City of San Diego Photo Enforcement System Review Final Report

CONFIDENTIAL

Submitted to:

City of San Diego Police Department

Submitted by:

PB Farradyne Inc.

In association with:
Darnell & Associates

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SUMMARY OF FINDINGS AND RECOMMENDATIONS

The City of San Diego Police Department has contracted with PB Farradyne (PBF), a Division of Parsons Brinckerhoff Quade & Douglas, Inc., conduct a review of the City's photo enforcement program. The review has been designed to accomplish the following objectives:

- Analysis of the existing program for performance and compliance with original design and specification standards; and
- Reassessment of the program's functions, technologies, and governing procedures for the purposes of identifying all potential improvements and to eliminate problem areas which have resulted in negative publicity that may have adversely affected community support for the program.

This report describes the project's findings, conclusions, and recommendations based on a review of red light running violations and accident data trends, system installations, camera unit setups, photographic data, intersection traffic signal timing and operations, and overall program management and operations.

The report is organized into seven sections, with certain supporting data contained in the report appendices. In this initial report section, the findings and conclusions developed and presented for each of the following report sections are summarized:

- Accidents and Red Light Running
- Photo Enforcement Equipment Installations
- Camera Unit Setups
- Review of Photographic Data
- Traffic Engineering and Traffic Operations Improvements
- Program Management and Policies

ACCIDENTS AND RED LIGHT RUNNING

- The City's photo enforcement program has resulted in a significant reduction in the number of red light running violations at the photo-enforced intersections. The measured reduction in red light running violations at intersections where cameras have been operational for six months varies from 20 percent to nearly 24 percent. Furthermore, the measured reductions in red light running violations have remained about the same as the cameras have been operated for longer periods of time.

  The reduction in red light running violations is generally not as high as reported for other photo enforcement programs.

  Generally, reductions in the number of violations are about the same for photo-enforced intersections where through red light running violations are being monitored and locations where left turn movements are being enforced.

- The City's photo enforcement program has resulted in significant reductions in the number of collisions attributable to red light running at the photo-enforced intersections, especially on the photo-enforced approaches where an overall reduction of 33 percent has been measured. This is an important finding and indicates that the program, on the whole, has been effective in reducing the number of accidents resulting from red light running at signalized intersections[1].

For intersections where through red light running violations are being monitored, the accident rate for accidents attributable to red light running has declined by 44 percent. For the photo-enforced approaches only at these intersections, the reduction in collisions is an impressive 60 percent.

For intersections where left turn red light running violations are being monitored, the accident rate for accidents attributable to red light running has declined by 20 percent. For the photo-enforced approaches only at these intersections, the number of collisions due to red light running dropped by only 12 percent, less than for all intersection approaches.

Overall, the analysis of the accident data indicates that the photo enforcement program has generated significant reductions in the number of accidents attributable to red light running. The accident rate reductions have been highest for intersections where through traffic movements are being monitored.

- The number of accidents attributable to red light running was found to be remarkably low at three photo-enforced intersections: NB Bernardo Drive to WB Rancho Bernardo Drive (1414); SB Harbor Drive to EB Grape Street (1533); and SB Mission Boulevard at Garnet Avenue (1542).

  One of these locations, at North Harbor Drive and Grape Street, has accounted for nearly one-quarter of the recorded violations and citations issued under the City's photo enforcement program. This location has not experienced a high number of accidents attributable to red light running either before or after photo enforcement. Generally, the locations selected for photo enforcement should be intersections where there are higher numbers of collisions resulting from motorists running red lights.

- Overall, the accident rate at the photo-enforced intersections increased by three percent after the installation of the photo enforcement cameras. This finding is not consistent with the program's overall objective of improving traffic safety for the City's motorists.

  The increase in the overall accident rate has resulted directly from an increase in the number of rear end collisions, an increase that has more than offset the reduced number of collisions resulting from motorists running red lights. After photo enforcement, the average rate of rear end accidents increased by 37 percent after photo enforcement.

  Rear end accidents increased by the largest amount, about 62 percent, for enforced through movements. Rear end accidents increased by the least amount, about 19 percent, for non-enforced left turn movements.

