# *An Investigation of the Change in Crash Rates at Automated Red Light Running Enforced and Comparison Intersections in Davenport and Council Bluffs, Iowa Using Descriptive Statistics*

Eric J. Fitzsimmons
Ph.D. Candidate
Iowa State University
Center for Transportation Research and Education
2711 South Loop Drive, Suite 4700
Ames, IA  50010-8664
Phone (515) 294-8103
E-mail: efitz@iastate.edu

*Midwest Transportation Consortium Fall 2007 Student Paper Competition*

Submission Date: October 12, 2007

**Word Count = 3,608 text + 2 tables & 4 figures @ 250 words each = 5,108**

**Abstract**

Red light running is a significant safety problem as drivers become increasingly aggressive and distracted on city roads, which results in drivers testing their patients to stop for a red light at a signalized intersection. As agencies have struggled to find ways to address the issue, they have increasingly turned to the use automated red light running camera enforcement systems to supplement having a uniformed officer patrol dangerous intersections. Red light running camera systems are a form of automated enforcement which detect, determine, and capture images of vehicles that run a red light to later issue a citation. In most cases the systems are operated by a private corporation. However, the use of red light running cameras is one of the most controversial topics facing drivers, traffic engineers, city councils, and public awareness groups. Many communities do not have the resources to perform a study to determine if the camera system is effective at reducing violations or crashes.

There are numerous ways to determine the effectiveness of and automated red light running camera system including the change in the number of violations or reduction in crashes using various statistical methods. This study presents the findings of a simple before and after crash rate analysis using descriptive statistics. The total number of vehicle crashes, rear-end crashes, and red light running related crashes at camera enforced intersections were compared to the same crash type at similar comparison intersections in Davenport and Council Bluffs, Iowa. Results indicated that the intersections with red light running cameras showed a decrease in red light running type crashes while the comparison intersections showed both an increase and decrease in red light running type crashes.

*Note:* This research was conducted as part of a Center for Transportation Research and Education / Iowa Department of Transportation active project “Red Light Running, Phase 2”

## INTRODUCTION

The effectiveness of automated red light running enforcement cameras in reducing crashes is constantly questioned and in some cases, it has been argued that automated red light running enforcement increases the percentage of rear-end collisions. The legality and acceptability of the systems are also constantly debated among government officials and citizens who see cameras as either "intrusive" or "constitutionally illegal" to a certain extent. The Federal Highway Administration (FHWA) estimates that between 40 and 45% of all motor vehicle crashes occur at signalized intersections *(1)*. It is estimated an economic loss to society of over $14 billion a year is due to over 100,000 crashes and 800 fatalities caused by red light running related crashes *(2)*.

One of the most cited research studies relating to investigating red light running crash analysis was performed by Retting and Kyrychenko (1998) which evaluated the effectiveness of eleven camera enforced intersections in Oxnard, California. Unlike many effectiveness studies, the research team had an extensive database of before and after crashes at each study site. A unique feature about this research project involved the use of comparison intersections located in the nearby cities of Bakersfield, San Bernardino, and Santa Barbara. In all four cities both signalized and non-signalized intersections were investigated as well as nearby intersections in Oxnard were investigated to see if any spillover or halo effects were occurring as a result of the newly installed cameras. Using the crash data, a generalized linear equation was determined and concluded that the camera enforced intersections in Oxnard had reduced the number of crashes by 5.4% and injury crashes by 20.1% of which both results were found to be statistically significant. Furthermore, research at the camera enforced intersections showed a significant decrease in right-angle crashes and a 3.1% increase in rear-end crashes *(3)*.

However, some studies have suggested that while red light running cameras reduce right-angle crashes, rear-end crashes may increase as reported by Council et al (2005) (4). Consequently, the net result is little or minimal change in the total number of crashes. Other studies have attempted to identify red light running crashes. Studies have evaluated right-angle crashes, angle-crashes, injury right-angle, rear-end crashes, and injury rear-end crashes *(4,5,6)*. However, as indicated by Bonneson and Zimmerman (2006), it is difficult to identify actual red light running crashes since red light running is not indicated on the crash forms of most states (6). Even when crash form attributes are available that indicate some type of disregard for traffic signal, officers may not take the time to determine whether the crash was red light running related. For instance, an officer reporting an angle-oncoming left turn crash at a signalized intersection may just assume that the left turning vehicle failed to select an adequate gap rather than attempting to determine if one of the drivers ran the red light.

Bonneson and Zimmerman (2006) listed the following common attributes to identify red light running crashes:

- Intersection relationship: "at" the intersection;
- Crash type: right angle; and
- First contributing factor: "disregard of stop and go signal"

They evaluated these attributes to identify red light-related crashes at 70 signalized intersections in three Texas cities for a 3 year period. Using the previous criteria, they found 274 crashes with all three attributes. After reviewing officer reports for 3,338 crashes at those intersections, they found that 232 red light related crashes were missed while only four of the 274 were determined to be "not red light running related." In many cases "left-turn opposing" crashes result from failure to yield right of way during a permissive indication and are not typically considered to be red light running related. They found that 75 "left-turn opposing" were in fact red light running related. Their conclusions were that red light running crashes are not always coded as right-angle crashes and police officers may designate disregard of traffic signal in different manners *(6)*.

