intersections had 2 cameras (monitored approaches) with the exception of Eubank and Montgomery, which had one monitored approach, and Coors and Montano which had 3 monitored approaches. All cameras took only rear photographs and video and all 40 approaches recorded both red light running violations and speeding violations. Red light running citations and/or speeding citations were issued to the vehicle owner. The program officially began in May 2005, the last RLC intersection was added in March 2007, and the program was discontinued in December 2010.

Defining Intersection Crashes

Intersection crashes in this study are defined as either 'intersection' crashes or 'intersection related' crashes that occurred at an intersection that was controlled by an active traffic signal. According to NM State Statute (Section 66-7-209 NMSA 1978) New Mexico law enforcement agencies are required to use the New Mexico Uniform Crash Report form (Appendix B). The statute requires that written reports contain sufficiently detailed information to describe the cause, conditions, the persons, and vehicles involved. Reports are most frequently completed by law enforcement officers at the scene of accidents but may also be completed by citizens who complete reports at a local law enforcement agency (usually one of the six APD substations in Albuquerque) typically, but not always, when a local enforcement officer is not able to respond to an accident. While not known it is believed that less than 5% of all accident reports in this study were completed by citizens. Because citizens, unlike law enforcement officers, are not trained to complete crash reports data quality is more of an issue in citizen completed reports. By NM State Statute written reports are supposed to be forwarded to the NM Department of Transportation where they are entered into a statewide database.

The Uniform Crash Report form contains driver/occupant level, vehicle level, and crash level information. Information includes: the date and time of the accident, the severity of the accident, the type of accident (i.e. intersection, non-intersection, intersection related), a major street code and secondary street code, contributing factors (i.e. excessive speed, failed to yield, improper overtaking, driver inattention, under influence of alcohol), the highest contributing factor, number of occupants, number killed, number of injuries by seriousness, number not injured, distance from in intersection, and relation to intersection (i.e. intersection, intersection related, and non-intersection).

These reports are entered into a traffic crash database that is maintained by the University of New Mexico's Division of Government Research (DGR). The database contains information on every crash that occurs in New Mexico with property damage over $500 and that occurs on public property.

From these crashes alcohol involved crashes were extracted. Alcohol involved crashes were removed because they would have occurred regardless of the existence of the YLI or ARL interventions. It is important to note whether a crash is an intersection crash or intersection related crash or not is coded by the reporting officer and so accuracy of this information is a potential problem. This is particularly true of intersection related crashes. Currently there is no standard method or policy that defines intersection related for officers completing reports and so reporting officers subjectively determine whether a crash is intersection related. There is a field on the uniform crash report that allows officers to note how far from the intersection in feet a crash occurred, but this field is rarely completed by officers.

Traffic Volumes

The raw traffic volume data provided by the MRCOG was compiled to provide annual and total traffic volumes for each study and comparison group intersection for each respective pre-time period and post-time period. Using these data we calculated an average daily traffic count for each pre- and post-time period. Table 3 reports the total pre-study traffic volume and post-study traffic volume for all 20 study intersections and each intersection separately.

Traffic volume increased 0.02% or slightly over 218 vehicles a day from the before time period to the after time period. Changes in traffic volume varied by intersection; with 6 intersections experiencing increases from 0.53% to 11.71% and 14 intersections experiencing decreases from 0.02% to 6.47%. While in the past few decades there has been a large increase in vehicle miles traveled (VMT) in the U.S. more recent evidence indicates that VMT is no longer increasing as rapidly and in some areas is decreasing (Traffic Volume Trends http://www.fhwa.dot.gov/ohim/tvtw/tvtpage.cfm).

Table 3. Study Intersections Traffic Volumes

Intersection	AADT Before Period	AADT After Period	Change in AADT	Percent Change
All Study Intersections	1,265,534.33	1,265,752.32	218.00	0.02%
Yellow light interval intervention Intersections				
Academy and Wyoming	59,432.81	58,519.50	-913.32	-1.54%
Central and Eubank	58,526.66	58,515.53	-11.13	-0.02%
Ellison and Coors Bypass	62,457.40	69,768.79	7311.40	11.71%
Lomas and Eubank	61,945.95	61,917.70	-28.25	-0.05%
Lomas and Juan Tabo	46,368.94	48,357.22	1988.28	4.29%
Lomas and Wyoming	56,652.02	55,858.89	-793.13	-1.40%
Menaul and Carlisle	55,650.57	55,235.81	-414.76	-0.75%
Menaul and Louisiana	54,198.47	54,486.55	288.08	0.53%
Menaul and San Mateo	63,514.61	59,404.37	-4110.24	-6.47%
Menaul and Wyoming	62,082.73	61,213.57	-869.16	-1.40%
Montano and Coors	72,423.95	72,416.71	-7.24	-0.01%
Montgomery and Carlisle	66,093.65	65,036.15	-1057.50	-1.60%
Montgomery and Eubank	63,124.72	61,087.14	-2037.57	-3.23%
Montgomery and San Mateo	76,610.42	80,917.24	4306.82	5.62%
Montgomery and Wyoming	89,340.75	87,911.29	-1429.45	-1.60%
Paseo Del Norte and Coors	92,131.69	92,122.47	-9.21	-0.01%
Paseo Del Norte and Jefferson	74,549.70	70,966.85	-3582.85	-4.81%
Quail and Coors	55,528.56	56,857.56	1329.00	2.39%
All-Red Light Clearance Intervention Intersections				
Central and Coors	47,932.39	48,293.49	361.11	0.75%
Central and Louisiana	46,968.37	46,865.50	-102.87	-0.22%

Yellow Light Signal Timing and All-Red Light Clearance Timing System Description

Table 4 provides the yellow light timings prior to January 1, 2011 and after the change in timings that occurred on January 1, 2011. As shown in the table the yellow light timings increased at 18 of the previous RLC intersections. These increases were between 0.2 seconds and 0.8 seconds. At two intersections the all-red phase timing was changed and the yellow light intervals were not changed (Coors & Central and Central & Louisiana).

Each yellow light at the 57 study intersections was simultaneously timed twice by two different researchers (20 intersections were former red light camera intersections plus an additional 37 comparison intersections). At two of these intersections the red lights were also timed due to an all stop red enhancement that was implemented by the City at these specific intersections. The four timings for each yellow and red light were averaged and compared against the timings provided by the City of Albuquerque. If an averaged timing taken was plus or minus 0.20 seconds, a researcher was sent to the intersection to re-time the specific yellow light or red lights in question. In a previous study, it was found that a technician timing yellow lights had a reaction time of approximately 0.16 seconds (PB Americas Inc., 2007). Due to this slight lag in reaction time, yellow lights and red lights with a timing difference of < 0.20 seconds were considered to be correct.

Originally 3 intersections contained one light with timing differences greater than plus or minus 0.20 seconds. Two of these lights were yellow lights and one was an all-red light clearance intersection. All three lights were running under the time at which the City said they were set. After a third researcher was sent to the intersections showing timing discrepancies, 1 of the 3 lights that were running shorter than the City stated they should be set appeared to be running at the correct timing. We determined one of the yellow lights running shorter was timed incorrectly by one of the original timers, and the third timer's findings corrected the timing. The remaining yellow light and red light continued to run at a time less than the stated City time. The City was provided this information.

Table 4. Study Intersections Yellow Light Signal Timing Changes and All-Red Light Clearance Interval Timing Changes

Name of Intersection	Old Yellow Light Timing		New Yellow Light Timing		Old All-Red Phase Timing		New All-Red Phase Timing		ISR Red Phase Timings	Difference between ISR and CABQ Red Phase Timings
	N/S	E/W	N/S	E/W	N/S	E/W	N/S	E/W		
Academy & Wyoming	4.0	4.0	4.5	4.8	N/A	N/A	N/A	N/A	N/A	N/A
Coors & Central	4.3	4.3	N/A	N/A	1.5	1.5	2.6	2.6	1.35	1.25
Central & Louisiana	4.0	4.0	N/A	N/A	1.5	1.0	1.6	1.6	1.75	0.15
Central & Eubank	4.0	4.0	4.5	4.5	N/A	N/A	N/A	N/A	N/A	N/A
Coors & Ellison	4.5	3.8	5.0	4.2	N/A	N/A	N/A	N/A	N/A	N/A
Lomas & Wyoming	4.0	4.5	4.5	4.5	N/A	N/A	N/A	N/A	N/A	N/A
Lomas & Eubank	4.0	4.0	4.5	4.5	N/A	N/A	N/A	N/A	N/A	N/A
Lomas & Juan Tabo	4.0	4.0	4.5	4.5	N/A	N/A	N/A	N/A	N/A	N/A
Menaul & Carlisle	4.0	4.0	4.2	4.5	N/A	N/A	N/A	N/A	N/A	N/A
Menaul & San Mateo	4.0	4.0	4.5	4.2	N/A	N/A	N/A	N/A	N/A	N/A
Menaul & Louisiana	4.0	4.0	4.2	4.5	N/A	N/A	N/A	N/A	N/A	N/A
Menaul & Wyoming	4.0	4.0	4.5	4.2	N/A	N/A	N/A	N/A	N/A	N/A
Coors & Montano	4.5	4.0	4.8	4.5	N/A	N/A	N/A	N/A	N/A	N/A
Montgomery & Carlisle	4.0	4.0	4.2	4.5	N/A	N/A	N/A	N/A	N/A	N/A
Montgomery & San Mateo	4.0	4.0	4.5	4.2	N/A	N/A	N/A	N/A	N/A	N/A
Montgomery & Wyoming	4.0	4.0	4.5	4.5	N/A	N/A	N/A	N/A	N/A	N/A
Montgomery & Eubank	4.0	4.0	4.5	4.5	N/A	N/A	N/A	N/A	N/A	N/A
Coors & Paseo	4.5	N/A	5.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Jefferson & Paseo	4.0	5.0	4.5	4.8	N/A	N/A	N/A	N/A	N/A	N/A
Coors & Quail	4.5	3.5	4.5	4.0	N/A	N/A	N/A	N/A	N/A	N/A

Yellow Light Interval Timings and All-Red Light Clearance Interval Timings

Because yellow light intervals have a large impact on crashes and because in our initial meetings with City of Albuquerque staff regarding this study this was mentioned as a particular area of interest, we have included this section. Both long intervals which can violate driver expectations and short intervals (shorter than Institute of Transportation Engineers suggested values) have resulted in a high number of red light running violations (FHWA 2009). As mentioned in the literature review, a study by Bonneson and Zimmerman (2003A) on the effect of yellow light interval timing on the frequency of red light running at urban intersections found that an increase of 0.5 to 1.5 seconds in the yellow light interval, as long as the total time did not exceed 5.5 seconds, decreased red light running by 50%. The authors also found that while drivers adjust to the longer yellow light interval the increase in time did not negate the benefit of an increased yellow interval.

As noted earlier the goal of implementing an all-red light clearance interval is to allow vehicles in the intersection when the light turns from green to yellow to red time to clear the intersection by holding all lights red for a limited time. Although this does not affect the act of running red lights, it has been proven to reduce the number of right-angle crashes at intersections, thereby increasing safety for motorists (ITE, 2003). Standard red light clearance intervals range from 0.5 to 2.0 seconds. A study by Datta, T. et al. (2000) showed all-red clearance intervals ranging from 1.5 to 2.0 seconds in length helped to reduce both right angle crashes and injuries at intersections in Detroit.

Selection of Comparison Intersections
For this study comparison intersections are the same as those used in the previous RLC intersection study less one intersection. This intersection was removed because we could not obtain accurate crash data for the post-study time period. Comparison intersections were selected using a number of available criteria. First, intersections must have been a signalized intersection in Albuquerque, New Mexico and must have had been signalized for the entire study period from January 2010 through December 2011. Using this broad criterion, potential study group signalized intersections were selected based on average daily traffic, average total crashes, average fatal and injury crashes, and average total crash rate for calendar year 2008. The 5th and 95th percentiles were used to select potential comparison signalized intersections. These criteria produced 53 potential comparison intersections where at least one of the criteria was met. Following this each intersection was reviewed by study group staff and some intersections were excluded. Excluded intersections included those with two or fewer total traffic lanes for a travel direction, intersections that include frontage road lanes and most intersections with less than four travel directions (one intersection included a residential street as a travel direction). This left us with 37 potential comparison group intersections. In addition to meeting the criteria noted above (average daily traffic, crashes by type and total crash rate) the comparison intersections have similar speed limits, number of travel lanes, yellow light interval timings, and other similar geographic characteristics (i.e. mixed land use, cross walks, median, curbs and left turn lanes). We did not have all the different variables that would have been useful to compare intersections like road grade.

Study intersections were originally chosen to be RLC intersections because they experienced high crash rates and so finding comparable comparison intersection could only be done very generally. As a group, the RLC intersections and now the YLI and ARL intersections had more total travel lanes, more left turn lanes, much higher crash rates, a much larger number of total crashes for the study period, and larger traffic volumes. With this in mind we matched intersections as well as possible using the available criteria. We also used general information on the geographic characteristics of the two groups of intersections combined with our knowledge of the City of Albuquerque to broadly match intersections on geography. Very importantly because the RLC system was in effect during most of the 11-month before study time frame at most of the intersections that are part of this study we cannot separate the effects of yellow light interval improvements and all-red clearance light change from the RLC system effects.

ANALYSIS

This section first provides a general description of Albuquerque crash data followed by the three different analyses described earlier.

Albuquerque Crash Data

This section provides a general description of crash data for Albuquerque, for the yellow light interval intervention intersections, and the comparison intersections. Crashes are represented in two distinct ways. Crashes are reported by type of crash, either angle crashes (right angle crashes and left turn crashes) or rear-end crashes and by crash severity (fatal/injury and property damage only). It is important to note angle crashes and rear-end crashes can either be fatal/injury or property damage only. It is also important to remember that angle crashes + rear-end crashes = total crashes and fatal/injury crashes + property damage only crashes = total crashes.