  While the rate of rear end collisions increased for the photo-enforced intersections, it was noted that the rate of rear end collisions dropped over time and, for those intersections where photo enforcement cameras have been in place for about three years, returned to the before enforcement level. This finding, based on limited data, suggests that the increased rate of rear end collisions will not be sustained over time. Additional data is needed to confirm that the increased rate of rear end collisions will not be sustained over time.

PHOTO ENFORCEMENT EQUIPMENT INSTALLATIONS

- Generally at all locations, the “as built” placement of the photo enforcement system improvements do not correspond with the intersection improvement plans, especially with regard to the placement of the vehicle detection loops. At most locations, the “as built” camera pole locations were found to be reasonably consistent with the intersection improvement plans.

  It is an important finding that the intersection improvement plans were not prepared by a California Registered Civil or Electrical Engineer and were not subject to the City’s plan check, permitting, and inspection procedures. Related to this finding, “as built” plans were not prepared for any of the 19 photo-enforced intersections.

  It is an important recommendation of this report that the City should require that any further photo enforcement system installations be done in accordance with the City’s plan check, permitting, and inspection procedures; that the intersection improvement plans be prepared by a California Registered Engineer; and that “as built” plans be prepared and then maintained to reflect any subsequent upgrades or adjustments.

- It is a general recommendation, the most important one of the project report, that the City not re-start its photo enforcement program without the relocation of the vehicle detection loops to locations where the first photograph is taken immediately before the vehicle crosses the stop line, instead of after the vehicle has already entered the intersection. This approach will eliminate the uncertainties associated with the measurement of vehicle speeds using the vehicle detection loop pairs.

  The implementation of this recommendation will require that the vehicle detection loops are re-cut and that camera unit settings be adjusted at 18 intersections. Vehicle detection required for the operation of the traffic signals may also need to be installed at selected locations. At these locations, it is recommended that video-based vehicle detection systems be employed for traffic signal control purposes.

  The estimated cost for re-cutting the photo enforcement loops and for installing video detection equipment at 18 intersections is $220,000.

- In conjunction with the relocation of the vehicle detection loops, it is recommended that enhanced advanced warning signs be installed at each intersection to supplement the standard photo enforcement signs currently installed at the photo-enforced intersections. The estimated cost for the purchase and installation of the enhanced advance warning signs for the 19 photo-enforced approaches is $3,800, assuming that the signs can be installed on existing poles.

- The vehicle detection loop configuration employed at 18 of the 19 photo-enforced intersections requires that the time when motorists entered the intersection against a red light is estimated based on the measured speed over the vehicle detection loops. Errors in the estimated vehicle speeds may result from this configuration as well as from the inherent operating characteristics of inductive vehicle detection loops.

  The possible errors resulting from the loop configuration and loop operating characteristics have been analyzed. From the analysis, it appears that the grace periods being applied before citations are issued are sufficiently long to compensate for any errors and that the City should be confident that all citations issued to date under the photo enforcement program have been properly issued with regard to possible errors resulting from the configuration of the vehicle detection loops.

CAMERA UNIT SETUPS

- Besides a few difficulties encountered during the inspection and testing of camera systems as described in the report, the camera equipment appeared to function properly and be well maintained. Appropriate camera unit settings were generally in place for all locations.

- The loop-to-loop pitch values, as input to the camera units at the 19 intersections, generally correspond very closely with the measured pitch dimensions. Small differences, up to one percent, were found between the camera unit and measured pitch values at selected locations. Any difference up to one percent should not be viewed as a significant difference and is well within the tolerances for cutting loops and for vehicle detection as vehicles pass over loops.

  At certain locations, it is difficult to determine with certainty what pitch measurement should be used for the camera unit setting due to the skewed installation of the vehicle detection loops and skewed intersection geometries. At these locations, it was necessary to make judgments regarding the expected paths of motor vehicles entering the intersection.

  The pitch measurements will continue to be important when the vehicle detection loops are re-located, as they will be the basis for established vehicle speeds for the application of the minimum speed threshold, but not nearly as critical as under the current configurations.

  The City should establish a written policy regarding pitch measurements and how pitch measurements are to be made where there are unusual or irregular loop configurations. For all cases, the policy should state that the shortest pitch dimension, where more than one pitch measurement may be applicable, should always be used for the camera unit setting (that is, in order that the measurement be in the favor of the motorist).