## PROBLEM STATEMENT AND RESEARCH OBJECTIVE

A statewide investigation of recent crash records through the Iowa Department of Transportation's (Iowa DOT) crash database reveled an average of 1,682 crashes were an officer indicated "ran traffic signal" as the major cause between 2001 and 2006. Illustrated in Figure 1 are the trends for red light running crashes and red light running type crashes for 2001 through 2006 in the State of Iowa.

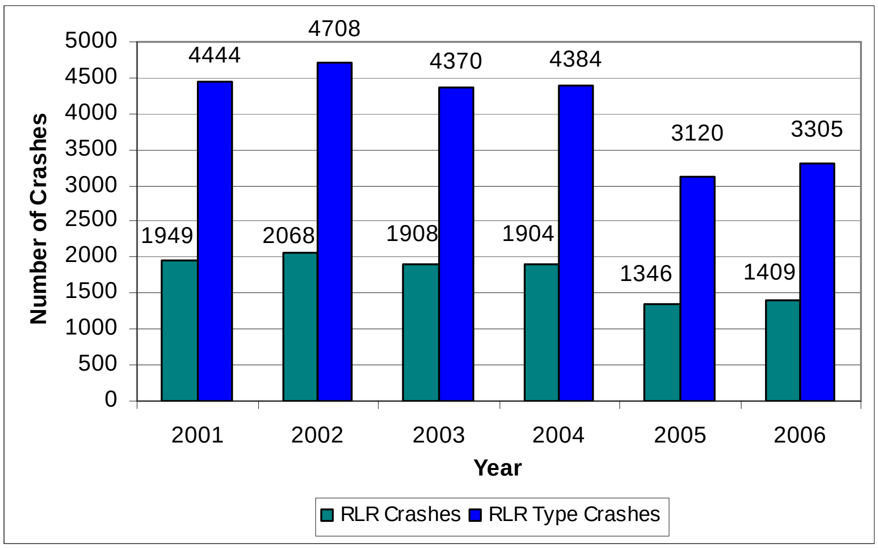


**FIGURE 1 RLR and RLR type crashes in Iowa from 2001 to 2006.**

Additionally, annually an average of 51 fatal and major injury red light running crashes occur at signalized intersections in Iowa.

An average of 8,162 total crashes and 147 fatal and major injury crashes occur at signalized intersections in Iowa every year from 2001 to 2006. Red light running crashes account for 20.6% of all signalized intersection crashes but account for 35.0% of the fatal and major injury crashes at signalized intersections. As indicated, red light running crashes are disproportionately likely to result in a fatal or major injury crash.

As indicated, both the number of red light running crashes and total signalized intersection crashes has decreased from 2001 to 2006. However, as indicated in Figure 2, the ratio of red light running to total number of signalized intersection crashes has remained relatively constant around 21% over time. The total number of specified red light running fatal and major injury crashes have also decreased over time, but the total number of fatal and major injury signalized intersection crashes in Iowa have also decreased. As a result, the ratio of red light running fatal and major injury crashes to total fatal and major injury crashes at signalized intersections have also remained constant over time at about 35%.

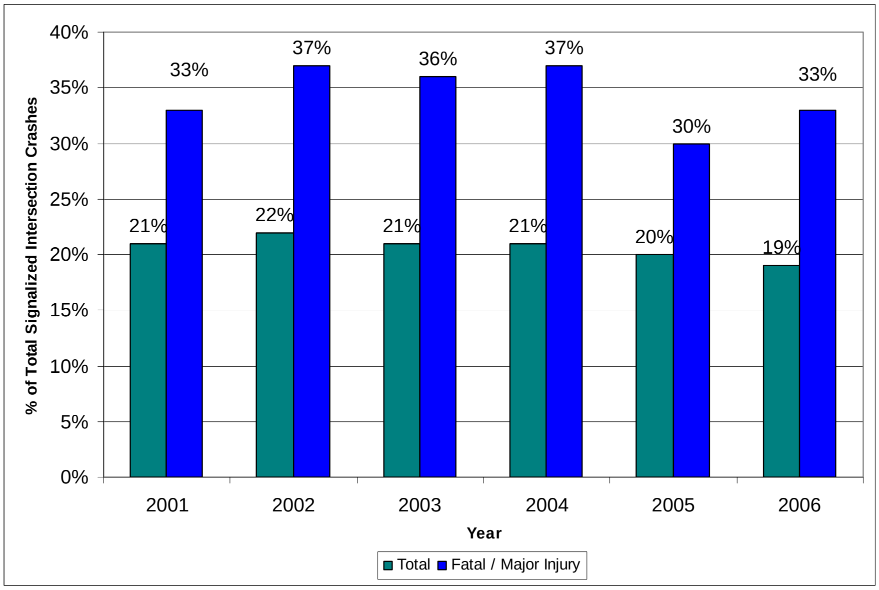


**FIGURE 2 Total and Fatal / Major Crashes as a percent of the total RLR crashes in Iowa.**

In order to address intersection red light running, three larger communities in Iowa have instituted red light running enforcement programs since 2004 with the newest program in Clive, Iowa which began in 2005. The researchers conducted a safety analysis of the effectiveness of red light running enforcement in reducing crashes for the two communities of Council Bluffs and Davenport, Iowa which had the most available data.