In time for this report we were only able to acquire complete crash data for January 2011 through November 2011. We were not able to acquire complete crash data for December 2011. This occurred because there is a time lag between when crashes occur and crash reports are completed by reporting law enforcement agencies, when crash reports are provided to the DOT, and when crash reports are entered into the traffic crash database. Since we were only able to acquire complete traffic crash data for January 2011 through November 2011 we restricted our study to an eleven month pre-time period (January 2010 through November 2010) and an eleventh month post-time period (January 2011 through November 2011).

Table 5 presents crash data for the 20 study intersections (18 YLI and 2 all-red phase intervention) and the 37 comparison intersections. Between January 2010 and November 2011 there were 1,196 crashes at the 37 comparison intersections and 938 crashes at the 20 study intersections. The average number of crashes of 32.3 for comparison intersections between January 2010 and November 2011 was much lower compared to the average number of 46.9 study intersection crashes.

As expected, there was very few fatal injury crashes. There was one fatal injury crash at a study intersection and one fatal injury crash at a comparison intersection. There were more rear-end crashes and PDO crashes at both study and comparison intersection when compared to angle crashes and injury crashes. Injury crashes made up almost 31% of all comparison intersection crashes and 26.3% of all study intersection crashes. Property damage only crashes accounted for the largest number and percent of all crashes at both comparison intersections (69%) and study intersections (73.6%).

Table 5. Summary Statistics of Crashes for the City of Albuquerque, Study Intersections and Comparison Intersections 2010 - 2011

Variable	Crashes in Comparison Intersections		Crashes in YLI and ARL Intersections	
Count of Intersections	37		20	
Count of Crashes	1,196		938	
Average Number of Crashes per Intersection	32.3		46.9	
	Frequency	Percent	Frequency	Percent
Fatal	1	0.1%	1	0.1%
Injury	370	30.9%	247	26.3%
PDO	825	69.0%	690	73.6%
Angle	421	35.2%	237	25.3%
Rear-end	775	64.8%	701	74.7%

Table 6 reports the count of crashes for the study period for each YLI and ARL intersection and the count and percent of crashes by type of crash. For every intersection the percent of rear-end crashes was greater than the percent of angle crashes.

Table 6. Study Intersection Count of Crashes by Intervention for the Two Year Study Period by Crash Type by Intersection

Intersection	Total Crashes	Angle Crashes		Rear-end Crashes	
Yellow Light Interval Intervention Intersections					
	Count	Count	Percent	Count	Percent
Academy & Wyoming	37	16	43.2%	21	56.8%
Central & Eubank	46	18	39.1%	28	60.9%
Coors & Ellison	26	5	19.2%	21	80.8%
Lomas & Wyoming	29	1	3.4%	28	96.6%
Lomas & Eubank	39	9	23.1%	30	76.9%
Lomas & Juan Tabo	33	11	33.3%	22	66.7%
Menaul & Carlisle	24	7	29.2%	17	70.8%
Menaul & San Mateo	34	13	38.2%	21	61.8%
Menaul & Louisiana	28	11	39.3%	17	60.7%
Menaul & Wyoming	45	14	31.1%	31	68.9%
Coors & Montano	70	7	10.0%	63	90.0%
Montgomery & Carlisle	36	14	38.9%	22	61.1%
Montgomery & San Mateo	59	11	18.6%	48	81.4%
Montgomery & Wyoming	67	14	20.9%	53	79.1%
Montgomery & Eubank	42	12	28.6%	30	30.0%
Coors & Paseo	95	8	8.4%	87	91.6%
Jefferson & Paseo	80	21	26.3%	59	73.8%
Coors & Quail	60	17	28.3%	43	71.7%
All-Red Light Clearance Intervention Intersections					
Coors & Central	49	15	30.6%	34	69.4%
Central & Louisiana	39	13	33.3%	26	66.7%

Table 7 reports the number of crashes by intersection for the two year study period by severity of crash. The number of crashes was greater for each intersection for property damage only crashes compared to injury and fatal crashes. As shown in the table, there was one fatal crash during the two year study period at an YLI intersection.

Table 7. Study Intersection Count of Crashes for the Two Year Study Period by Crash Severity by Intersection

Intersection	Total Crashes	Fatal Crashes		Injury Crashes		PDO Crashes	
Yellow Light Interval Intervention Intersections							
	Count	Count	Percent	Count	Percent	Count	Percent
Academy & Wyoming	37	0	0.0%	13	35.1%	24	64.9%
Central & Eubank	46	0	0.0%	11	23.95	35	76.1%
Coors & Ellison	26	0	0.0%	6	23.1%	20	76.9%
Lomas & Wyoming	29	0	0.0%	9	31.0%	20	69.0%
Lomas & Eubank	39	0	0.0%	10	25.6%	29	74.4%
Lomas & Juan Tabo	33	0	0.0%	12	36.4%	21	63.6%
Menaul & Carlisle	24	0	0.0%	6	25.0%	18	75.0%
Menaul & San Mateo	34	0	0.0%	8	23.5%	26	76.5%
Menaul & Louisiana	28	0	0.0%	8	28.6%	20	71.4%
Menaul & Wyoming	45	0	0.0%	18	40.0%	27	60.0%
Coors & Montano	70	0	0.0%	15	21.4%	55	78.6%
Montgomery & Carlisle	36	0	0.0%	7	19.4%	29	80.6%
Montgomery & San Mateo	59	0	0.0%	4	6.8%	55	93.2%
Montgomery & Wyoming	67	0	0.0%	17	25.4%	50	74.6%
Montgomery & Eubank	42	0	0.0%	14	33.3%	28	66.7%
Coors & Paseo	95	0	0.0%	27	28.4%	68	71.6%
Jefferson & Paseo	80	0	0.0%	20	25.0%	60	75.0%
Coors & Quail	60	1	1.7%	15	25.0%	44	73.3%
All-Red Light Clearance Intervention Intersections							
Coors & Central	49	0	0.0%	18	36.7	31	63.3%
Central & Louisiana	39	0	0.0%	9	23.1	30	76.9%

Table 8 and Chart 1 report YLI and all-red light clearance intersection crashes by crash type by crash severity. The single fatal crash was an angle crash, 29.1% of angle crashes had injuries, and 70.5% were property damage only crashes. Slightly more than 25% of all rear-end crashes were injury crashes and 74.6% were property damage only crashes.

Table 8. Study Intersection Crashes - Crash Type by Crash Severity

Severity/Type	Angle Crashes		Rear-End Crashes	
	Count	Percent	Count	Percent
Fatal	1	0.4%	0	0.0%
Injury	69	29.1%	178	25.4%
PDO	167	70.5%	523	74.6%
Total	237	100.0%	701	100.0%

Chart 1. Crashes by Crash Type and Crash Severity

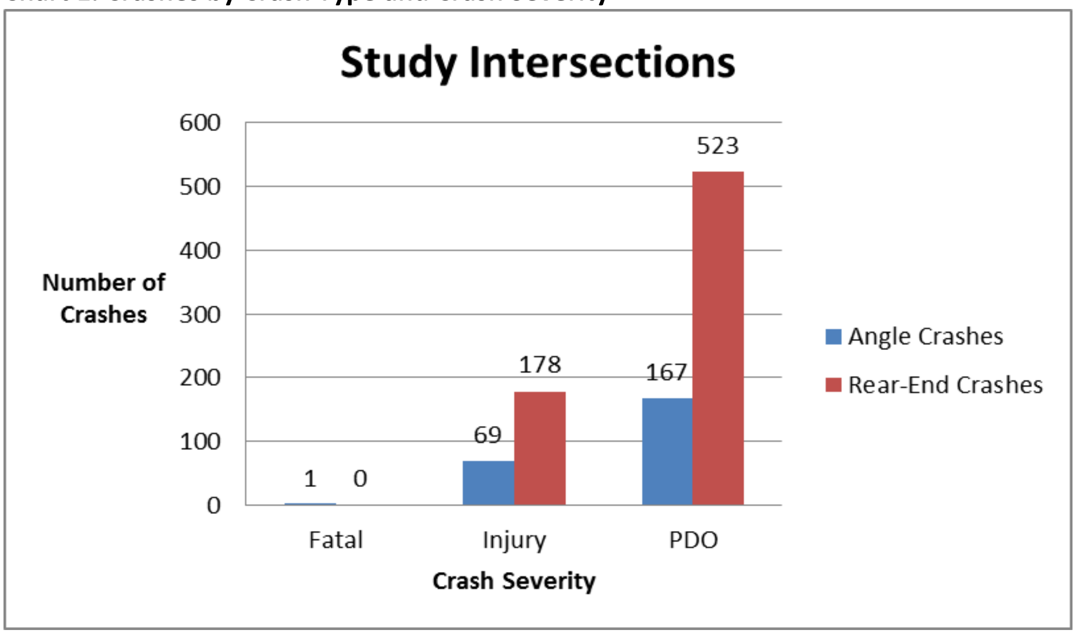

Table 9 reports differences in crashes by crash type and crash severity for the 20 study intersections. Between the pre- and post-study period there were 34 (7%) fewer total crashes. By crash severity there were 7 more injury crashes and 40 (11.1%) fewer PDO crashes. There was one fatal crash in the pre-time period and there were no fatal crashes in the post-time period. By crash type there were 17 (5.6%) fewer rear-end crashes and 17 (13.4%) fewer angle crashes.

Table 9. Study Intersections Crashes Pre and Post

	Pre-Count	Post-Count	Count Increase / Decrease	Percent Increase / Decrease
Total Crashes	486	452	-34	-7.0%
Crash Severity				
Fatal	1	0	-1	-100%
Injury Crashes	120	127	+7	+5.8%
PDO Crashes	365	325	-40	-11.0%
Crash Type				
Rear-End Crashes	359	342	-17	-4.7%
Angle Crashes	127	110	-17	-13.4%

The next two tables separately report the crash counts at the 18 YLI interventions and the 2 ARL intersections. As shown in Table 10 (YLI intersections) and Table 11 (ARL intersections) total crashes decreased by 8.1% for the YLI intersections and increased by 4.7% for the two ARL intersections. Injury crashes and angle crashes increased by 45.5% and 33.3% respectively for the ARL intersections while for the YLI intersections injury crashes increased 1.8% and angle crashes decreased by 18.3%. PDO crashes decreased by 11.1% for YLI intersections and 9.4% for ARL intersections and rear-end crashes decreased by 4.6% for YLI intersections and 6.5% for ARL intersections. These two tables show that crashes at the two types of intersections varied by type of intervention, with YLI intersections showing a reduction in total crashes and ARL intersections showing an increase in total crashes.

Table 10. YLI Study Intersections Crashes Pre and Post

	Pre-Count	Post-Count	Count Increase / Decrease	Percent Increase / Decrease
Total Crashes	443	407	-36	-8.1%
Crash Severity				
Fatal	1	0	-1	-100%
Injury Crashes	109	111	+2	+1.8%
PDO Crashes	333	296	-37	-11.1%
Crash Type				
Rear-End Crashes	328	313	-15	-4,6%
Angle Crashes	115	94	-21	-18.3%

Table 11. ARL Study Intersections Crashes Pre and Post

	Pre-Count	Post-Count	Count Increase / Decrease	Percent Increase / Decrease
Total Crashes	43	45	+2	4.7%
Crash Severity				
Fatal	0	0	0	N/A
Injury Crashes	11	16	+5	+45.5%
PDO Crashes	32	29	-3	-9.4%
Crash Type				
Rear-End Crashes	31	29	-2	-6.5%
Angle Crashes	12	16	+4	+33.3%

Table 12 reports the number of crashes by type and severity for study intersections for the pre-study period and post-study period. Because we were not able to classify one of the pre-study angle crashes as an injury or PDO crash the count of angle crashes in this table (126) is one less than the 127 pre-crashes shown in Table 9. Compared to the pre-study period there was a slightly higher percent of rear-end PDO crashes, rear-end injury crashes and angle injury crashes in the post-study period. Interestingly, there was 4.1% fewer angle PDO crashes in the post-study period compared to the pre-study period.

Table 12. Study Intersection Crashes by Type and Severity Pre- to Post-Study

Crash Type and Severity	Pre-study		Post-study	
	Count	Percent	Count	Percent
Rear-End Injury	90	18.6%	88	19.5%
Rear-End PDO	269	55.5%	254	56.2%
Angle Injury	30	6.2%	39	8.6%
Angle PDO	96	19.8%	71	15.7%
Total	485	100.0%	452	100.0%

Analysis 1: Simple Before and After Study

This analysis focuses on the comparison of the frequency and rate of crashes by total, crash severity (injury and property damage only) and crash type (rear-end and right-angle) for a period of time before the installation of YLIs and ARLs and for a similar period of time after the installation of YLIs and ARLs.

Table 13 shows the monthly average crashes in the before and after periods and the average difference. A positive average difference indicates an increase in the average crashes from the pre- to post-time period and a negative difference indicates a decrease in the average number of crashes from the pre- to post-time periods.

A paired sample t-test was performed to compare the pre- and post-period total crash counts for total crashes, each crash severity (fatal, injury and PDO) and each crash type (rear-end and angle) in the 20 study intersections. This test compares the average count of crashes per intersection for the pre- and post-time periods for the two interventions, and tests the difference in the means. The underlying assumption is that significant differences are a result of the YLI and all-red light clearance intervention, and other differences are due to random chance. For example; the average number of total crashes per intersection in 2010 was 24.3 and 22.6 in 2011, the difference in the means (1.7) was not statistically significant. A weak statistically significant difference (pre to post) was found for property damage only crashes. These results suggest the interventions reduced the number of these types of crashes. However, some caution is warranted when attributing all significant decreases in crashes to the intervention. The reason is that other factors could be at play that could have contributed to the change; such as the effects of the red light camera (RLC) intervention at these intersections. The analysis does show that the YLI and all-red light clearance reduced crashes above and beyond (or in addition too) the RLC's.