- At certain locations, two sets of loops are in place making it difficult to determine with certainty which set of loops are currently operational for the photo enforcement system. In the future, as built drawings should be maintained so that the operational loops can be readily identified. Abandoned loops should be intentionally cut on two sides so that it is clear that the loops have been abandoned as well as to eliminate any possibility of loop-to-loop crosstalk. Crosstalk between active loops and abandoned loops that have not been cut is possible and can result in unreliable loop detector performance.

- The delay time represents a “grace” period for motorists entering the intersection against a red traffic signal indication. The actual grace periods being applied the 19 photo-enforced intersections, except for the A Street/10th Street intersection, varies according to vehicle speed and the distance of the leading edge of the second loop from the stop line. In other words, the grace period is not consistent from intersection to intersection nor, for the most part, from vehicle to vehicle. The actual grace times may be determined by examining the tables developed by LM/ACS for each intersection and used to determine whether a citation should be issued for each photographed violation. From an examination of these tables, the actual grace periods applied in issuing citations vary from 0.25 seconds to 0.57 seconds.

  For the future when the vehicle detection loops have been re-located in accordance with the manufacturer’s recommended configuration and industry practice, the City needs to establish its policy for delay times at photo-enforced intersections. Delay times ranging between 0.3 seconds and 0.5 seconds are typically used.

REVIEW OF PHOTOGRAPHIC DATA

- A total of 83,931 citations have been issued to motorists under the City’s photo enforcement program. About one quarter of the citations have been issued for violations at one intersection, at North Harbor Drive and Grape Street, where the photo enforcement cameras monitor left turn movements.

  Citations are issued for approximately 36 percent of the possible violations recorded at the photo-enforced intersections. Accounting for the number of possible violations that are discarded after the grace period time allowances are applied, the percentage of recorded violations that are converted to citations is increased to 43 percent.

  The percent of citations issued varies from a low level of about 21 percent for the Imperial Avenue/Euclid Street (1484) and Miramar Road/Camino Ruiz (1534) intersections to a high level of about 54 percent at the intersection of Mission Boulevard and Garnet Avenue (1542). More than 50 percent of the violations recorded at the College Avenue/Montezuma Road (1462) and Black Mountain Road/Gemini Avenue (1551) intersections are cited.

- The largest number of citations not issued, amounting to 16.3 percent of the possible violations, is for no front license plate. This percentage is consistent with the levels reported by other photo enforcement programs. A portion of these violations could be cited with the installation of nearside cameras that are able to photograph the rear license plates of red light runners. With nearside cameras at each photo-enforced intersection, the number of issued citations each month would increase by approximately seven percent.

- Approximately 14 percent of the possible violations are discarded due to lighting and optical problems where the driver's face is not clearly visible in the second photograph as required by the California Vehicle Code. Auxiliary flash units could be installed to provide additional vehicle interior lighting at photo-enforced intersections where dark vehicle interiors are a recurring problem. It is also possible that polarizing filters could be employed at additional locations, especially for intersection approaches that are oriented east and west, to increase the number of citations issued.

  Approximately 23 percent of the possible violations are not cited because the driver's face, vehicle, or license plate is out of the frame of the photograph or is obstructed. These factors are more common at intersections where double left turn lane movements are being enforced.

  The City and its contractor, LM/ACS, should address these various problems at the photo-enforced intersections, one at a time, using photographic data to analyze the nature of problems, to develop improvement strategies, and to evaluate whether the improvements have been effective.

- The City should review the other photo enforcement systems that are currently being deployed in California and other States. New photo enforcement technologies have become available over the past five years, most notably technologies that employ digital camera equipment where photographic data, including streamed video clips, may be immediately downloaded for processing using T-1 telephone line or microwave communications. Additionally, photo enforcement systems that use non-intrusive vehicle detection methods as well as systems that employ overhead camera placements and floodlighting equipment as an alternative to the curb-based placements used for the San Diego program are being tested by cities throughout California and elsewhere.