Both cities, along with the Iowa DOT have not conducted a valid study to investigate what impacts the red light running cameras are on safety. Since both cities installed the systems in 2004, enough time has passed to perform a before and after study to investigate the change in crash rates using descriptive statistics.

## SITE SELECTION

A total of ten camera enforced intersections and nine comparison intersections were evaluated for red light running crashes in both Davenport and Council Bluffs and the location of the sites are illustrated in Figures 3 and 4. Comparison intersections were selected based on there location in relevance to the enforced intersections, and also if the comparison intersection had experienced any red light running related crashes at all.

The use of comparison intersections is important to ensure that reductions in violations are not due to factors other than the red light running enforcement. Retting, Ferguson, and Shalom Hakkart (2003), indicated that spillover effects, regression to the mean, driver behavioral changes, and other factors independent of camera enforcement can influence the number of crashes and violations. As a result, evaluations of the effectiveness of red light running cameras in reducing crashes and violations which do not include control intersections can give misleading results *(7)*.

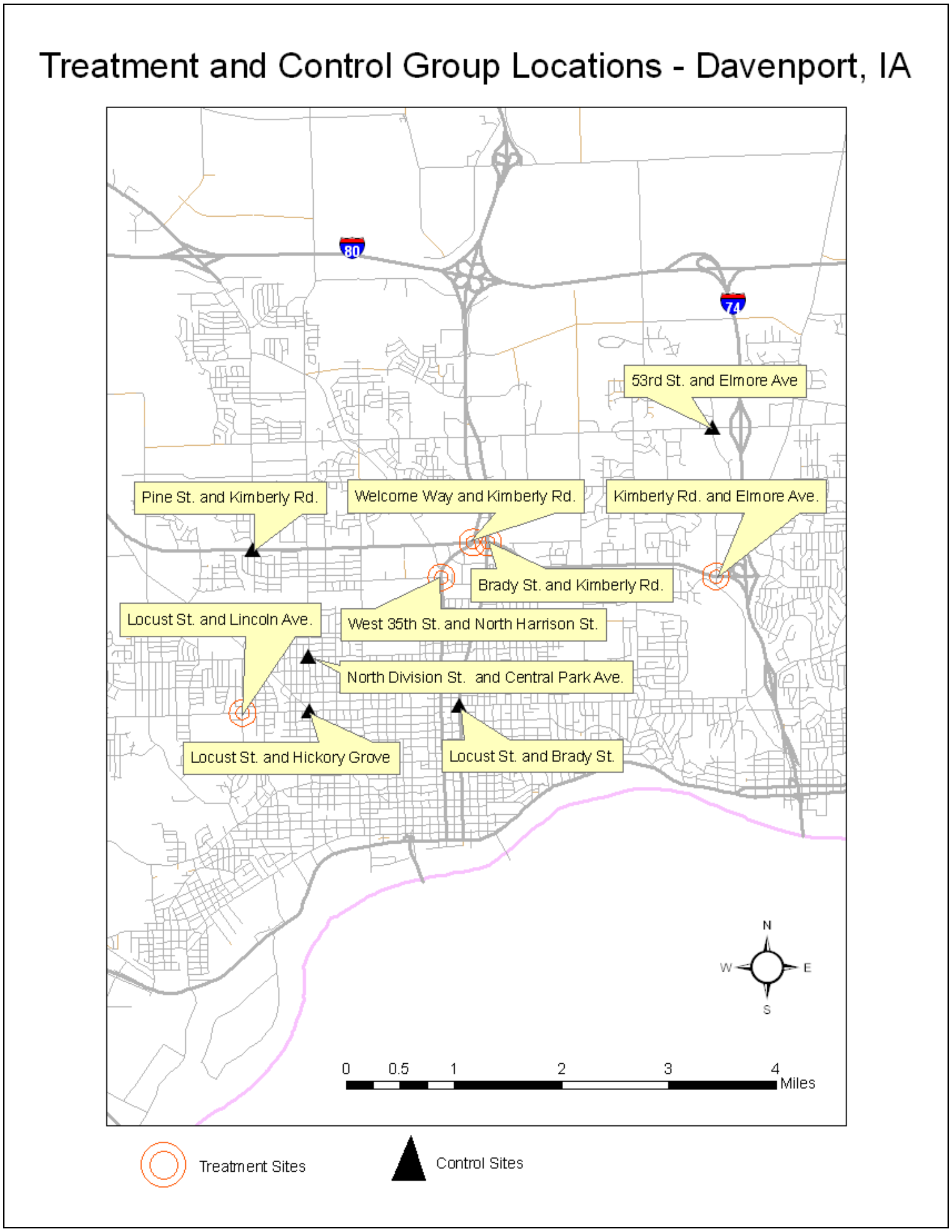


**FIGURE 3 Davenport, IA treatment and comparison sites.**

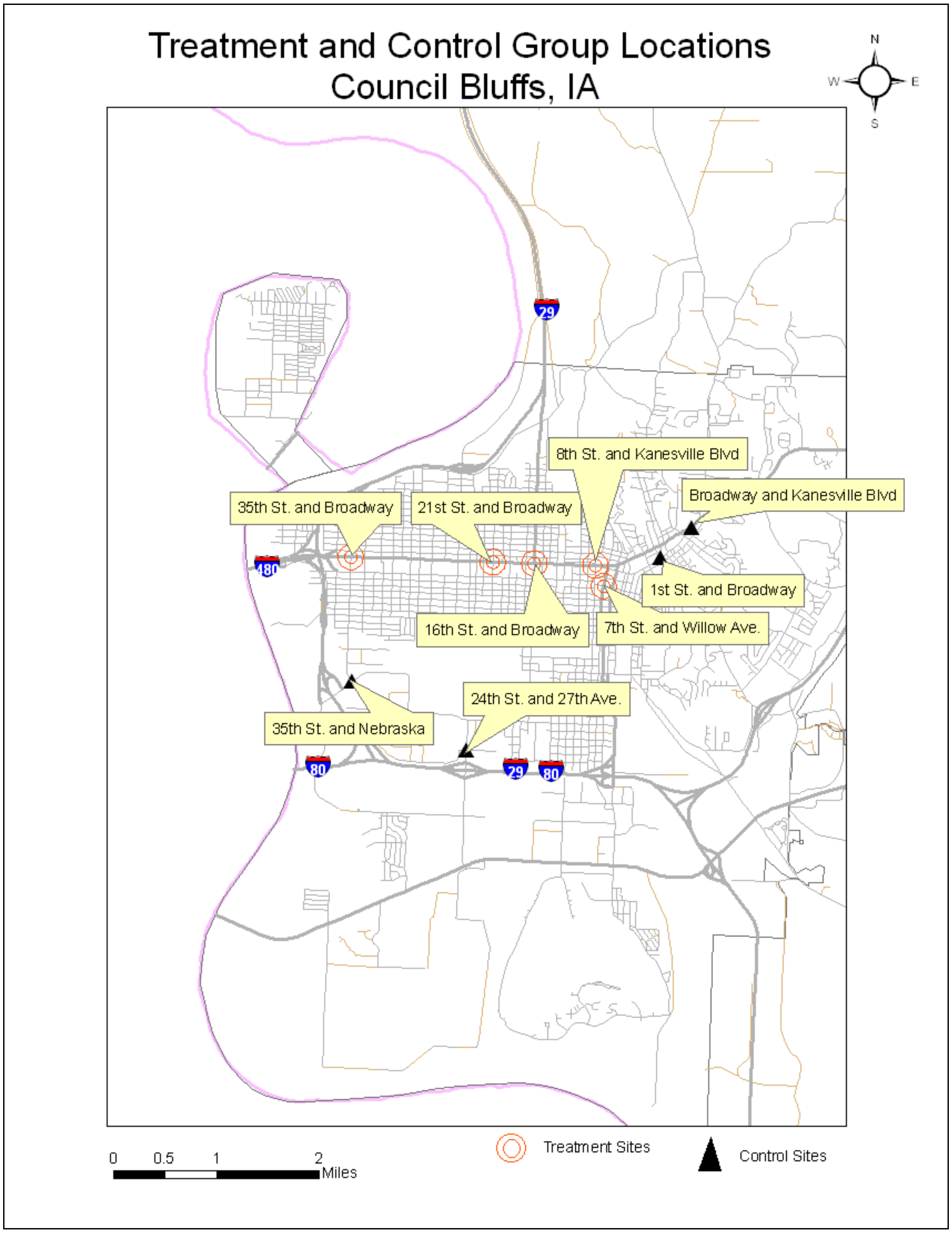


**FIGURE 4 Council Bluffs, IA treatment and comparison sites.**

## DATA COLLECTION AND REDUCTION

Based on the results and conclusions of other relating studies and available data, it was determined that the most effective approach was to attempt to identify red light running crashes for analysis instead of violations. Red light running (RLR) rear-end crashes and other red light running (RLR) crashes (which included any crash indicated as RLR except for rear-end crashes), hereafter referred to as "RLR other crashes," were extracted and analyzed separately. For each community, several intersections with similar crash history and volumes which were not likely to have been influenced by the locations with cameras were selected as control sites.

Extraction of red light running crashes at Davenport and Council Bluffs intersections with cameras and comparison intersections without cameras were completed using the following methodology. The Iowa DOT crash database, which includes spatial referencing, was used to select crashes which occurred within 25 meters of a specified study intersection. This is the method that the Iowa DOT uses to identify an intersection crash. Crashes were extracted from 2001 to 2006. Next, crashes in which the officer had indicated "Ran Traffic Signal" as the major cause were selected as RLR crashes. This included all crash types and accounted for a total of 247 crashes (237 RLR other and 10 RLR rear-end crashes). Since officers may not always use the designation "Ran Traffic Signal" to indicate the major cause, or may not take the time to determine whether the crash was due to one vehicle running a red light, the crash report for each crash which was not indicated as having "Ran Traffic Signal" as the major cause was reviewed. Crashes where an officer or witness indicated that at least one vehicle involved had ran the red light were coded as red light running. Crashes where the crash diagram geometry and/or narrative indicated that a collision had occurred between two vehicles that were initially coming from perpendicular approaches were also included as red light running. For instance, a right angle crash between a vehicle which was going straight westbound and a vehicle going straight west bound would have entailed one of the vehicles running the red light.