Table 13. Study Intersection Average Number of Crashes Pre and Post

	Pre-Count Average	Post-Count Average	Average Difference
Total Crashes	24.3	22.6	-1.7
Fatal	0.05	0.0	-0.05
Injury Crashes	6.0	6.4	0.4
PDO Crashes	18.3	16.3	*-2.0
Rear-End Crashes	18.0	17.1	-0.9
Angle Crashes	6.4	5.5	-0.9

*P< 0.1, **p<0.05, ***p<0.01, ****p<.0001

The next table (Table 14) provides similar information as Table 13 for each YLI and ARL intersection, but without the paired sample t-test. This statistical test is not appropriate for these data and neither is any other statistical test. The pre-count and post-count of crashes is provided for each intersection. This is followed by the change from the pre- to post-time period in the number of total crashes, injury type of crash (fatal, injury and PDO), and crash type (rear-end and angle). A positive number signifies an increase in the number of crashes from the pre- to post-time period and a negative number signifies a decrease in the number of crashes from the pre- to post-time period. The difference in the number of crashes from the pre- to post-time period varied by total crashes, crash type and injury type by intersection.

Six of the 18 YLI intersections experienced an increase in the total number of crashes and 12 YLI intersections experienced a decrease from the pre- to post-time period. One ARL intersection experienced an increase in crashes and the other ARL intersection experienced a decrease from the pre- to post-time period in the total number of crashes.

We found an overall increase of 2 crashes (5%) in the count of total crashes from the pre-study to the post-study time period at the two all-red light clearance intersections and an overall reduction of 36 crashes (8.0%) in the count of total crashes at the 18 yellow light timing increase intersections. Further, there was an overall increase in injury crashes (5 crashes) and angle crashes (4 crashes) at the two ARL intersections. There was an increase of two injury crashes and a reduction of 21 angle crashes and 37 PDO crashes at the 18 YLI intersections. Of interest is that one intersection (Coors & Central) accounted for 4 of the increase of 6 injury crashes in the post-study time period. Further, all 5 of additional crashes in the post-study time period were angle crashes. Four of these crashes were injury crashes and one was a PDO crash. As noted earlier in the report, all-red light clearance interval interventions have been proven to reduce the number of right angle crashes. The increase in angle injury crashes at this intersection should be further explored.

Table 14. Study Intersection Differences of Crashes at Intersections Pre and Post

	Differences in Crashes for Each Type of Crash							
Intersection	Pre Count	Post Count	Total	Fatal	Injury	PDO	Rear-End	Angle
Yellow Light Interval Intervention Intersections								
Academy & Wyoming	14.0	23.0	9.0	0.0	5.0	4.0	7.0	2.0
Central & Eubank	21.0	25.0	4.0	0.0	1.0	3.0	8.0	-4.0
Coors & Ellison	14.0	12.0	-2.0	0.0	2.0	-4.0	-1.0	-1.0
Lomas & Wyoming	15.0	14.0	-1.0	0.0	-1.0	0.0	0.0	-1.0
Lomas & Eubank	19.0	20.0	1.0	0.0	0.0	1.0	6.0	-5.0
Lomas & Juan Tabo	20.0	13.0	-7.0	0.0	-8.0	1.0	-4.0	-3.0
Menaul & Carlisle	14.0	10.0	-4.0	0.0	4.0	-8.0	-3.0	-1.0
Menaul & San Mateo	14.0	20.0	6.0	0.0	4.0	2.0	5.0	1.0
Menaul & Louisiana	15.0	13.0	-2.0	0.0	4.0	-6.0	-5.0	3.0
Menaul & Wyoming	24.0	21.0	-3.0	0.0	0.0	-3.0	1.0	-4.0
Coors & Montano	38.0	32.0	-6.0	0.0	3.0	-9.0	-9.0	3.0
Montgomery & Carlisle	24.0	12.0	-12.0	0.0	3.0	-15.0	-10.0	-2.0
Montgomery & San Mateo	28.0	31.0	3.0	0.0	0.0	3.0	8.0	-5.0
Montgomery & Wyoming	33.0	34.0	1.0	0.0	-5.0	6.0	1.0	0.0
Montgomery & Eubank	24.0	18.0	-6.0	0.0	-4.0	-2.0	-4.0	-2.0
Coors & Paseo	51.0	44.0	-7.0	0.0	-3.0	-4.0	-3.0	-4.0
Jefferson & Paseo	42.0	38.0	-4.0	0.0	-4.0	0.0	-7.0	3.0
Coors & Quail	33.0	27.0	-6.0	-1.0	1.0	-6.0	-5.0	-1.0
Total	443.0	407.0	-36.0	-1.0	2.0	-37.0	-15.0	-21.0
All-Red Light Clearance Intervention Intersections								
Coors & Central	22.0	27.0	5.0	0.0	4.0	1.0	0.0	5.0
Central & Louisiana	21.0	18.0	-3.0	0.0	1.0	-4.0	-2.0	-1.0
Total	43.0	45.0	2.0	0.0	5.0	-3.0	-2.0	4.0

Table 15 is similar to Table 13 with the exception that this table excludes the two ARL intersections in order to report the differences from the pre-study to the post-study period for YLI only. As noted earlier it is not possible to statistically test for differences for the two ARL intersections because there are too few intersections. The average number of total crashes per intersection in 2010 was 24.6 and 22.6 in 2011 and the average difference was not statistically significant. A statistically significant difference (pre-study to post-study) was found for angle crashes for YLI intersections, while for all intersections the difference between PDO crashes was the only statistically significant crash difference. While not statistically significant there were decreases in the average count of PDO and rear-end crashes and a slight increase in the average number of injury crashes. These results suggest the YLI interventions reduced the number of angle crashes. Like the findings for Table 13 some caution is warranted because other factors could be operating that may have contributed to the change including the effects of the red light camera (RLC) intervention at these intersections.

Table 15. YLI Study Intersection Average Number of Crashes Pre and Post

	Pre-Count Average	Post-Count Average	Average Difference
Total Crashes	24.6	22.6	-2.0
Fatal	0.1	0.0	-0.1
Injury Crashes	6.1	6.2	0.1
PDO Crashes	18.5	16.4	-2.1
Rear-End Crashes	18.2	17.4	-0.8
Angle Crashes	6.4	5.2	*-1.2

*P< 0.1, **p<0.05, ***p<0.01, ****p<.0001

In general Analysis 1, which is a simple before and after study, shows some change (34 crashes or 7.0% decrease) from the pre-time period to the post-time period in the average count of total crashes for all 20 study intersections. There are differences between the 18 YLI intersections and the 2 ARL intersections. While there was an overall decrease of 8.0% in the total count of crashes at the YLI intersections there was a 4.7% increase of 2 crashes at the ARL intersections. Importantly, there was an increase of 5 injury crashes at the 2 ARL intersections.

There was a statistically significant difference in PDO crashes from the pre-study to post-study time period for all 20 study intersections. The average number of total crashes per intersection in 2010 was 18.3 and 16.3 in 2011; the difference in the means (2.0) is statistically significant. There were no other statistically significant differences found.

When only YLI intersections (Table 15) were analyzed a statistically significant difference was found for angle crashes and no other statistically significant differences were found. This finding along with the findings in Table 12 and Table 13 preliminarily suggests the two interventions had a different effect on crashes.

While we are not able to measure statistical differences at individual study intersections there are differences in the number of pre- to post-time period total crashes, injury crashes, PDO crashes, rear-end crashes, and angle crashes. It is apparent that the differences regarding the number and type of crashes by intersections varies with some intersections showing a net increase in the number and type of crashes and other intersections showing a net decrease in the number and type of crashes.

As noted earlier one of the two ARL intersections (Coors & Central) of the 20 study intersections accounted for 4 of the additional 6 injury crashes in the post-study time period. These findings serve as a baseline finding for the remaining methods.

Analysis 2: Simple Before and After Study with a Correction for Traffic Flow

This analysis adjusts the impact of YLI and all-red light clearance safety from the before to after study period by correcting for traffic volumes. Numerous factors may affect safety such as changes in traffic volume, changes in the geometry of the intersection (i.e. increase/decrease in the number of travel lanes), weather, surrounding land uses, and the driving population. In this analysis we use calculated crash rates to standardize the crashes by traffic volume. Total crash rates for all study group intersection crash rates, YLI intersections, and individual YLI intersection and ARL intersections crash rates are calculated separately.

For each intersection and approach we used average annual daily traffic (AADT) counts for each approach to arrive at the number of vehicles daily in a given year that enter each intersection. This number is then multiplied by 334 (number of days in an 11 month period) to arrive at the number of estimated vehicles that enter each intersection in each year of the study period. For the pre-study period and post-study period we then summed the traffic volume yearly (or portion of a year) to arrive at the number of vehicles that entered each intersection and each monitored approach for each time period. These estimated counts of vehicles are used in the calculations in this analysis. Additionally, because we need to calculate a single crash rate each for the pre-period and post-period we sum the number of crashes for the pre-period and post-period separately. Using a specific formula we calculated the crash rate per million entering vehicles (MEV) for all 20 study intersections and each intersection separately. The information for all 20 study intersections and each intersection separately is provided in the following tables.

Table 16 describes crashes per million entering vehicles by injury type and crash type for all study intersections from the pre-period to the post-period. Overall crashes decreased from the pre-period to the post-period and there was a slight decrease in crashes per MEV. From the pre-period to the post-period PDO and rear-end crashes also decreased both in frequency and crashes per MEV for all study intersections. There was a slight increase in crashes per MEV for injury crashes for all study intersections

A paired sample t-test was used to compare pre and post crashes while incorporating or accounting for the amount of traffic travelling through the intersections. In other words, Table 13 shows the results when comparing the average number of crashes per MEV for intersections for the pre-period and post-period. The results are similar to the counts results (Table 12), where property damage only crashes are weakly statistically significant; again implying that the YLI and all-red light clearance intervention reduced these types of crash rates. The same interpretation cautions apply as noted for Table 13.

Table 16. Study Intersection Differences in Crashes per MEV by Type of Injury and Type of Crash Pre to Post

	Pre-period Crashes per MEV	Post-period Crashes per MEV	Difference in Crashes per MEV
Total Crashes	1.15	1.07	-0.08
Fatal Crashes	0.00	0.00	0.00
Injury Crashes	0.28	0.30	0.02
PDO Crashes	0.86	0.77	*-0.09
Rear- End Crashes	0.85	0.81	-0.04
Angle Crashes	0.30	0.26	-0.04

*p< 0.1, **p<0.05, ***p<0.01, ****p<.0001

The next table (Table 17) further describes changes from the pre-period to the post-period by total crashes, type of crash and type of injury per MEV by intersection. Six YLI intersections (Academy & Wyoming, Central & Eubank, Lomas & Eubank, Menaul & San Mateo, Montgomery & San Mateo, and Montgomery & Wyoming) experienced overall increases in crash rates per MEV and 12 intersections experienced decreases. In general there were decreases in all types and severities excepting a slight increase (.01) in injury crashes while there was no change in fatalities. Central and Louisiana experienced a decrease in total crash rate per MEV from the pre-study to post-study time period.

Similar to Analysis 1 this analysis indicates that one ARL intersection (Coors & Central) accounted for the majority of the increase in the injury crash rate per MEV.

Table 17. Study Intersection Differences in Crashes per MEV by Intersection, Type of Injury and Type of Crash Pre to Post by YLI Intersection and ARL Intersection

Intersection	Total	Fatal	Injury	PDO	Rear-End	Angle
All Intersections	-0.08	0.00	0.02	-0.09	-0.04	-0.04
Yellow Light Interval Intervention Intersections						
Academy & Wyoming	0.47	0.00	0.26	0.21	0.36	0.11
Central & Eubank	0.20	0.00	0.05	0.15	0.41	-0.20
Coors & Ellison	-0.16	0.00	0.08	-0.23	-0.10	-0.06
Lomas & Wyoming	-0.04	0.00	-0.05	0.01	0.01	-0.05
Lomas & Eubank	0.05	0.00	0.00	0.05	0.29	-0.24
Lomas & Juan Tabo	-0.49	0.00	-0.52	0.04	-0.28	-0.20
Menaul & Carlisle	-0.21	0.00	0.22	-0.43	-0.16	-0.05
Menaul & San Mateo	0.35	0.00	0.21	0.14	0.28	0.07
Menaul & Louisiana	-0.11	0.00	0.22	-0.33	-0.28	0.16
Menaul & Wyoming	-0.13	0.00	0.01	-0.14	0.06	-0.19
Coors & Montano	-0.25	0.00	0.12	-0.37	-0.37	0.12
Montgomery & Carlisle	-0.53	0.00	0.14	-0.67	-0.45	-0.09
Montgomery & San Mateo	0.05	0.00	0.00	0.06	0.25	-0.20
Montgomery & Wyoming	0.05	0.00	-0.16	0.22	0.05	0.00
Montgomery & Eubank	-0.26	0.00	-0.18	-0.07	-0.17	-0.09
Coors & Paseo	-0.23	0.00	-0.10	-0.13	-0.10	-0.13
Jefferson & Paseo	-0.08	0.00	-0.14	0.06	-0.23	0.14
Coors & Quail	-0.36	-0.05	0.04	-0.35	-0.29	-0.06
Total	-0.09	0.00	0.01	-0.09	-0.04	-0.05
All-Red Light Phase Intervention Intersections						
Coors & Central	0.30	0.00	0.24	0.05	-0.01	0.31
Central & Louisiana	-0.19	0.00	0.06	-0.25	-0.13	-0.06
Total	0.06	0.00	0.16	-0.10	-0.07	0.12

Like Table 15 this Table 18 reports the YLI intersections only and excludes the ARL intersections. Only angle crashes were weakly statistically significantly different.