TRAFFIC ENGINEERING AND TRAFFIC OPERATIONS IMPROVEMENTS

- It was determined that the actual yellow change intervals at 17 of the photo-enforced intersections were equal to or higher than yellow times calculated using the City's guidelines. The intersections where the yellow times were lower than the City's guideline were at Harbor Drive and 32nd Street (4.5 seconds actual versus 4.7 seconds per City's guideline) and Black Mountain Road and Gemini Avenue (3.7 seconds actual versus 4.2 seconds per City's guideline).

  Speed surveys should be done for the approaches at the two intersections where the yellow times did not meet the City's guidelines in order to re-calculate the yellow times for these intersections. The yellow times should be adjusted accordingly when the yellow times have been re-calculated.

- SB 667 requires that the yellow change intervals be based on the Caltrans Traffic Manual. The yellow change intervals at 10 of the 19 photo-enforced intersections are shorter than the yellow times specified by the Caltrans Traffic Manual. Eight of the yellow change intervals that are not in compliance are for left turns where the Caltrans Traffic Manual specifies a minimum yellow time of 3.1 seconds, as opposed to 3.0 seconds per the City guidelines.

Before the photo enforcement systems is re-started, it will be necessary to adjust the yellow change intervals to be in compliance with the Caltrans Traffic Manual, including any changes being implemented or considered for the Caltrans Traffic Manual that may be required for compliance with the Millennium MUTCD.

- It is a key recommendation of this review that the City's Police Department work more closely with the City's Traffic Engineering Department to develop a comprehensive methodology for the deployment of photo enforcement cameras in the City, building upon the Traffic Engineering Department's on-going traffic safety improvement program and resulting in the future deployment of photo enforcement cameras within the context of an overall traffic safety improvement program; to ensure that the yellow change intervals at photo-enforced intersections are adjusted in accordance with the City's guidelines; to coordinate photo enforcement system installations so that vehicle detection is provided for both photo enforcement and traffic signal control applications without one adversely impacting the other; and to reinforce the mutual interests and capabilities of the City's law enforcement and traffic engineering professionals to develop an overall traffic safety improvement program for the City that is a model for other cities and agencies throughout California.

PROGRAM MANAGEMENT AND POLICIES

- From the project team observations and audits, the procedures and methods applied by LM/ACS are generally proper and being applied in a timely manner consistent with the requirements of the California Vehicle Code. The procedures and methods are designed to ensure the chain of evidence for each recorded violation so that backup data and documentation can be easily retrieved when needed. Internal quality control is maintained by a double blind internal review of each violation. Additionally, all citations prepared by LM/ACS are reviewed and approved by the Police Department before they are issued.

  It is noted that LM/ACS provides similar system operation and citation processing services to a number of other cities in California and elsewhere using, for the most part, the same internal procedures and methods.

- LM/ACS has carried out the required equipment servicing and inspection functions since the system startup. LM/ACS has maintained service and inspection logs for the photo enforcement equipment installed at the 19 intersections from the period of their installation to the time at which the cameras were turned off in June 2001.

- The internal procedures and methods used by the Police Department and LM/ACS should be clearly documented in writing. In particular, the procedures should address in detail the following items:

  - Guidelines to be applied for issuing a citation, in other words, a very specific definition of what constitutes a red light running violation;

  - Citation review and approval requirements, including provisions for the procedure to be used when the time to review is shortened, traffic officers are not available to conduct the reviews, or the number of citations is larger than usual; and

  - Quality assurance audits, to be conducted by trained traffic officers for randomly selected sample of recorded violations on a periodic basis.

- The following elements are recommended as the basis for re-starting the City's photo enforcement program and for its development as an effective element of a comprehensive traffic safety improvement program.

  - Traffic Safety Partnership. The photo enforcement should not be viewed in isolation and needs to be viewed as one element of an overall traffic safety improvement program. A Coordinating Committee, under the leadership of the City's Police Department and consisting of representatives from the Traffic Engineering Department, Public Works Department, Traffic Courts, City Attorney's Office, selected community groups, and outside agencies concerned with traffic safety such as Caltrans and the Auto Club should be established and meet on a regular basis, monthly to start with but not less often than quarterly. Regular agenda items should be the review of the violations and citations issued data with a discussion of any changes or trends noted. Discussion should be encouraged on whether program objectives are being met through the deployment of photo enforcement cameras or whether alternative measures should be applied.