Rear-end crashes were also evaluated to determine whether they were red light running related. There is some speculation that installation of red light running cameras may actually increase rear end crashes. In some studies, total rear-end crashes are included in the analyses. However, not all rear-end crashes at intersections are related to a leading vehicle coming to an abrupt stop for a red signal and being rear-ended by a following vehicle. Rear-end crashes which were coded with a major cause of "Ran Traffic Signal" were included. The crash record for the remaining rear-end crashes was evaluated. Rear-end crashes were discarded from this group when an officer or witness indicated that the rear-end crash had not been the result of a red light. For instance, in a number of cases, it was indicated that the light had just turned green and the following vehicle started up faster than the lead vehicle, thus resulting in a rear-end crash. In several other cases, a read-end occurred during a lane change which was not related to a red light and in several others, a rear-end crash occurred when vehicles slowed due to downstream congestion or a vehicle turning into a driveway.

A total of 1,291 crash reports for both RLR other and RLR rear-end crashes were evaluated for Davenport and Council Bluffs for both treatment and control intersections. This process yielded 10 additional RLR other crashes for a total of 258 and an additional 80 red light related rear-end crashes for a total of 90 crashes. Total number of crashes, total number of RLR other crashes, and total number of RLR rear-end crashes were separated by quarter for each intersection. Quarters were used rather than years so that the quarter when the camera was installed could be excluded from the analysis, rather than excluding an entire year. It should be noted that it was extremely difficult to determine whether left turn oncoming and right turn on red crashes were a result of red light running if they were not indicated with a major cause of "Ran Red Light." Review of the crash reports indicates that in most cases it did not appear that the officer had attempted to distinguish whether the vehicle involved in a right turn on red accident had slowed or stopped and simply failed to see oncoming traffic or whether they did not slow and were involved in the crash because they ran the red light. The same applied to left turn oncoming. In most cases the officer indicated that one or more drivers had failed to yield right of way but did not appear to attempt to determine whether the left turn driver had a permissive signal and simply failed to select an appropriate gap or whether the driver had a red indication and ran the signal.

## STATISTICAL ANALYSIS

Descriptive statistics are generally used to describe the basic statistical features of a set of data in a study, although not as powerful or conclusive as a statistical model. Descriptive statistics for this study were determined as a simplistic means to express the effectiveness of the red light running system at camera enforced intersections compared to specified control intersections in Council Bluffs and Davenport which could later be used a primer for a Monte Carlo or Hieratical Empirical Bayes statistical analysis. The resulting values that were desired included a percent change in average quarterly crash rates prior to and after the installation of a red light running camera at a specified intersection. Comparison intersections were evaluated using the same criteria and assumed an imaginary camera was installed in the same quarter as the camera enforced intersections, and a before and after crash rate analysis would be performed. To account for the construction time, the quarter in which the cameras were installed was disregarded at both enforced and comparison sites, and not included in the analysis. As explained in the previous section, quarterly before and after camera installation crash data were separated into four analysis groups which included:

- Total Crashes
- RLR Rear-End Crashes
- RLR Other Crashes
- Not a RLR Crash

A means of comparison between the four subgroups were made by taking into consideration the change in crash rates before and after the red light running camera installation for both the camera enforced intersections and the control intersections. To perform this task, crash rates for each subgroup per intersection were determined using equation 1 found in the Institute of Transportation Engineers (ITE) Traffic Engineering Handbook 5th Edition *(8).*

$$Crash\ Rate\ per\ MEV = (a \times 1,000,000) \div (b \times 365) \qquad \textbf{[1]}$$

Where:

*a* = number of accidents in one year
*b* = 24-hr total intersection entering volume

As mentioned in the previous section, crashes were extracted for each quarter three years prior to and two years following the installation of the red light running camera systems. The number of crashes per quarter were summed and divided by the number of before and after studied quarters which gave the value of 'a' in Equation 1. The daily entering vehicle (DEV) count was found using either the Iowa DOT's GIS road network database if the intersection was located on a state road, or taken from city counts, or extracted from manual field counts. As expected, the traffic volumes were not consistent year to year, so the volume was normalized to a rounded averaged volume for each intersection. Equation 2 illustrated the method used to determine the average DEV per quarter.

The DEV for each year was divided by 4 quarters and then averaged by the number of before and after studied quarters to find the value of 'b' in equation 1.

$$DEV\ per\ Quarter\ (before\ or\ After) = \frac{\sum \begin{matrix}[(Yearly_{Before\ or\ After\ installation}\ DEV \times 365\ Days)] \\ +[(DEV_{Installation\ Year} \times 365\ Days)/\#\ Quarters_{Before\ or\ After\ Quarter\ of\ Installation}]\end{matrix}}{\#\ of\ Quarters_{Before\ or\ After\ Installation}}$$

**[2]**

Where:

*DEV* = Daily Entering Vehicles as determined by the Iowa DOT or city
*Quarter* = Represents the a group of four consecutive months

As shown in Equation 1, this recommended procedure recommended by ITE was intended for a yearly analysis with an assumed uniform intersection entering vehicle volume. This study modified Equation 1 to represent the before and after crashes in a quarter system and then modified to accommodate the analysis based on yearly quarters.