Table 18. YLI Study Intersection Differences in Crashes per MEV by Type of Injury and Type of Crash Pre to Post

	Pre-period Crashes per MEV	Post-period Crashes per MEV	Difference in Crashes per MEV
Total Crashes	1.13	1.04	-0.09
Fatal Crashes	0.00	0.00	0.00
Injury Crashes	0.28	0.28	0.01
PDO Crashes	0.85	0.76	-0.09
Rear- End Crashes	0.84	0.80	-0.04
Angle Crashes	0.29	0.24	*-0.05

*p< 0.1, **p<0.05, ***p<0.01, ****p<.0001

The findings in this section support the findings of the simple before and after analysis. For all study intersections this analysis found statistically significant differences in MEV from the pre-time period to the post-time period for PDO crashes. For the YLI intersections angle crashes were statistically significantly different and decreased from the pre-study to post-study time period.

As noted crash rates per MEV varied by intersection with almost three times as many intersections experiencing decreases in total crash rates per MEV. The YLI Academy and Wyoming had the largest crash rate increase per MEV followed by the ARL intersection Coors and Central. These intersections deserve further study.

Analysis Three: Before and After Study Using Comparison Intersections

This analysis uses comparison intersections in order to consider the effects of unrecognized factors. This type of study allows the comparison of intersections without YLIs and ARL interventions with YLI and ARL intersections. Comparison intersections are defined as intersections that are similar in crash rates, traffic volume, and geographic characteristics. Using available information described earlier we selected 37 intersections in Albuquerque as comparison intersections. We had originally hoped to conduct analyses between matched individual YLI and ARL intersections or groups of similar YLI intersections and ARL intersections with individual or groups of comparison intersections but this turned out to not be possible. This level of analysis would have allowed us to compare individual YLI intersections and ARL intersections with comparison intersections. Because of the individual uniqueness of intersections a close match was difficult. For example, there is no match to the YLI intersection of Coors and Paseo del Norte. This intersection is an off ramp and there are not similar comparison intersections. In addition, the number of crashes at some intersections, both YLI and comparison, is not large enough to conduct intersection to intersection analyses and the pre- and post-time study periods are too short For these reasons we focus on a comparison in this section of study intersections (both ARL and YLI) with comparison intersections. With this in mind we still report on study intersections to provide information on the study intersection level differences.

Table 19 provides traffic volume information for the 37 comparison intersections. Traffic volume decreased 0.11% (2048.7 vehicles) from the before time period to the after time period compared to the very slight 0.02% increase in traffic volume at the 20 study intersections. Changes in traffic volume varied by intersection; with 13 intersections experiencing increases from 0.86% to 9.72% and 24 intersections experiencing decreases from 0.1% to 11.75%. As noted earlier while in the past few decades there has been a large increase in VMT in the U.S. more recent evidence indicates that VMT is no longer increasing as rapidly and in some areas is decreasing (Traffic Volume Trends http://www.fhwa.dot.gov/ohim/tvtw/tvtpage.cfm).

Traffic volumes for both the 20 study intersections and 37 comparison group intersections changed very slightly from calendar year 2010 (pre-study) to calendar year 2011 (post-study).

Table 19. Comparison Intersection Traffic Volumes

Intersection	AADT Before Period	AADT After Period	Change in AADT	Percent Change
All Comparison Intersections	1871134	1869085	-2048.7	-0.11%
Academy and Eubank	38287.03	37674.44	-612.59	-1.60%
Academy and San Mateo	62022.2	63812.63	1790.43	2.89%
Candelaria and Carlisle	44758.73	43071.48	-1687.25	-3.77%
Candelaria and Juan Tabo	36952.64	40545	3592.36	9.72%
Candelaria and San Mateo	43930.14	43840.88	-89.26	-0.20%
Candelaria and Wyoming	50287.79	44379.24	-5908.55	-11.75%
Central and Juan Tabo	41163.06	43507.9	2344.84	5.70%
Central and Rio Grande	55364.75	54811.11	-553.65	-1.00%
Central and San Mateo	50478.34	51776.14	1297.79	2.57%
Central and University	41620.49	42779.61	1159.12	2.78%
Central and Wyoming	51715.2	51355.22	-359.99	-0.70%
Constitution and Eubank	39548.42	38901.6	-646.82	-1.64%
Constitution and Wyoming	37895.91	37365.37	-530.54	-1.40%
Cutler and San Mateo	44364.44	43743.33	-621.1	-1.40%
Ellison and NM 528	50320.76	51731.03	1410.28	2.80%
Gibson and Yale	48241.03	48870.48	629.45	1.30%
Indian School and Louisiana	48675.45	48074.73	-600.72	-1.23%
Indian School and San Mateo	50274.8	48035.64	-2239.16	-4.45%
Irving and Coors	89322.2	89232.87	-89.33	-0.10%
Lomas and Louisiana	48139.68	51022.99	2883.31	5.99%
Lomas and San Mateo	60957.23	63428.69	2471.46	4.05%
Lomas and San Pedro	39581.59	38339.12	-1242.47	-3.14%
Lomas and University	55705.56	56182.54	476.98	0.86%
Menaul and Eubank	54171.35	56422.19	2250.84	4.16%
Menaul and Juan Tabo	49787.12	53382.22	3595.09	7.22%
Menaul and San Pedro	44786.87	44413.16	-373.71	-0.83%
Montgomery and Juan Tabo	42721.18	43470.47	749.29	1.75%
Montgomery and Louisiana	68175.13	67084.33	-1090.8	-1.60%
Montgomery and Morris	35650.72	35080.31	-570.41	-1.60%
Montgomery and San Pedro	50625.5	47276.69	-3348.81	-6.61%
Montgomery and Tramway	43235.56	40178.17	-3057.39	-7.07%
Osuna and Wyoming	54126.99	53861.2	-265.78	-0.49%
Paradise and Golf Course	40284.92	39390.29	-894.63	-2.22%
Paseo Del Norte and Eagle Ranch	44724.6	44679.88	-44.73	-0.10%
Paseo Del Norte and San Pedro	45821.32	45088.18	-733.14	-1.60%
Paseo Del Norte and Wyoming	48430.73	47756.83	-673.9	-1.39%
St. Josephs and Coors	52579.07	52180.28	-398.79	-0.76%

Table 20 reports the number of crashes by type and severity for comparison intersections for the pre-study period and post-study period. There were a total of 598 crashes in the pre-study period and 598 crashes in the post-study period indicating no change from the pre-study time period to the post-study time period. Compared to the pre-study period there was a slightly higher percentage of rear-end PDO crashes and angle injury crashes in the post-study period. The percent of rear-end injury crashes remained almost the same between the pre-study and post-study time periods. There was 5.9% fewer angle PDO crashes in the post-study period compared to the pre-study period.

Table 20. Comparison Intersection Crashes by Type and Severity Pre- to Post-Study

Crash Type and Severity	Pre-study		Post-study	
	Count	Percent	Count	Percent
Fatal Angle Crash	1	0.1%	0	0.0%
Rear-End Injury	97	16.2%	98	16.4%
Rear-End PDO	275	46.0%	305	51.0%
Angle Injury	85	14.2%	90	15.1%
Angle PDO	140	23.5%	105	17.6%
Total	598	100.0%	598	100.0%

Table 21 provides the total number of crashes, the average number of crashes, and the median number of crashes at comparison intersections by crash type and injury type. Similar to the study intersections the most common type of crash was rear-end and the most common type of injury was PDO.

Table 21. Comparison Intersection Crashes by Crash Type and Type of Injury

Statistics	Angle Crashes	Rear-End Crashes	Fatal Crashes	Injury Crashes	PDO Crashes
Total Count	421	775	1	370	825
Average	11.4	20.9	0.0	10.0	22.3
Median	11.0	20.0	0.0	10.0	22.0

Table 22 reports crash type by crash severity for the 37 comparison group intersections. During the entire approximate two-year study period there was a single angle crash that was fatal. Approximately 41% of all angle crashes involved at least one injury and 58.2% of all angle crashes were PDO. Fewer rear-end crashes involved any injuries (25.2%) and the large majority of rear-end crashes (74.8%) were PDO only crashes.

Table 22. Comparison Intersection Crash Type by Crash Severity

Severity/Type	Angle Crashes		Rear-End Crashes	
	Count	Percent	Count	Percent
Fatal	1	0.2%	0	0.0%
Injury	175	41.6%	195	25.2%
PDO	245	58.2%	580	74.8%
Total	421	100.0%	775	100.0%

Table 23 documents the number of crashes at comparison intersections by crash type and type of injury. At all but 6 comparison intersections rear-end crashes were the most frequent type of crash and PDO crashes were the most common type of injury at all 37 comparison intersections.

Table 23. Comparison Intersection Crashes by Crash Type and Type of Injury

Intersection	Total Crashes	Angle Crashes	Rear-End Crashes	Fatal	Injury Crashes	PDO Crashes
Academy and Eubank	25	5	20	0	10	15
Academy and San Mateo	44	12	32	0	11	33
Candelaria and Carlisle	20	10	10	0	7	13
Candelaria and Juan Tabo	26	9	17	0	11	15
Candelaria and San Mateo	39	14	25	0	18	21
Candelaria and Wyoming	23	9	14	0	10	13
Central and Juan Tabo	31	11	20	0	3	28
Central and Rio Grande	29	15	14	0	10	19
Central and San Mateo	58	14	44	0	20	38
Central and University	32	10	22	0	10	22
Central and Wyoming	32	17	15	0	11	21
Constitution and Eubank	18	10	8	0	4	14
Constitution and Wyoming	30	8	22	0	9	21
Cutler and San Mateo	32	13	19	0	6	26
Ellison and NM 528	35	11	24	0	11	24
Gibson and Yale	25	10	15	0	11	14
Indian School and Louisiana	33	7	26	0	7	26
Indian School and San Mateo	29	16	13	0	12	17
Irving and Coors	59	17	42	0	18	41
Lomas and Louisiana	37	16	21	0	11	26
Lomas and San Mateo	42	16	26	0	15	27
Lomas and San Pedro	18	8	10	0	6	12
Lomas and University	38	10	28	0	10	28
Menaul and Eubank	37	17	20	0	14	23
Menaul and Juan Tabo	40	16	24	0	12	28
Menaul and San Pedro	15	3	12	0	2	13
Montgomery and Juan Tabo	30	15	15	0	8	22
Montgomery and Louisiana	31	12	19	0	8	23
Montgomery and Morris	11	7	4	0	3	8
Montgomery and San Pedro	21	8	13	0	7	14
Montgomery and Tramway	28	12	16	0	11	17
Osuna and Wyoming	17	7	10	0	7	10
Paradise and Golf Course	30	13	17	0	10	20
Paseo Del Norte and Eagle Ranch	37	16	21	1	9	27
Paseo Del Norte and San Pedro	52	9	43	0	13	39
Paseo Del Norte and Wyoming	61	13	48	0	16	45
St. Josephs and Coors	31	5	26	0	9	22

Table 24 reports on the differences in crashes by MEV crash rates for total crashes, by type of injury and type of crash from the before time period to the after time period. The statistical tests were constructed and implemented in the same way as Table 16. The analysis in this table compares total crashes, crash types and crash severity across study intersections and comparison group intersections. Interestingly there were no significant differences between the pre and post average of MEV crash rates for total, fatal, injury, PDO, rear-end or angle crashes for the comparison intersections as opposed to weakly statistically significant findings for PDO crashes for the study intersections.

Table 24. Study Intersection and Comparison Intersection Differences in Crashes per MEV by Type of Injury and Type of Crash Before Period to After Period

	Pre-period Crashes per MEV	Post-period Crashes per MEV	Difference in Crashes per MEV
Study Intersections			
Total Crashes	1.15	1.07	-0.08
Fatal	0.00	0.00	0.00
Injury Crashes	0.28	0.30	0.02
PDO Crashes	0.86	0.77	*-0.09
Rear-End Crashes	0.85	0.81	-0.04
Angle Crashes	0.30	0.26	-0.04
Comparison Intersections			
Total Crashes	0.99	0.99	0.00
Fatal	0.00	0.00	0.00
Injury Crashes	0.30	0.31	0.01
PDO Crashes	0.69	0.68	-0.01
Rear-End Crashes	0.62	0.67	0.05
Angle Crashes	0.37	0.32	-0.05

*p< 0.1, **p<0.05, ***p<0.01, ****p<.0001

Table 25 reports differences in crashes per MEV for YLI intersections only. Like Analysis 1 and Analysis 2 only angle crashes are weakly significantly different and no statistically significant differences were found for comparison intersections crashes.

Table 25. YLI Study Intersection and Comparison Intersection Differences in Crashes per MEV by Type of Injury and Type of Crash Before Period to After Period

	Pre-period Crashes per MEV	Post-period Crashes per MEV	Difference in Crashes per MEV
YLI Study Intersections			
Total Crashes	1.13	1.04	-0.09
Fatal	0.00	0.00	0.00
Injury Crashes	0.28	0.28	0.01
PDO Crashes	0.85	0.76	-0.09
Rear-End Crashes	0.84	0.80	-0.04
Angle Crashes	0.29	0.24	*-0.05
Comparison Intersections			
Total Crashes	0.99	0.99	0.00
Fatal	0.00	0.00	0.00
Injury Crashes	0.30	0.31	0.01
PDO Crashes	0.69	0.68	-0.01
Rear-End Crashes	0.62	0.67	0.05
Angle Crashes	0.37	0.32	-0.05

*p< 0.1, **p<0.05, ***p<0.01, ****p<.0001

The findings in all three analyses were similar with the only statistically significant differences found in PDO crashes for all intersections and in angle crashes for YLI intersections. Interestingly, there were no statistically significant differences found in comparison intersections total crashes, crash types (angle and rear-end) and injury type crashes (PDO and Injury).

Cost Analysis

This section calculates the cost of YLI and ARL intersection crashes through November 2011 and relies on National Safety Council (NSC) cost estimates of the comprehensive costs of crashes. This is done for two reasons. First, the NSC cost estimate is directly comparable to NM Uniform Crash report injury severity coding because both use the KABCO injury severity scale. Second, the NSC cost estimate is completed annually making the estimate more recent. As proposed in the literature review we collapsed injury severity to two codes – injury and property damage only. This means that whether a crash resulted in a possible injury or an incapacitating injury, the same cost was applied to each injury crash.