  - Program Objectives. The program objectives need to be defined as clearly as possible as an early step for moving forward. It is clear that the primary objective of any red light running photo enforcement program, including the City's program, is the reduction of collisions at signalized intersections resulting from red light running.

    Importantly, the program objectives should address specific operational objectives as well as objectives related to financial performance. The latter is especially important and questions such as whether or not each location where photo enforcement equipment is installed needs to be self-sustaining need to be addressed and incorporated into the statement of operational objectives. Additionally, the program objectives should support the development of a formula for the use of the revenues generated by the photo enforcement program, such as by the allocation of "x" percent of the program revenue for on-going accident data analysis and reporting; "y" percent for the development and maintenance of a public awareness and information campaign; and "z" percent for the funding or partial funding of other traffic safety improvements, not related to accidents caused by red light running violations.

  - Re-Engineered Photo Enforcement Equipment Installations. It is it is necessary that the vehicle detection loops used to trigger the photo enforcement cameras at 18 of the 19 photo-enforced intersections be re-located. At the same time, the City should consider the installation of enhanced advanced warning signs and investigate camera equipment upgrades, such as nearside cameras and auxiliary flashes, for selected locations.

- Public Awareness and Information Campaign.

- City Design and Construction Review. For any future modifications, changes, or expansion to the photo enforcement installations, the City's normal design review and construction inspection procedures should be in place and carried out. Installation plans should be prepared by a registered California Civil or Electrical Engineer.

- On-Going Problem Identification and Analysis. The on-going analysis of the violations and citations issued data provided by the photo enforcement program as well as on-going analysis of intersection accident rates by type of accident together with community inputs are the foundation of a comprehensive traffic safety improvement program.

• It is recommended that the photo enforcement program be maintained at locations and expanded to new locations on the following basis:

  - To provide uniform coverage throughout the City according to a pre-determined minimum coverage standard; or

  - For intersection approaches where the accident rate for accidents caused by red light running exceeds a pre-determined minimum threshold standard; and

  - For intersection approaches meeting one of the above standards where installation of the photo enforcement equipment is feasible and can be expected to meet or exceed the pre-determined minimum percent cited standard; or

  - For intersection approaches where a diagnostic team review has determined that photo enforcement should be effective to mitigate a particular traffic safety hazard, even through the intersection approach may not be in compliance with one or both of the above standards.

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[1] Accidents, especially those involving injuries, are relatively rare events statistically. Large, long-term data sets are required for a statistical analysis of accurate trends. The findings and conclusions on accidents should be viewed as accurate indications based on the limited data available.

1.0 INTRODUCTION

PB Farradyne (PBF), a Division of Parsons Brinckerhoff Quade & Douglas, Inc. has undertaken a review of the City's photo enforcement program for the City of San Diego Police Department to accomplish the following objectives:

- Analysis of the existing program for performance and compliance with original design and specification standards; and
- Reassessment of the program's functions, technologies, and governing procedures for the purposes of identifying all potential improvements and to eliminate problem areas which have resulted in negative publicity that may have adversely affected community support for the program.

This report describes the project's findings, conclusions, and recommendations based on a review of red light running violations and accident data trends, system installations, camera unit setups, photographic data, intersection traffic signal timing and operations, and overall program management and operations.

1.1 BACKGROUND

In 1998, the City of San Diego Police Department contracted with U. S. Public Technologies, Inc., (USPT) for the provision of "red light camera enforcement" technology and services at selected intersections throughout the City. The contract period of performance is for a five- year period. Later that same year, the Lockheed Martin Information Management Services (IMS) Division acquired USPT and its contracts. More recently, Automated Computer Services (ACS) has acquired Lockheed Martin's IMS Division. The acquisition by ACS became effective in October, 2001.

For the purposes of this report when abbreviated reference is appropriate, the City's management services company is referred to as LM/ACS.