Once the average quarterly crash rate for before and after camera installation was determined, a percent change was found using Equation 3.

$$Crash\ Rate\ Percent\ Change\ (\%) = \frac{(Crash\ Rate\ After\ Camera\ Installation\ -\ Crash\ Rate\ Before\ Camera\ Installation)}{Crash\ Rate\ Before\ Camera\ Installation}$$

**[3]**

A sample crash rate calculation spreadsheet can be found in the appendix which shows how the above steps described were used to find the percent change.

**RESULTS**

Shown in Tables 1 and 2 are the results of the statistical crash rate analysis for both cities. The Davenport intersection of Lincoln Avenue and Locust Street could not be evaluated because the red light running camera equipment was recently installed after moving from another intersection in Davenport where crashes were once high and now non-existent. As shown in the "Other RLR Crash" column for both tables, the percent change for the camera enforced intersections showed a decrease in average crash rates while the comparison intersections showed both increasing and decreasing values. The column "Rear-End RLR Crash" for both cities shown mixed results at both the camera and comparison intersections which is consistent with similar studies where researchers could not conclude if red light running cameras increased the chances of a rear-end crash *(9)*.

Furthermore, as shown in Tables 1 and 2, the before and after average quarterly crash rates were low to begin with, and resulted in a lower value per 1 million entering vehicles, thus raises the question of how really effective the cameras are for a small crash sample size. However, this study does initially conclude the red light running cameras are helping improve safety in both cities, but citywide effectiveness or spillover effects could not be determined with the available sample data.

**TABLE 1 Davenport, Iowa Change in Crash Rates[1] Before and After Camera Installation with Comparison Intersections**

| Intersection | Total Recorded Crashes | | | Rear-End RLR Crash | | | Other RLR Crash | | | Not a RLR Crash | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Before | After | % Change | Before | After | % Change | Before | After | % Change | Before | After | % Change |
| ***RLR Camera Enforced Intersections*** | | | | | | | | | | | | |
| Kimberly Road & Welcome Way | 1.29 | 0.97 | **-25.20%** | 0.25 | 0.23 | **-6.70%** | 0.56 | 0.28 | **-49.70%** | 0.49 | 0.46 | **-6.70%** |
| Kimberly Road & Brady Street | 0.92 | 0.83 | **-10.10%** | 0.22 | 0.31 | **45.20%** | 0.17 | 0.16 | **-9.30%** | 0.53 | 0.36 | **-32.70%** |
| Welcome Way & 35th Street | 1.18 | 0.83 | **-30.00%** | 0.12 | 0.05 | **-61.10%** | 0.38 | 0.00 | **-100.00%** | 0.68 | 0.78 | **15.00%** |
| Lincoln Avenue & Locust Street | **Not Enough Data for an After Study** | | | | | | | | | | | |
| Kimberly Road & Elmore Avenue | 0.52 | 0.77 | **46.90%** | 0.12 | 0.34 | **191.70%** | 0.17 | 0.16 | **-9.30%** | 0.23 | 0.27 | **16.70%** |
| ***Comparison Intersections*** | | | | | | | | | | | | |
| Elmore Avenue & 53rd Street | 2.26 | 1.76 | **-22.20%** | 1.04 | 0.84 | **-18.70%** | 0.21 | 0.18 | **-13.60%** | 1.01 | 0.73 | **-27.60%** |
| Locust Street & Brady Street | 1.01 | 0.93 | **-7.80%** | 0.19 | 0.29 | **55.60%** | 0.26 | 0.26 | **0.00%** | 0.56 | 0.38 | **-32.60%** |
| Locust St. & Hickory Grove Rd. | 1.26 | 1.16 | **-10.40%** | 0.33 | 0.44 | **34.80%** | 0.22 | 0.24 | **8.90%** | 0.74 | 0.68 | **-8.50%** |
| N. Division St. & Central Park Ave. | 0.77 | 0.76 | **-1.00%** | 0.12 | 0.25 | **117.80%** | 0.33 | 0.25 | **-22.20%** | 0.33 | 0.25 | **-22.20%** |
| Pine Street & Kimberly Road | 3.04 | 2.01 | **-33.80%** | 0.55 | 0.40 | **-26.80%** | 1.29 | 0.50 | **-61.10%** | 1.20 | 1.11 | **-7.50%** |

[1]Average quarterly crash rates are expressed in per million entering vehicles

**TABLE 2 Council Bluffs, Iowa Change in Crash Rates[1] Before and After Camera Installation with Comparison Intersections**