For this study we use the possible injury comprehensive cost ($26,000) and the property damage only comprehensive cost ($2,400) to report injury crash costs and property damage only crash costs. We use these costs to estimate the cost increase or cost reduction of the YLI and the ARL intervention. As indicated in Table 26 there was a cost increase of $156,000 based on an actual increase of 6 injury crashes from January 2011 through November 2011 and a decrease of $96,000 based on an actual decrease of 40 possible injury crashes for the same time period. The YLI and ARL system has experienced a small aggregate crash cost increase of $60,000 (+$156,000 - $96,000) since the implementation of the two interventions in January 2011 through November 2011.

Table 26. Study Intersection Crash Costs Pre and Post

Severity	Actual Before Crashes	Actual After Crashes	Change	Cost per Crash	Calculated Cost
Injury (K+A+B+C)	121	127	+6	$26,000	+$156,000
Possible Injury (O)	365	325	-40	$2,400	-$96,000
Total Crashes	486	452	-34	---	+$60,000

Table 27 separates the crash costs by intervention. The YLI intersections experienced a small cost decrease of $62,800 which resulted from an increase of one injury crash and a reduction of 37 possible injury crashes. The two ARL intersections experienced a cost increase of $122,800 based on an increase of 5 injury crashes. Four of five of these injury crashes occurred at the Coors and Central intersection.

Table 27. YLI and ARL Study Intersection Crash Costs Pre and Post

Severity	Actual Before Crashes	Actual After Crashes	Change	Cost per Crash	Calculated Cost
YLI Intersections					
Injury (K+A+B+C)	110	111	+1	$26,000	+$26,000
Possible Injury (O)	333	296	-37	$2,400	-$88,800
Total Crashes	443	407	-36	---	-$62,800
ARL Intersections					
Injury (K+A+B+C)	11	16	+5	$26,000	+$130,000
Possible Injury (O)	32	29	-3	$2,400	-$7,200
Total Crashes	43	45	+2	---	+$122,800

DISCUSSION AND CONCLUSION

This section discusses the study findings based on the use of the three methods and cost analysis to measure the overall goal of this study, which was to report on whether the use of a YLI intervention and a ARL intervention on the previous RLC intersections in Albuquerque, New Mexico has improved traffic safety as measured by a reduction in the number and rate of crashes and crash severity at study intersections (YLI intersections and ARL intersections) compared to a group of comparison intersections. To complete this study we first conducted a review of relevant traffic safety literature with an emphasis on YLI and ARL research to better understand the use of YLI and ARL systems and current best practices to study their effectiveness. In conjunction with the literature review we compiled intersection crash information for the 20 study intersections and a comparison group of 37 intersections in Albuquerque, New Mexico from January 2010 through November 2010 and January 2011 through November 2011. We also collected other necessary information including traffic volume data and information on each intersection in the study.

Based on the literature review, what was completed for the RLC study, and what we considered to be practical we decided to use a variety of different methods to analyze the data. We believe the use of the three methods we chose is beneficial because succeeding methods build upon the knowledge of the previous method and in total the three methods tell a more complete story. The simple before and after analysis, the simple before and after analysis with the addition of traffic volume, and the analysis of study intersections with a matched comparison group of intersections provide useful information. **All the analyses support the finding that the combined YLI and ARL interventions reduced PDO crashes. The analyses of YLI intersections found that angle crashes were reduced.** The study interventions did not statistically significantly impact total crashes, angle crashes, rear-end crashes or injury crashes. While the differences were not statistically significant for all 20 intersections and YLI intersections there were reductions in the count and percent of total crashes, rear-end crashes, and angle crashes and increases in injury crashes. The analyses also suggest these changes varied by study intersection. Importantly, we are not able to separate out the differences between the effect of the YLI intervention and ARL intervention. Because 18 of the 20 study intersections were YLI intersections the largest impact was made by YLI intersections and this is indicated in the YLI only analyses. Importantly, there were no inconsistencies in the trend of the findings across the three methods.

All 20 Study Intersections (YLI and ARL)

Analysis 1 which is a simple before and after study showed a 7% reduction in the number of crashes (34 crashes) from the pre-time period to the post-time period for all 20 study intersections. There was a 13.4% reduction in the number of angle crashes (Table 9) from the before period to the after period. This reduction of 17 angle crashes equated to a decrease of 25 angle PDO crashes and an increase of 9 angle injury crashes, with one angle crash having an unknown injury type. The average number of total crashes per intersection in 2010 was 24.3 and 22.6 in 2011 and the difference in the means (-1.7) was not statistically significant. A moderate statistically significant difference (pre to post) was found for PDO crashes. No other statistically significant differences were found. While a reduction in the average number of angle crashes, which are the type of crashes most likely to be effected by these types of interventions, was found the difference was not statistically significant.

These findings generally support the literature which notes that at intersections where yellow light timings are increased and all-red clearance intervals are implemented red-light running crashes are reduced. These findings serve as a baseline finding for the remaining methods. As noted earlier because there were only two all-red light clearance intersections we could not test for statistically significant differences for all-red clearance interval study intersections only.

The findings in Analysis 2 support the findings of the simple before and after analysis (Analysis 1). This analysis, like Analysis 1, found statistically significant differences in crashes per MEV from the before time period to the after time period for PDO crashes. The mean differences from the pre-period to the post-period for PDO crashes was statistically significant, again implying that the YLI and the ARL reduced the rate of this type of crash. Again, like Analysis 1, while there was a reduction in angle crash rates in MEV this difference was not statistically significant.

Analysis 3 was similar to Analysis 2, but included a comparison group of intersections. Analysis 3 compared total crashes, crash types and crash severity across study intersections and comparison group intersections. It is interesting to note there was not a statistically significant difference between the pre and post average of the crash rates for total, fatal, injury, PDO, rear-end or angle crashes for the comparison intersection as opposed to statistically significant findings for PDO crashes for the study intersections.

All three analyses showed a statistically significant reduction in PDO crashes. In Analysis 1 this is shown by a reduction in the count of crashes and type of crashes between the pre-study and post-study time period. In Analysis 2 and Analysis 3 this is shown in the decrease in the crash rate per MEV. Further, Analysis 3 compares the crash rate of the study intersections to a set of comparison intersections. There were no statistically significant differences from the pre-study to post-study time period among the comparison intersections.

While statistically significant differences were not found for total crashes, angle crashes or rear-end crashes, both Analysis 1 and Analysis 2 showed a reduction in the rate of these crashes. Both analyses also showed an increase in injury crashes.

Both study interventions are designed to reduce red-light running and associated crashes (i.e. angle crashes) and though this was found in the three analyses these reductions were not statistically significant.

Yellow Light Interval intervention (YLI) Intersections Only

In total there was an 8.1% decrease in total crashes, an 18.3% decrease in angle crashes, a 4.6% decrease in rear-end crashes, an 11.1% decrease in PDO crashes, and a 1.8% increase in injury crashes. In Analysis 1 a statistically significant difference was found for angle crashes only. While there were decreases in the average number of PDO crashes, rear-end crashes, and an increase in the average number of injury crashes from the pre-study time period to the post-study time period these differences were not statistically significant. The findings in Analysis 2 are similar to Analysis 1. Analysis 2 uses traffic volume measured in million entering vehicles (MEV) to control for traffic flow. Statistically significant differences were again found for angle crashes. Analysis 3 used comparison intersections to consider the impact of unrecognized factors. No statistically significant differences were found at comparison intersections while there were statistically significant differences found at YLI intersections for angle crashes.

YLI intersection interventions are designed to reduce red-light running and associated crashes (i.e. angle crashes) and this was found in the three analyses.

Cost Analysis

This section discusses the cost analysis for all 20 study intersections and separately for the 18 YLI intersections. The cost analysis of all 20 study intersections found a cost increase based on an actual reduction of 40 PDO crashes and one fatal crash through November 2011 and an increase of 6 injury crashes for the same time period. Through 11 months (January 2011 through November 2011) the YLI and ARL system experienced an aggregate crash cost increase of $60,000 ($156,000 - $96,000).

To differentiate the costs for the 18 YLI intersections and 2 ARL intersections separate cost analyses were conducted. The YLI intersections experienced a small cost decrease of $62,800 which resulted from an increase of one injury crash and a reduction of 37 possible injury crashes. The two ARL intersections experienced a cost increase of $122,800 based on an increase of 5 injury crashes. Four of five of these injury crashes occurred at the Coors and Central intersection.

Conclusion
This study was designed to address two questions:

1. What is the impact on crashes of increased yellow light time intervals on safety at signalized intersection approaches that were equipped with cameras?
2. What is the impact on crashes of a brief all-red light clearance interval on safety at the two signalized intersection approaches that were equipped with cameras?

All three analyses for the 20 study intersections showed a statistically significant reduction in PDO crashes. The three analyses for the 18 YLI intersections showed a statistically significant reduction in angle crashes. We were not able to statistically test for differences for the two ARL intersections.

We were not able to separate the safety effects measured as a decrease in crashes and increase in the cost of crashes at the 18 yellow light timing increase intersections and the 2 all-red light clearance timing increase intersections. This occurred because we were not able to separately statistically analyze the effects on the two all-red light clearance intersections. We were also not able to separately create comparison group intersections for the yellow light timing increase intersections and all-red light clearance intersections.

While this occurred we found an overall 4.7% increase in the count of total crashes from the pre-study to the post-study time period for the two all-red light clearance intersections and an increase in the total MEV crash rate at both all-red light clearance intersections. We also found an overall 8.1% reduction in the count of total crashes from the pre-study to the post-study time period for the 18 yellow light timing increase intersections and a .09 reduction in the MEV crash rate.

These findings partly support findings in the literature and cited in the literature review that note appropriate yellow light timings is crucial for intersection safety and that all-red light clearance intervals help reduce both right angle crashes and injuries. The purpose of increasing the yellow light interval is to allow drivers greater reaction time to the changing light, allow vehicles more time to clear the intersection, and to decrease the number of red light runners. The practice of enhancing the yellow light interval in an effort to decrease the number of red light runners has shown promising results from a number of studies. Implementations of both all-red clearance intervals and lengthening yellow light intervals have been shown to increase safety at signalized intersections.

As noted before a pre-test post-test study design assumes that the study group and comparison group are similar and the intervention being studied is the only or primary difference between the pre- and post-time period. Since the RLC system was in place and operational during most of the pre-time period at most of the study intersections this assumption is violated. Because the yellow light timing change occurred right at the time the RLC system was discontinued it is not possible to study the change in the yellow light interval timings without including the time period during which the RLC system was operational. We were also not able to account for the possible effect of the RLC in the post-time period. There is the possibility that the moderate net cost benefit of the RLC system found in the RLC study extended beyond the end of the program. For this reason it is difficult to attribute any changes in crashes and crash rates solely to the yellow light time intervals and the all-red light clearance intervals. A longer post-study period would be useful for studying the benefit of the yellow light timing intervention and the all-red clearance timing interval and to better understand if the benefit found in the RLC system extended beyond the end of the program.

Like RLC systems YLI systems and all-red light clearance intervals are not a complete remedy to address red light running problems that include crashes at intersections. YLI systems and ARL are one of several possible countermeasures that can be utilized to address crash problems at intersections.

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APPENDICES

Appendix A: Intersection Data Collection Instrument
Appendix B: State of New Mexico Uniform Crash Report Form
Appendix C: Study Intersections
Appendix D: Comparison Intersections

Appendix A: Intersection Data Collection Instrument

CITY OF ALBUQUERQUE YELLOW LIGHT INTERVENTION STUDY
INTERSECTION DATA COLLECTION FORM

GENERAL INFORMATION

Date of Visit:_____/_____/________ Time of Visit Begin::____________________
End::_______________________
mm/dd/yyyy

Intersection Name:____

Name:____

Last *First*

	Northbound	**Southbound**	**Eastbound**	**Westbound**
Pedestrian crossing signal	Yes______ No______	Yes______ No______	Yes______ No______	Yes______ No______
Presence of solid median	Yes______ No______	Yes______ No______	Yes______ No______	Yes______ No______
Painted crosswalk	Yes______ No______	Yes______ No______	Yes______ No______	Yes______ No______

Notes on general description of surrounding land uses for entire intersection. Please map the following features of the intersection. Check off each feature as you map it. Write “N/A” to any feature that does that not apply to the intersection.

_____ RED LIGHT CAMERAS

_____RED LIGHT CAMERA SIGNS

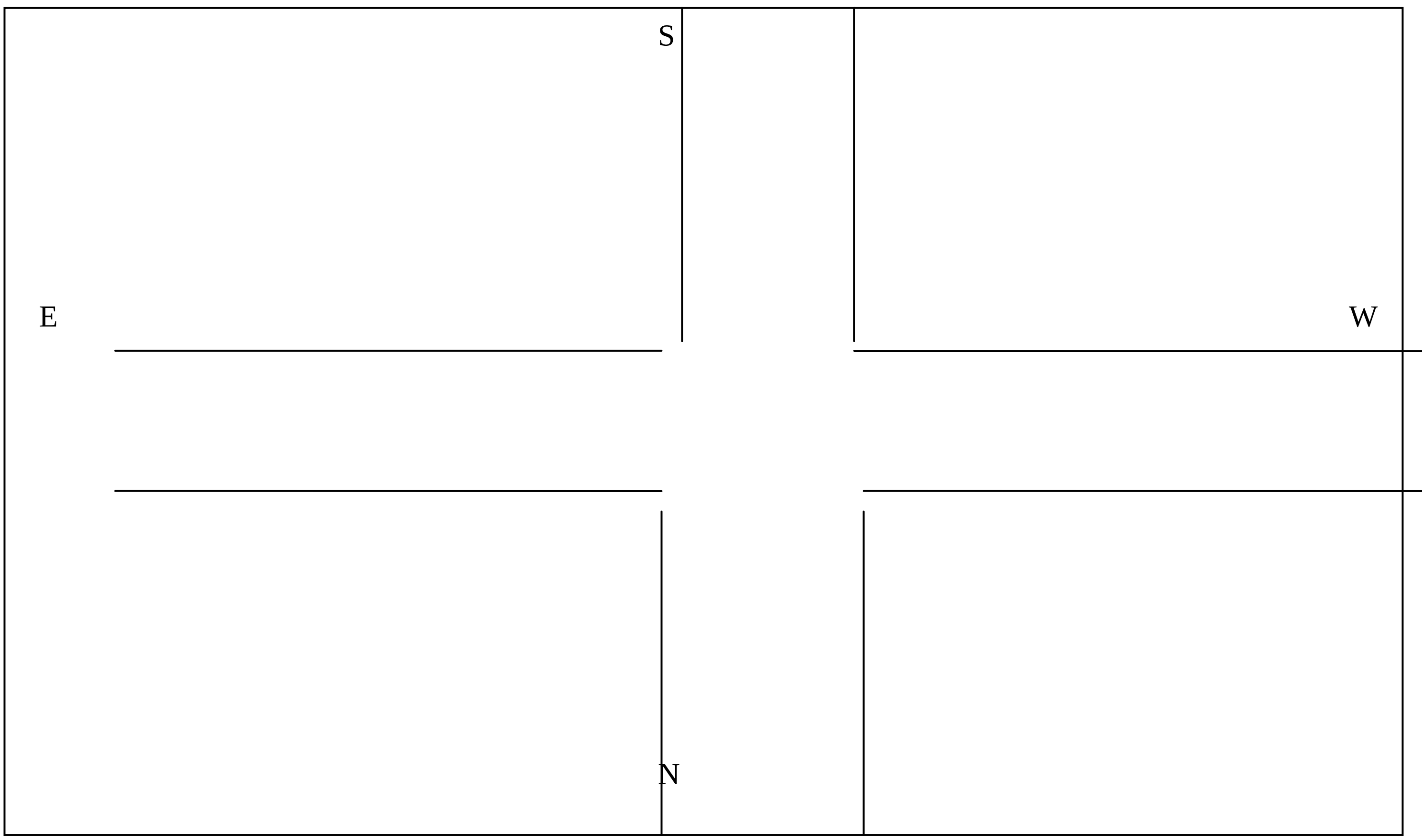
_____RUMBLE STRIPS

_____DRIVEWAYS WITHIN 100 FT OF INTERSECTION

_____COMMERCIAL BUSINESSES

_____RESIDENTIAL PROPERTIES

_____ VACANT LOTS



NORTHBOUND TRAFFIC INFORMATION

Yellow Light Timing **(straight lane)**

Time 1:____________ Time 2:_____________

Green Light Timing **(straight lane)**

Time 1:____________ Time 2:_____________

Number of travel lanes: ______________ Number of left turn lanes:______________ Speed limit:________________

Number of right turn lanes: _____________ Presence of sidewalk: Yes______ No______ Presence of Stop Bar: Yes______ No______

Light Timing

Yellow Light Timing **(left lane)**

Time 1:____________ Time 2:_____________

Green Light Timing **(left lane)**

Time 1:____________ Time 2:_____________

Light Timing

Yellow Light Timing **(right lane)**

Time 1:____________ Time 2:_____________

Green Light Timing **(right lane)**

Time 1:____________ Time 2:_____________

EASTBOUND STREET INFORMATION

Light Timing

Yellow Light Timing **(straight lane)**

Time 1:____________ Time 2:_____________

Green Light Timing **(straight lane)**

Time 1:____________ Time 2:_____________

Number of travel lanes:______________ Number of left turn lanes:______________ Speed limit:________________

Number of right turn lanes:_____________ Presence of sidewalk: Yes______ No______ Presence of Stop Bar: Yes______ No______

Light Timing

Yellow Light Timing **(left lane)**

Time 1:____________ Time 2:_____________

Green Light Timing **(left lane)**

Time 1:____________ Time 2:_____________

Light Timing

Yellow Light Timing **(right lane)**

Time 1:____________ Time 2:_____________

Green Light Timing **(right lane)**

Time 1:____________ Time 2:_____________

SOUTHBOUND TRAFFIC INFORMATION

Yellow Light Timing **(straight lane)**

Time 1:____________ Time 2:_____________

Green Light Timing **(straight lane)**

Time 1:____________ Time 2:_____________

Number of travel lanes: ______________ Number of left turn lanes:______________ Speed limit:________________

Number of right turn lanes: _____________ Presence of sidewalk: Yes______ No______ Presence of Stop Bar: Yes______ No______

Light Timing

Yellow Light Timing **(left lane)**

Time 1:____________ Time 2:_____________

Green Light Timing **(left lane)**

Time 1:____________ Time 2:_____________

Light Timing

Yellow Light Timing **(right lane)**

Time 1:____________ Time 2:_____________

Green Light Timing **(right lane)**

Time 1:____________ Time 2:_____________

WESTBOUND TRAFFIC INFORMATION

Yellow Light Timing **(straight lane)**

Time 1:____________ Time 2:_____________

Green Light Timing **(straight lane)**

Time 1:____________ Time 2:_____________

Number of travel lanes: ______________ Number of left turn lanes:______________ Speed limit:________________

Number of right turn lanes: _____________ Presence of sidewalk: Yes______ No______ Presence of Stop Bar: Yes______ No______

Light Timing

Yellow Light Timing **(left lane)**

Time 1:____________ Time 2:_____________

Green Light Timing **(left lane)**

Time 1:____________ Time 2:_____________

Light Timing

Yellow Light Timing **(right lane)**

Time 1:____________ Time 2:_____________

Green Light Timing **(right lane)**

Time 1:____________ Time 2:_____________

Notes on signage for red light camera (notes should be by travel direction)

Eastbound:

West bound:

North bound:

South Bound:

Notes on signage (i.e. left turn must yield on green, no right turn on red, no U turn, left turn on green arrow only, etc.)

East bound:

Westbound:

Northbound:

Southbound:

Other general observations and reviewer notes

Appendix B: State of New Mexico Uniform Crash Report Form

STATE OF NEW MEXICO UNIFORM CRASH REPORT
0000000000

REPORTING DEPARTMENT

☐ ON PRIVATE PROPERTY | ☐ FATAL ☐ INJURY | PROPERTY DAMAGE ONLY ☐ UNDER $500 ☐ $500 OR MORE | ☐ HIT AND RUN | Case Number: | NMDOT: | CAD Num:

CRASH DATE (MM/DD/YY) | MILITARY TIME | CITY OCCURRED IN | COUNTY

Sun ☐ M ☐ Tu ☐ W ☐ Th ☐ F ☐ S ☐ | OCCURRED ON: (Route No. or Name) | AT INTERSECTION WITH: | TRIBAL LAND? ☐ Yes ☐ No

OTHER LOCATION | ☐ FEET ☐ MILES | N ☐ NE ☐ NW ☐ S ☐ SE ☐ SW ☐ E ☐ W ☐ | PERMANENT LANDMARK - COUNTY LINE – INTERSECTION - MILEPOST | LAT: LONG:

CRASH OCCURRED ☐ On Roadway ☐ Off Roadway | CRASH CLASSIFICATION ☐ Overturned ☐ Rollover ☐ Other N-Col ☐ R. R. Train ☐ Pedestrian ☐ Pedalcyclist ☐ Other Vehicle ☐ Animal ☐ Vehicle on Other Rdwy ☐ Fixed Object ☐ Parked Vehicle ☐ Other Object | ANALYSIS CODE:

Vehicle No. 0

VEHICLE NO. HEADED N ☐ NE ☐ NW ☐ S ☐ SE ☐ SW ☐ E ☐ W ☐ | On: | Left Scene of Crash | Posted Speed | Safe Speed

Drivers Full Name (Last, First, Middle) | Address

Driver's License Number | State | Type | Status | Restrictions | Endorsements | Expires | City/State | Zip Code | Phone

Date of Birth - M/D/YR | Occupation | Seat Pos. | Age | Sex (M/F) | Race | Injury Code | OP Code | OP Used Proper'y | Airbag Deploy | Ejected | EMS# | Med Trans

Seat Pos.	Occupant's Name (Last, First, Middle)	Occupant's Address (City, State, Zip)	Age	Sex (M/F)	Race	Injury Code	OP Code	OP Used Properly	Airbag Deploy	Ejected	EMS#	Med Trans

Vehicle Yr. | Vehicle Make | Color | Body Style | Cargo Body Type | Vehicle Use (1) | Vehicle Use (2) | Towed? ☐ Yes ☐ No | Damage Severity ☐ Heavy ☐ Moderate ☐ Slight ☐ None ☐ Unknown ☐ All Areas | Extent ☐ Disabled ☐ Functional ☐ Appearance ☐ Property ☐ Fire ☐ None | 1 2 3 4 5 6 7 8 9 10 11 12 ☐ Top ☐ Undercarriage

License Yr. | State | License Plate Number | VIN | Towed due to disabling damage? ☐ Yes ☐ No

DOT # | Interstate Carrier Code | Towed By | Towed To

Number of Axles | Vehicle Weight Rating/Gross Combination Weight Rating ☐ 10,000 lbs. or less ☐ 10,001 lbs. to 26,000 lbs. ☐ Greater than 26,000 lbs. | HazMat Placard | Hazmat Placard 4 digit # | OR | Hazmat Name | AND | 1 digit # | Hazmat Released?

Carrier's Name | Carrier's Address | Carrier'sZip

Owner's Name | Owner's Company Name | Owner's Address | Owner's Zip | Owner's Telephone

Insured By: (Name of Company) | Policy Number | Trailer or Towed Vehicles (1) | Type | Year | Make | License Yr. | License State | License Number

Trailer or Towed vehicles (2) | Type | Year | Make | License Yr. | License State | License Number | Trailer or Towed Vehicles (3) | Type | Year | Make | License Yr. | License State | License Number

Vehicle No. 1 or PEDESTRIAN - OTHER

Vehicle No. HEADED N ☐ NE ☐ NW ☐ S ☐ SE ☐ SW ☐ E ☐ W ☐ | On: | Left Scene of Crash | Posted Speed | Safe Speed

Drivers Full Name (Last, First, Middle) | Address

Driver's License Number | State | Type | Status | Restrictions | Endorsements | Expires | City/State | Zip Code | Phone

Date of Birth - M/D/YR | Occupation | Seat Pos. | Age | Sex (M/F) | Race | Injury Code | OP Code | OP Used Proerty | Airbag Deploy | Ejected | EMS # | Med Trans

Seat Pos.	Occupant's Name (Last, First, Middle)	Occupant's Address (City, State, Zip)	Age	Sex (M/F)	Race	Injury Code	OP Code	OP Used Properly	Airbag Deploy	Ejected	EMS #	Med Trans

Vehicle Yr. | Vehicle Make | Color | Body Style | Cargo Body Type | Vehicle Use (1) | Vehicle Use (2) | Towed? ☐ Yes ☐ No | Damage Severity ☐ Heavy ☐ Moderate ☐ Slight ☐ None ☐ Unknown ☐ All Areas | Extent ☐ Disabled ☐ Functional ☐ Appearance ☐ Property ☐ Fire ☐ None | 1 2 3 4 5 RR 6 7 8 9 10 11 LR ☐ Top ☐ Undercarriage

License Yr. | State | License Plate Number | VIN | Towed due to disabling damage? ☐ Yes ☐ No

DOT # | Interstate Carrier Code | Towed By | Towed To

Number of Axles | Vehicle Weight Ratings/Gross Combination Weight Rating ☐ 10,000 lbs. or less ☐ 10,001 lbs. to 26,000 lbs. ☐ Greater than 26,000 lbs. | HazMat Placard | Hazmat Placard 4 digit # | OR | Hazmat Name | AND | 1 digit # | Hazmat Released?