| Intersection | Total Recorded Crashes | | | Rear-End RLR Crash | | | Other RLR Crash | | | Not a RLR Crash | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Before | After | % Change | Before | After | % Change | Before | After | % Change | Before | After | % Change |
| ***RLR Camera Enforced Intersections*** | | | | | | | | | | | | |
| Broadway & 16th Street | 1.07 | 0.86 | **-19.54%** | 0.18 | 0.17 | **-6.67%** | 0.20 | 0.11 | **-43.43%** | 0.68 | 0.54 | **-20.12%** |
| Willow Avenue & 7th Street | 1.10 | 0.49 | **-55.56%** | 0.16 | 0.12 | **-22.22%** | 0.39 | 0.00 | **-100.00%** | 0.55 | 0.37 | **-33.33%** |
| Broadway & 35th Street | 1.01 | 0.90 | **-11.11%** | 0.19 | 0.34 | **75.00%** | 0.29 | 0.11 | **-61.11%** | 0.53 | 0.45 | **-15.15%** |
| Broadway & 21st Street | 0.65 | 0.60 | **-7.82%** | 0.24 | 0.23 | **-6.67%** | 0.17 | 0.19 | **11.11%** | 0.24 | 0.19 | **-22.22%** |
| Kanesville Boulevard & 8th Street | 0.92 | 0.90 | **-1.88%** | 0.20 | 0.24 | **22.22%** | 0.10 | 0.02 | **-77.78%** | 0.62 | 0.64 | **2.53%** |
| ***Comparison Intersections*** | | | | | | | | | | | | |
| 24th Street & 27th Street | 1.76 | 2.27 | **28.89%** | 0.10 | 0.08 | **-22.22%** | 0.15 | 0.39 | **159.26%** | 1.51 | 1.80 | **19.26%** |
| 35th Street & Nebraska Avenue | 0.93 | 0.76 | **-18.13%** | 0.15 | 0.15 | **3.70%** | 0.10 | 0.15 | **55.56%** | 0.69 | 0.46 | **-33.33%** |
| Broadway & Kanesville Boulevard | 0.63 | 0.43 | **-31.56%** | 0.13 | 0.00 | **-100.00%** | 0.18 | 0.24 | **33.33%** | 0.33 | 0.20 | **-40.17%** |
| Broadway & 1st Street | 0.99 | 1.14 | **15.23%** | 0.00 | 0.00 | **0.00%** | 0.20 | 0.12 | **-41.67%** | 0.48 | 0.67 | **39.18%** |

[1]Average quarterly crash rates are expressed in per million entering vehicles

## SUMMARY OF FINDINGS AND CONCLUSIONS

Crash data was used to analyze the effectiveness of the red light running cameras in both the cities of Davenport and Council Bluffs, Iowa. Using descriptive statistics an average quarterly before and after crash rate was determined for four specified crash types at camera enforced and comparison intersections. Although it appears that both cities have seen a continuing reduction in overall crashes, most of the studied intersections with red light cameras have experienced a greater decline in crash rates when investigating red light running type crashes.

Similar to other studies which evaluate camera effectiveness using crash data, it cannot be determined without a statistical model if rear-end crashes are decreasing or increasing significantly. In terms of an increase safety, red light running cameras are effective in influencing driver behavior and reducing red light running type crashes at their current deployed locations in each city.

## ACKNOWLEGEMENTS

The author wishes to thank the Iowa Department of Transportation Office of Traffic and Safety for their sponsorship of this research. The author would also like to thank city officials from the cities of Council Bluffs and Davenport, Iowa who provided data and information about the study sites.

## REFERENCES

1. National Highway traffic Safety Administration. Traffic Safety Facts 2005, U.S. Department of Transportation. National Center for Statistics and Analysis. DOT-HS_810-631. 2005.

2. Federal Highway Administration. Stop Red Light Running Facts and Statistics, U.S. Department of Transportation. FHWA Safety. August 3, 2006. http://safety.fhwa.dot.gov/intersections/redl_facts.htm. Accessed Oct. 2, 2007.

3. Retting, R.A. and S.Y. Kyrychenko. Reductions in Red Light Camera Enforcement in Oxnard, California. *American Journal of Public Health*, Vol. 92, No.11, 2002, pp.1822-1825.

4. Council, F.M., B. Persuad, K. Eccles, C. Lyon, and M.S. Griffith. Safety Evaluation of Red-Light Cameras. ITS Joint Program Office of Safety Research and Development, Federal Highway Administration. FHWA-HRT-05-048. April 2005.

5. Retting, R.A. and S. Kyrychenko. Crash Reductions Associated with Red Light Enforcement in Oxnard, California. Insurance Institute for Highway Safety. April 2001.

6. Bonneson, James A. and Karl Zimmerman. Identifying Intersections with Potential for Red Light-Related Safety Improvements. Journal of the Transportation Research Board. No. 1953. 2006. pp. 128-136.

7. Retting, R.A., S.A. Ferguson, and A. Shalom Hakkert. Effects of Red Light Cameras on Violations and Crashes: A review of the International Literature. *Traffic Injury Prevention*, Vol. 4, 2003, pp. 17-23.

8. Pline, J.L., *Traffic Engineering Handbook.* [Washington, D.C.]: Institute of Transportation Engineers, 1999.

9. McGee, H.W., and K.A. Eccles. *NCHRP Synthesis of Highway Practice 310: Impact of Red Light Camera Enforcement on Crash Experience*. TRB, National Research Council, Washington D.C., 2003.