Carrier's Name | Carrier's Address | Carrier'sZip

Owner's Name | Owner's Company Name | Owner's Address | Owner's Zip | Owner's Telephone

Insured By: (Name of Company) | Policy Number | Trailer or Towed Vehicles (1) | Type | Year | Make | License Yr. | License State | License Number

Trailer or Towed Vehicles (2) | Type | Year | Make | License Yr. | License State | License Number | Trailer or Towed Vehicles (3) | Type | Year | Make | License Yr. | License State | License Number

Crash Report Number 0000000000 | **STATE OF NEW MEXICO UNIFORM CRASH REPORT** **NM Statute 66-7-209** | SHEET OF SHEETS

Case Number 0

ROAD – WEATHER

LIGHTING (Check 1)	WEATHER (Check 1)	ROAD COND (Check 1 for each)	ROAD SURFACE (Check 1 for each)	TRAFFIC CONTROL (Check 1 for each)	ROAD CHARACTER (Check 1)
		V0 V0	V0 V0	V0 V0	
☐ Daylight	☐ Clear	☐ ☐ Dry	☐ ☐ Paved	☐ ☐ No Passing Zone	☐ Straight
☐ Dawn	☐ Raining	☐ ☐ Wet	☐ ☐ Paved	☐ ☐ Stop Sign	☐ Curve
☐ Dusk	☐ Snowing	☐ ☐ Snow	☐ ☐ Paved Center & Edgeline	☐ ☐ Traffic Signals	GRADE (Check 1)
☐ Dark - Lighted	☐ Fog	☐ ☐ Ice	☐ ☐ Unpaved	☐ ☐ Yield Sign	☐ Level
☐ Dark - Not Lighted	☐ Dust	☐ ☐ Loose		☐ ☐ R.R. Gate	☐ Hillcrest
☐ Other and not stated	☐ Wind	☐ ☐ Other		☐ ☐ 4 Way Stop	☐ On Grade
	☐ Other	☐ ☐ Standing or Moving Water		☐ ☐ Flashers	☐ Dip
	☐ Sleet or Hail	☐ ☐ Slush		☐ ☐ No Controls	
				☐ ☐ Other	

Crash Report Number 0000000000

Case Number 0

ROAD DESIGN (Check 1 OR more for each)

V V		V0 V	
☐ ☐	1 Lane	☐ ☐	One Way
☐ ☐	2 Lanes	☐ ☐	Ramp
☐ ☐	3 Lanes	☐ ☐	Full Access Control
☐ ☐	4 + Lanes	☐ ☐	Undeveloped
☐ ☐	Undivided	☐ ☐	Alley
☐ ☐	Physical Divider	☐ ☐	Other
☐ ☐	Painted Divider	☐ ☐	Constr. Zone

EVENT

APPARENT CONTRIBUTING FACTORS (Check 1 or more for each)

V0 V0		V0 V0		V0 V0	
☐ ☐	Excessive Speed	☐ ☐	Following too closely	☐ ☐	Defective steering
☐ ☐	Speed too fast for conditions	☐ ☐	Made improper turn	☐ ☐	Defective tires
☐ ☐	Failed to yield right of way	☐ ☐	Driver inattention	☐ ☐	Other mech. defect
☐ ☐	Passed stop sign	☐ ☐	Under influence of alcohol	☐ ☐	Road defect
☐ ☐	Disregarded traffic signal	☐ ☐	Other improper driving	☐ ☐	Other No driver error
☐ ☐	Drove left of center	☐ ☐	Pedestrian error	☐ ☐	Traffic control not functioning
☐ ☐	Improper overtaking	☐ ☐	Inadequate brakes	☐ ☐	Improp lane change
☐ ☐	Avoid no contact vehicle	☐ ☐	Driverless moving vehicle	☐ ☐	Improper backing
☐ ☐	Avoid no contact -other	☐ ☐	Failed to yield - Police Veh(s)	☐ ☐	None
☐ ☐	Cell phone	☐ ☐	Failed to yield – Emrgcy Veh(s)	☐ ☐	Vehicle Skidded Before Brake
☐ ☐	Low Visibility due to smoke	☐ ☐	Under the influence of Drugs or Medication		
		☐ ☐	High speed pursuit		

DRIVERS' ACTIONS (Check 1 or more for each)

V0 V0		V0 V0	
☐ ☐	Going Straight	☐ ☐	Stopped for traffic
☐ ☐	Overtaking /Passing	☐ ☐	Stopped for sign/signal
☐ ☐	Right Turn	☐ ☐	Start in traffic lane
☐ ☐	Left Turn	☐ ☐	Start from park
☐ ☐	U Turn	☐ ☐	Parked
☐ ☐	Slowing	☐ ☐	Other
☐ ☐	Backing		

SEQUENCE OF EVENTS (See event codes)

V0	V0	
		FIRST EVENT
		SECOND
		THIRD
		FOURTH EVENT

DRIVER

DRIVER/PED/PEDALCYCLIST SOBRIETY (Check 1 or more for each with X)

D1 D2	
☐ ☐	Consumed Alcohol
☐ ☐	Consumed a Controlled Substance
☐ ☐	Had Not Consumed Alcohol
☐ ☐	Sobriety Unknown
☐ ☐	Consumed Medication
☐ ☐	Tested by Instrument
☐ ☐	Breath Test Administered

_______ gms/210L _______ gms/210L

☐ ☐	Blood Test Administered
☐ ☐	Standard Field Sobriety Test Administered
☐ ☐	Refused Test

DRIVER/PED/PEDALCYCLIST PHYSICAL COND. (Mark 1 or more for each with X)

D0 D0		D0 D0	
☐ ☐	Fatigue-Asleep	☐ ☐	Medication
☐ ☐	Eyesight Imp.	☐ ☐	Amputee
☐ ☐	Hearing Imp.	☐ ☐	No App. Defects
☐ ☐	Illness	☐ ☐	*Other Physical Impairment
		☐ ☐	Unknown

*SPECIFY:

PEDESTRIAN

PEDESTRIAN/PEDALCYCLIST ACTION

At Intersection P0 P0		Not at Intersection P0 P0		P0 P0	
☐ ☐	With Signal	☐ ☐	From Behind Obstruction	☐ ☐	Walking Against Traffic
☐ ☐	Against Signal	☐ ☐	No Crosswalk	☐ ☐	Standing
☐ ☐	No Signal	☐ ☐	Crosswalk	☐ ☐	Pushing or Working on Vehicle
☐ ☐	Crossing Diagonally	☐ ☐	Walking W/Traffic	☐ ☐	Playing in Road
		☐ ☐	*Other		

*SPECIFY:

Describe what happened – refer to vehicles by number.

NARRATIVE

Use Diagram/Narrative Sheet for additional information

OTHER PROPERTY INVOLVED	Property Type	DESCRIPTION OF PROPERTY AND DAMAGE		
	Owner's Name	Owner's Addres	Owner's Zip Code	Owner's Telephone

WITNESS

NAME	AGE	ADDRESS	TELEPHONE

ENFORCEMENT ACTION

VEH. NO.	NAME	VIOLATION (COMMON NAME)	ACTION		
			☐ Booked	☐ Cited	☐ Pending
			☐ Booked	☐ Cited	☐ Pending
			☐ Booked	☐ Cited	☐ Pending

Time Notified	Time Arrived	Notified By	Supervisor at Scene	Checked By

Officer's Signature	Printed Officers Name	Rank	ID No.	District	Date of Report

Crash Report Number 0000000000

Case Number 0

STATE OF NEW MEXICO UNIFORM CRASH REPORT
NM Statute 66-7-209

0

SHEET OF SHEETS

DIAGRAM/NARRATIVE

Use Additional Sheets As Necessary

CRASH REPORT NUMBER: 0000000000

CASE NUMBER: 0

DIAGRAM DRAWING BY:

MEASUREMENTS TAKEN BY:

Indicate North By Arrow

Crash Report Number 0000000000 Case Number 0	**STATE OF NEW MEXICO UNIFORM CRASH REPORT** **NM Statute 66-7-209** 0	SHEET OF SHEETS

Appendix C: Study Intersections and Approaches

Survey of Yellow Light Intervention Intersections

Intersection Name	Direction	2008 ADT	Speed Limit	No. of lanes	CABQ Straight Yellow Interval (sec)	ISR Straight Yellow Interval (sec)	Straight Yellow Interval Difference	CABQ Left Turn Yellow Interval (sec)	ISR Left Turn Yellow Interval (sec)	Left Turn Yellow Interval Difference
Academy and Wyoming	NB	20998	40	6	4.50	4.46	0.04	3.50	3.46	0.04
	EB	10229	45	4	4.80	4.78	0.02	3.50	3.43	0.07
	SB	17185	40	5	4.50	4.48	0.02	3.00	2.92	0.08
	WB	10107	40	4	4.80	4.80	0.00	3.00	3.00	0.00
Central and Coors	NB	8640	45	5	4.30	4.43	-0.13	3.00	2.93	0.07
	EB	9552	45	3	4.30	4.36	-0.06	3.00	2.85	0.15
	SB	17003	45	4	4.30	4.37	-0.07	3.00	2.93	0.07
	WB	13098	40	3	4.30	4.39	-0.09	3.00	2.88	0.12
Central and Eubank	NB	13376	40	4	4.50	4.39	0.11	3.00	2.93	0.07
	EB	16224	40	5	4.50	4.42	0.08	3.00	2.95	0.05
	SB	15549	40	5	4.50	4.41	0.09	3.00	3.03	-0.03
	WB	13367	40	4	4.50	4.47	0.03	3.00	2.94	0.06
Central and Louisiana	NB	9845	35	4	4.00	3.93	0.07	3.00	2.96	0.04
	EB	8919	35	4	4.00	3.95	0.05	3.00	2.96	0.04
	SB	16334	35	4	4.00	3.95	0.05	3.00	2.99	0.01
	WB	11767	35	4	4.00	3.96	0.04	3.00	2.99	0.01
Ellison and Coors Bypass	NB	24435	45	6	5.00	4.97	0.03	3.00	2.98	0.02
	EB	14348	40	5	4.20	4.10	0.10	3.00	3.00	0.00
	SB	13318	45	6	5.00	4.98	0.02	3.00	3.00	0.00
	WB	17667	35	5	4.20	4.20	0.00	3.00	2.98	0.02
Lomas and Eubank	NB	21512	40	6	4.50	4.46	0.04	3.00	3.00	0.00
	EB	9023	40	5	4.50	4.41	0.09	3.00	2.98	0.02
	SB	18923	40	5	4.50	4.48	0.02	3.00	2.97	0.03
	WB	12459	40	5	4.50	4.46	0.04	3.00	3.01	-0.01
Lomas and Juan Tabo	NB	16582	40	5	4.50	4.41	0.09	3.00	2.97	0.03
	EB	9791	40	4	4.50	4.44	0.06	3.00	3.01	-0.01
	SB	14005	40	4	4.50	4.42	0.08	3.00	2.99	0.01
	WB	7979	40	5	4.50	4.45	0.05	3.00	2.97	0.03
Lomas and Wyoming	NB	14765	40	6	4.50	4.46	0.04	3.00	2.99	0.01
	EB	15607	40	5	4.50	4.45	0.05	3.00	2.98	0.02
	SB	16522	40	5	4.50	4.45	0.05	3.00	2.99	0.01
	WB	8965	40	5	4.50	4.42	0.08	3.00	2.96	0.04
Menaul and Carlisle	NB	14914	35	5	4.20	4.16	0.04	3.00	2.96	0.04
	EB	10137	40	5	4.80	4.76	0.04	3.00	2.99	0.01
	SB	14158	35	5	4.20	4.15	0.05	3.00	2.96	0.04
	WB	16027	35	5	4.80	4.76	0.04	3.00	2.99	0.01
Menaul and Louisiana	NB	13998	35	6	4.20	4.15	0.05	3.00	3.00	0.00
	EB	15225	35	6	4.50	4.47	0.03	3.00	2.98	0.02
	SB	9250	35	3	4.20	4.20	0.00	3.00	2.99	0.01
	WB	16013	35	6	4.50	4.47	0.03	3.00	2.97	0.03

Menaul and San Mateo	NB	15141	35	6	4.20	4.16	0.04	3.00	2.98	0.02
	EB	13707	35	5	4.50	4.42	0.08	3.00	2.99	0.01
	SB	13006	35	5	4.20	4.15	0.05	3.00	2.99	0.01
	WB	17550	35	5	4.50	4.43	0.07	3.00	2.99	0.01
Menaul and Wyoming	NB	14486	40	5	4.50	4.46	0.04	3.00	2.95	0.05
	EB	17002	35	5	4.20	4.12	0.08	3.00	2.99	0.01
	SB	17923	40	5	4.50	4.80	0.02	3.00	2.92	0.08
	WB	11803	35	5	4.20	4.13	0.07	3.00	2.98	0.02
Montano and Coors	NB	25193	45	7	4.80	4.41	0.39	3.50	3.48	0.02
	EB	13157	40	5	4.50	4.45	0.05	3.50	3.44	0.06
	SB	21824	40	6	4.80	4.73	0.07	3.50	3.41	0.09
	WB	12243	40	2	4.50	4.48	0.02	3.50	3.44	0.06
Montgomery and Carlisle	NB	11797	35	4	4.20	4.06	0.14	3.00	2.96	0.04
	EB	20106	35	5	4.50	4.46	0.04	3.00	2.98	0.02
	SB	11797	25	3	4.20	4.13	0.07	3.00	2.98	0.02
	WB	21336	35	5	4.50	4.46	0.04	3.00	3.00	0.00
Montgomery and Eubank	NB	15007	40	4	4.50	4.48	0.02	3.00	2.97	0.03
	EB	14562	40	4	4.50	4.46	0.04	3.00	2.96	0.04
	SB	14286	40	4	4.50	4.49	0.01	3.00	3.03	-0.03
	WB	17232	40	3	4.50	4.45	0.05	3.00	2.98	0.02
Montgomery and San Mateo	NB	19195	40	6	4.50	4.49	0.01	3.00	3.00	0.00
	EB	21174	35	6	4.20	4.06	0.14	3.00	2.99	0.01
	SB	19195	40	6	4.50	4.44	0.06	3.00	2.99	0.01
	WB	21353	35	6	4.20	4.24	-0.04	3.00	2.98	0.02
Montgomery and Wyoming	NB	17868	40	5	4.50	4.45	0.05	3.00	3.00	0.00
	EB	18379	40	5	4.50	4.46	0.04	3.00	2.98	0.02
	SB	33579	40	5	4.50	4.47	0.03	3.00	2.98	0.02
	WB	18085	40	5	4.50	4.47	0.03	3.00	3.00	0.00
Paseo Del Norte and Coors	NB	19346	45	5	5.00	5.01	-0.01	4.00	3.96	0.04
	EB	19346	45	3	Light does not exist			4.00	4.02	-0.02
	SB	19378	45	6	5.00	4.96	0.04	4.00	4.05	-0.05
	WB	36125	55	4	Light does not exist			4.00	3.98	0.02
Paseo Del Norte and Jefferson	NB	10257	35	4	4.50	4.44	0.06	3.00	2.99	0.01
	EB	22889	45	6	4.80	4.92	-0.12	3.00	3.00	0.00
	SB	4836	40	6	4.50	4.48	0.02	3.00	2.98	0.02
	WB	32984	45	3	4.80	4.94	-0.14	3.00	2.98	0.02
Quail and Coors	NB	21538	45	6	4.50	4.35	0.15	3.00	2.96	0.04
	EB	6224	25	3	4.00	3.94	0.06	3.50	3.42	0.08
	SB	21538	45	6	4.50	4.47	0.03	3.00	2.96	0.04
	WB	7559	25	4	4.00	3.93	0.07	3.00	2.96	0.04