# APPENDIX

| Kimberly Road & Welcome Way | | | | |
|---|---|---|---|---|
| Year - Quarter | Total Recorded Crashes | Rear-End RLR Crash | Other RLR Crash | Not RLR Associated Crash |
| *Daily Entering Vehicles = 47900* | | | | |
| 2001-01 | 10 | 1 | 4 | 5 |
| Crash Rate | 2.29 | 0.23 | 0.92 | 1.14 |
| 2001-02 | 4 | 1 | 2 | 1 |
| Crash Rate | 0.92 | 0.23 | 0.46 | 0.23 |
| 2001-03 | 2 | 0 | 0 | 2 |
| Crash Rate | 0.46 | 0.00 | 0.00 | 0.46 |
| 2001-04 | 7 | 2 | 1 | 4 |
| Crash Rate | 1.60 | 0.46 | 0.23 | 0.92 |
| **2001 Total Crashes** | 23 | 4 | 7 | 12 |
| **2001 Avg. Crash Rate** | 1.32 | 0.23 | 0.40 | 0.69 |
| *Daily Entering Vehicles = 47900* | | | | |
| 2002-01 | 8 | 1 | 4 | 3 |
| Crash Rate | 1.83 | 0.23 | 0.92 | 0.69 |
| 2002-02 | 9 | 3 | 4 | 2 |
| Crash Rate | 2.06 | 0.69 | 0.92 | 0.46 |
| 2002-03 | 2 | 0 | 2 | 0 |
| Crash Rate | 0.46 | 0.00 | 0.46 | 0.00 |
| 2002-04 | 7 | 1 | 3 | 3 |
| Crash Rate | 1.60 | 0.23 | 0.69 | 0.69 |
| **2002 Total Crashes** | 26 | 5 | 13 | 8 |
| **2002 Avg. Crash Rate** | 1.49 | 0.29 | 0.74 | 0.46 |
| *Daily Entering Vehicles = 47900* | | | | |
| 2003-01 | 5 | 1 | 1 | 3 |
| Crash Rate | 1.14 | 0.23 | 0.23 | 0.69 |
| 2003-02 | 5 | 0 | 3 | 2 |
| Crash Rate | 1.14 | 0.00 | 0.69 | 0.46 |
| 2003-03 | 5 | 1 | 2 | 2 |
| Crash Rate | 1.14 | 0.23 | 0.46 | 0.46 |
| 2003-04 | 7 | 1 | 4 | 2 |
| Crash Rate | 1.60 | 0.23 | 0.92 | 0.46 |
| **2003 Total Crashes** | 22 | 3 | 10 | 9 |
| **2003 Avg. Crash Rate** | 1.26 | 0.17 | 0.57 | 0.51 |
| *Daily Entering Vehicles = 47900* | | | | |
| 2004-01 | 7 | 2 | 4 | 1 |
| Crash Rate | 1.60 | 0.46 | 0.92 | 0.23 |
| 2004-02 | 1 | 1 | 0 | 0 |
| Crash Rate | 0.23 | 0.23 | 0.00 | 0.00 |
| 2004-03 | Quarter of Camera Installation (not included) | | | |
| **2004 Total Crashes** | 8 | 3 | 4 | 1 |
| **2004 Avg. Crash Rate** | 0.92 | 0.34 | 0.46 | 0.11 |
| 2004-04 | 7 | 0 | 4 | 3 |
| Crash Rate | 1.60 | 0.00 | 0.92 | 0.69 |
| **2004 Total Crashes** | 7 | 0 | 4 | 3 |
| **2004 Avg. Crash Rate** | 1.60 | 0.00 | 0.92 | 0.69 |
| *Daily Entering Vehicles = 47900* | | | | |
| 2005-01 | 5 | 1 | 1 | 3 |
| Crash Rate | 1.14 | 0.23 | 0.23 | 0.69 |
| 2005-02 | 6 | 2 | 2 | 2 |
| Crash Rate | 1.37 | 0.46 | 0.46 | 0.46 |
| 2005-03 | 6 | 2 | 1 | 3 |
| Crash Rate | 1.37 | 0.46 | 0.23 | 0.69 |
| 2005-04 | 4 | 1 | 1 | 2 |
| Crash Rate | 0.92 | 0.23 | 0.23 | 0.46 |
| **2005 Total Crashes** | 17 | 5 | 4 | 8 |
| **2005 Avg. Crash Rate** | 1.30 | 0.38 | 0.31 | 0.61 |
| *Daily Entering Vehicles = 47900* | | | | |
| 2006-01 | 5 | 1 | 1 | 3 |
| Crash Rate | 1.14 | 0.23 | 0.23 | 0.69 |
| 2006-02 | 1 | 0 | 0 | 1 |
| Crash Rate | 0.23 | 0.00 | 0.00 | 0.23 |
| 2006-03 | 1 | 0 | 0 | 1 |
| Crash Rate | 0.23 | 0.00 | 0.00 | 0.23 |
| 2006-04 | 3 | 2 | 1 | 0 |
| Crash Rate | 0.69 | 0.46 | 0.23 | 0.00 |
| **2006 Total Crashes** | 10 | 3 | 2 | 5 |
| **2006 Avg. Crash Rate** | 0.57 | 0.17 | 0.11 | 0.29 |
| Crashes per Quarter Before | 5.64 | 1.07 | 2.43 | 2.14 |
| DEV per Quarter Before | 4,370,875 | 4,370,875 | 4,370,875 | 4,370,875 |
| Crashes per Quarter After | 4.22 | 1.00 | 1.22 | 2.00 |
| DEV After | 4,370,875 | 4,370,875 | 4,370,875 | 4,370,875 |
| Before Crash Rate | 1.29 | 0.25 | 0.56 | 0.49 |
| After Crash Rate | 0.97 | 0.23 | 0.28 | 0.46 |
| **% Change in Crash Rate** | -25.18% | -6.67% | -49.67% | -6.67% |