Appendix D: Comparison Intersections

Survey of Comparison Intersections

Intersection Name	Direction	2008 ADT	Speed Limit	No. of lanes	CABQ Straight Yellow Interval (sec)	ISR Straight Yellow Interval (sec)	Straight Yellow Interval Difference	CABQ Left Turn Yellow Interval (sec)	ISR Left Turn Yellow Interval (sec)	Left Turn Yellow Interval Difference
Academy and Eubank	NB	12562	40	4	4.00	3.98	0.02	3.50	3.45	0.05
	EB	9350	40	4	4.00	3.98	0.02	3.50	3.46	0.04
	SB	8358	40	4	4.00	4.00	0.00	3.50	3.46	0.04
	WB	7404	40	4	4.00	3.99	0.01	3.50	3.44	0.06
Academy and San Mateo	NB	18221	40	5	4.00	3.96	0.04	3.00	2.98	0.02
	EB	12858	40	3	3.50	3.44	0.06	3.00	2.95	0.05
	SB	19876	40	5	4.00	3.94	0.06	3.00	2.98	0.02
	WB	12858	40	5	3.50	3.45	0.05	3.00	2.97	0.03
Candelaria and Carlisle	NB	12939	35	4	4.00	3.96	0.04	3.00	3.01	-0.01
	EB	8785	35	3	4.00	3.96	0.04	3.00	3.00	0.00
	SB	12787	35	4	4.00	3.99	0.01	3.00	3.01	-0.01
	WB	8560	35	3	4.00	3.93	0.07	3.00	2.98	0.02
Candelaria and Juan Tabo	NB	13528	40	4	4.00	3.97	0.03	3.00	2.97	0.03
	EB	3902	35	3	4.00	4.00	0.00	3.00	2.96	0.04
	SB	15188	40	4	4.00	3.96	0.04	3.00	2.99	0.01
	WB	7927	35	3	4.00	3.98	0.02	3.00	2.97	0.03
Candelaria and San Mateo	NB	12341	40	4	4.00	3.94	0.06	3.00	2.95	0.05
	EB	8637	35	3	4.00	3.95	0.05	3.00	2.96	0.04
	SB	15109	40	4	4.00	3.99	0.01	3.00	2.94	0.06
	WB	7754	40	3	4.00	3.96	0.04	3.00	2.94	0.06
Candelaria and Wyoming	NB	11480	40	4	4.00	3.95	0.05	3.00	2.94	0.06
	EB	9151	35	3	4.00	3.94	0.06	3.00	2.96	0.04
	SB	15460	40	4	4.00	3.97	0.03	3.00	2.94	0.06
	WB	8288	35	3	4.00	3.96	0.04	3.00	2.93	0.07
Central and Juan Tabo	NB	8842	35	4	4.00	3.89	0.11	3.00	2.88	0.12
	EB	8526	40	4	4.30	4.24	0.06	3.00	2.90	0.10
	SB	14051	40	4	4.00	3.87	0.13	3.00	2.89	0.11
	WB	12089	40	4	4.30	4.27	0.03	3.00	2.94	0.06
Central and Rio Grande	NB	13547	25	2	4.00	3.88	0.12	Light does not exist		
	EB	13532	35	4	4.00	3.92	0.08	3.00	2.98	0.02
	SB	13547	35	4	4.00	3.88	0.12	3.00	2.92	0.08
	WB	14186	30	4	4.00	3.90	0.10	Light does not exist		
Central and San Mateo	NB	11470	40	5	4.00	3.95	0.05	3.00	2.99	0.01
	EB	13705	35	4	4.00	3.98	0.02	3.00	3.02	-0.02
	SB	12391	40	5	4.00	3.93	0.07	3.00	2.96	0.04
	WB	14211	35	3	4.00	3.94	0.06	3.00	2.96	0.04
Central and University	NB	6123	30	4	4.00	3.91	0.09	3.00	2.88	0.12
	EB	13246	30	3	4.00	3.91	0.09	3.00	2.92	0.08
	SB	11165	30	4	4.00	3.88	0.12	3.00	2.93	0.07
	WB	12246	30	4	4.00	3.92	0.08	3.00	2.91	0.09
Central and	NB	9952	35	4	4.00	3.93	0.07	3.00	2.90	0.10

Wyoming	EB	13065	35	4	4.00	3.83	0.17	3.00	2.91	0.09
	SB	14060	40	4	4.00	3.93	0.07	3.00	2.88	0.12
	WB	14278	40	4	4.00	3.89	0.11	3.00	2.91	0.09
Constitution and Eubank	NB	17074	40	4	4.00	3.96	0.04	3.00	2.99	0.01
	EB	3421	35	2	4.00	3.96	0.04	3.00	2.95	0.05
	SB	15334	40	4	4.00	3.99	0.01	3.00	2.92	0.08
	WB	3073	30	2	4.00	3.95	0.05	3.00	2.97	0.03
Constitution and Wyoming	NB	14654	40	4	4.00	3.98	0.02	3.00	2.95	0.05
	EB	3570	30	2	4.00	3.95	0.05	3.00	2.96	0.04
	SB	14948	40	4	4.00	3.95	0.05	3.00	2.95	0.05
	WB	4194	35	3	4.00	3.94	0.06	3.00	2.95	0.05
Cutler and San Mateo	NB	15419	35	5	4.00	3.92	0.08	3.00	2.95	0.05
	EB	6223	30	3	4.00	3.93	0.07	3.00	2.89	0.11
	SB	15878	35	4	4.00	3.84	0.16	Light does not exist		
	WB	6223	30	4	4.00	3.92	0.08	3.00	2.93	0.07
Ellison and NM 528	NB	17447	35	4	3.80	3.78	0.02	3.00	2.92	0.08
	EB	12385	35	4	4.20	4.16	0.04	3.00	2.94	0.06
	SB	18201	25	3	3.80	3.79	0.01	3.00	2.96	0.04
	WB	3699	40	4	4.20	4.15	0.05	3.00	2.96	0.04
Gibson and Yale	NB	9296	35	5	4.20	4.09	0.11	3.00	2.87	0.13
	EB	14695	45	5	4.50	4.31	0.19	3.00	2.91	0.09
	SB	6232	40	3	4.20	4.08	0.12	3.00	2.86	0.14
	WB	18648	45	5	4.50	4.42	0.08	3.00	2.83	0.17
Indian School and Louisiana	NB	15900	35	7	4.00	3.92	0.08	3.00	2.99	0.10
	EB	5209	35	4	4.00	3.92	0.08	3.00	3.01	-0.01
	SB	19513	35	7	4.00	3.95	0.05	3.00	3.03	-0.03
	WB	7453	35	4	4.00	3.93	0.07	3.00	2.97	0.03
Indian School and San Mateo	NB	19488	40	4	4.00	3.96	0.04	3.00	2.91	0.09
	EB	5064	40	3	3.50	3.47	0.03	3.00	2.97	0.03
	SB	20445	35	5	4.00	3.92	0.08	3.00	2.85	0.15
	WB	3039	35	4	3.50	3.38	0.12	3.00	2.92	0.08
Irving and Coors	NB	34881	45	5	4.50	4.48	0.02	3.00	2.99	0.01
	EB	9982	40	3	4.20	4.17	0.03	3.00	3.00	0.00
	SB	34387	45	5	4.50	4.48	0.02	3.00	3.00	0.00
	WB	9982	40	4	4.20	4.16	0.04	3.00	2.99	0.01
Lomas and Louisiana	NB	10979	40	4	4.00	3.95	0.05	3.00	2.98	0.02
	EB	17122	40	4	4.00	3.97	0.03	3.00	2.95	0.05
	SB	11810	40	4	4.00	3.96	0.04	3.00	3.01	-0.01
	WB	11112	40	4	4.00	3.95	0.05	3.00	2.96	0.04
Lomas and San Mateo	NB	16018	40	4	4.00	3.95	0.05	3.00	2.97	0.03
	EB	12525	35	4	4.00	3.93	0.07	3.00	2.92	0.08
	SB	21218	40	4	4.00	3.95	0.05	3.00	2.98	0.02
	WB	13668	35	4	4.00	3.95	0.05	3.00	2.93	0.07
Lomas and San Pedro	NB	4478	35	4	4.00	3.94	0.06	3.00	3.00	0.00
	EB	13745	40	4	4.00	3.96	0.04	3.00	3.01	-0.01
	SB	6396	35	3	4.00	3.99	0.01	3.00	2.99	0.01
	WB	13720	40	4	4.00	3.96	0.04	3.00	2.98	0.02
Lomas and University	NB	10184	30	4	4.00	3.97	0.03	3.00	3.01	-0.01
	EB	19758	35	4	4.00	3.99	0.01	3.00	2.96	0.04

	SB	10474	35	3	4.00	3.96	0.04	3.00	2.96	0.04
	WB	15766	35	4	4.00	3.95	0.05	3.00	2.96	0.04
Menaul and Eubank	NB	17054	40	4	4.00	3.97	0.03	3.50	3.47	0.03
	EB	11080	40	3	4.00	3.96	0.04	3.50	3.46	0.04
	SB	17276	40	4	4.00	3.95	0.05	3.50	3.50	0.00
	WB	11013	40	4	4.00	3.95	0.05	3.50	3.45	0.05
Menaul and Juan Tabo	NB	19439	40	4	4.00	3.96	0.04	3.00	3.00	0.00
	EB	8913	40	3	4.00	3.96	0.04	3.00	2.98	0.02
	SB	18436	40	4	4.00	3.94	0.06	3.00	2.96	0.04
	WB	6595	40	3	4.00	3.97	0.03	3.00	2.99	0.01
Menaul and San Pedro	NB	9386	35	5	4.00	3.98	0.02	3.00	2.98	0.02
	EB	18855	35	5	4.00	3.98	0.02	3.00	3.00	0.00
	SB	6538	35	4	4.00	3.98	0.02	3.00	2.99	0.01
	WB	9634	35	5	4.00	3.99	0.01	3.00	3.03	-0.03
Montgomery and Juan Tabo	NB	11986	40	4	4.00	3.99	0.01	3.00	2.96	0.04
	EB	11674	40	4	4.30	4.26	0.04	3.00	2.99	0.01
	SB	10984	40	4	4.00	3.96	0.04	3.00	3.00	0.00
	WB	8827	40	4	4.30	4.22	0.08	3.00	2.99	0.01
Montgomery and Louisiana	NB	10946	35	3	4.00	3.99	0.01	3.00	2.98	0.02
	EB	32430	40	4	4.00	3.95	0.05	3.00	2.99	0.01
	SB	4578	35	3	4.00	3.96	0.04	3.00	3.00	0.00
	WB	19131	40	4	4.00	3.96	0.04	3.00	2.98	0.02
Montgomery and Morris	NB	3034	35	2	4.00	3.99	0.01	3.00	2.99	0.01
	EB	14982	40	4	4.00	3.97	0.03	3.00	2.97	0.03
	SB	4944	30	3	4.00	4.01	-0.01	3.00	2.99	0.01
	WB	12120	40	5	4.00	4.01	-0.01	3.00	2.97	0.03
Montgomery and San Pedro	NB	6432	30	3	4.00	3.98	0.02	3.00	2.99	0.01
	EB	17210	35	4	4.00	3.96	0.04	3.00	3.00	0.00
	SB	7081	35	3	4.00	3.97	0.03	3.00	2.99	0.01
	WB	16553	40	4	4.00	3.98	0.02	3.00	2.99	0.01
Montgomery and Tramway	NB	10237	50	5	4.80	4.77	0.03	3.00	2.97	0.03
	EB	8135	40	3	4.50	4.45	0.05	3.00	2.95	0.05
	SB	13046	50	5	4.80	4.77	0.03	3.00	2.98	0.02
	WB	8760	30	4	4.50	4.50	0.00	3.00	2.99	0.01
Osuna and Wyoming	NB	23160	40	4	4.00	3.97	0.03	3.00	3.00	0.00
	EB	5613	35	3	4.00	3.97	0.03	3.00	3.00	0.00
	SB	21842	40	4	4.00	3.99	0.01	3.00	2.94	0.06
	WB	3247	35	2	4.00	3.93	0.07	3.00	3.00	0.00
Paradise and Golf Course	NB	9717	40	4	4.20	4.14	0.06	3.00	2.97	0.03
	EB	10193	35	3	4.20	4.13	0.07	3.00	2.98	0.02
	SB	10743	30	3	4.20	4.13	0.07	3.00	2.95	0.05
	WB	8738	40	3	4.20	4.15	0.05	3.00	2.95	0.05
Paseo Del Norte and Eagle Ranch	NB	4484	35	3	4.20	4.15	0.05	3.00	2.99	0.01
	EB	14305	45	4	4.20	4.10	0.10	3.00	2.96	0.04
	SB	11149	35	4	4.20	4.09	0.11	3.00	2.99	0.01
	WB	14742	45	4	4.20	4.09	0.11	3.00	2.96	0.04
Paseo Del Norte and San Pedro	NB	6390	35	4	4.00	3.97	0.03	3.00	3.01	-0.01
	EB	10795	45	6	5.00	5.00	0.00	3.00	2.99	0.01
	SB	7660	35	4	4.00	3.96	0.04	3.00	3.02	-0.02

	WB	20243	45	6	5.00	4.94	0.06	3.00	2.99	0.01
Paseo Del Norte and Wyoming	NB	13140	40	5	4.00	3.99	0.01	3.00	3.03	-0.03
	EB	9775	55	6	5.00	4.99	0.01	3.00	2.99	0.01
	SB	9206	40	4	4.00	3.98	0.02	3.00	2.99	0.01
	WB	15636	55	5	5.00	4.95	0.05	3.00	2.96	0.04
St. Josephs and Coors	NB	19262	45	5	4.50	4.40	0.10	3.00	2.93	0.07
	EB	3725	35	4	3.50	3.41	0.09	3.00	2.99	0.01
	SB	25119	45	5	4.50	4.41	0.09	3.00	2.92	0.08
	WB	4075	25	3	3.50	3.44	0.06	3.00	2.95	0.05