The City's photo enforcement system was implemented under the provisions of California Vehicle Code (CVC) Section 21455.5, Traffic Signal Automated Enforcement. This section and related CVC sections clearly define certain requirements for the installation and operation of photo enforcement cameras where the photographs are used as the basis for citations for red light running violations. For example, it is required that advance warning signs be placed at intersections where photo enforcement cameras are installed so that the signs are visible to motorists approaching from any direction where photo enforcement cameras are operational. Alternatively, signs may be posted at all major entrances to the city, including at a minimum, freeways, bridges, and state highway routes, although most cities where photo enforcement systems are operational have elected to install signs at each intersection. As a second example, CVC Section 21455.5 specifies that only a governmental agency, in cooperation with a law enforcement agency, may operate an automated enforcement system. The CVC does not prohibit cities from contracting with firms such as LM/ASC to provide and install the equipment and to provide day-to-day services for system operations and maintenance, and in fact, no cities in California or elsewhere in the United States have undertaken photo enforcement programs without the involvement of contractors to support system installation, operations, and maintenance.

1.1.1 System Description

The City's photo enforcement system uses equipment manufactured by Gatso, a Dutch company. The equipment is widely deployed throughout the world and is used by a number of cities in California.

The Gatso system provides for the detection of motor vehicles entering the intersection being enforced by inductive loops, similar to the loops that are widely used for traffic signal control and freeway management purposes, and for the recording of red light violations by a high quality 35 mm camera system. The logic required to identify red light running violations and then take two photographs of each violation at pre-determined locations is implemented on a computer processor situated in the camera unit enclosure or housing, using inputs from the vehicle detection loops and traffic signal yellow and red control circuits.

A pair of vehicle detection loops is laid in sealed grooves in each traffic lane to be monitored for red light running violations. The loops are laid in a rectangular configuration, with the long side perpendicular to the curb line. The loops each have three turns of wire and are connected back to the camera unit. Connections from the traffic signal system are also wired directly back into the camera unit for instantaneous recognition of the yellow and red ball indications.

Figure 1-1
VIEW OF PHOTO-ENFORCED INTERSECTION

The red light running violations are recorded on a 35 mm film cassette and also on memory cards, where data for each photograph taken is written, that are retrieved from the camera unit on a daily or regular basis. The film is developed and then transferred to high-resolution digital images for further processing and storage. Each of the recorded violations are reviewed by trained technicians to verify that a violation was recorded, that there is a clear view of the motorist's face, and that the license plate number can be clearly determined. For violations that meet these requirements, a citation is prepared and delivered to the Police Department for final review and approval.

1.1.2 Method of Operation

The photo enforcement system functions generally as follows.

- For a violation to be recorded, three conditions must be satisfied – first, that the traffic signal display facing the motorist is red; second, that the pre-determined delay or grace time (for example, 0.3 seconds) has expired; and third, that the vehicle speed crossing from the first loop to the second loop is greater that a pre-determined minimum speed threshold (for example, 12 or 15 mph).

- The motorist must be detected crossing both loops, from the first loop to the second loop, at a calculated speed that is greater than the pre-determined minimum speed threshold. Photographs are not taken if the vehicle merely stops over the first loop or if a vehicle is traveling slower than minimum speed threshold. The amount of elapsed time between crossing the first and second loops along with the known distance between the two loops (referred to as the “pitch”) allows the calculation of the vehicle speed.

- Two photographs are taken for each violation. A flash unit is also activated at the same time to assist with lighting for each of the photographs. At selected locations, auxiliary flash units may be employed especially to provide for better second photographs. The first photograph shows the vehicle at the point where it has triggered the second loop. The second photograph is taken at a pre-determined distance from the point where the first photograph is taken, determined to be the preferred or optimal location for the second photograph. This is done by calculating a time interval until the second photograph is taken, based on dividing the pre-determined distance (for example, 40 feet) by the calculated vehicle speed (for example, 15 miles per hour or 22 feet per second).

- The distance between the center point of the first loop and the center point of the second loop, or pitch, needs to be accurately measured and then entered into the camera unit as the basis for estimating vehicle speeds from the first loop to the second loop.

- Both photographs are time and date stamped. The first photograph also has the lane number and yellow time preceding the violation, a sequential violation number, the elapsed red time, and the location identifier. The second photograph shows the time interval between the first and second photographs, the violation number, the elapsed red time at the time of the second photograph, and the calculated vehicle speed. These data are also reproduced on the computer memory card for ease of tracking.

- The first and second loops are installed at all but one location in the City inside the intersection or on the intersection side of the stop line. This installation method means that the actual time of the violation, that is, the precise time when the motorists crossed the stop line facing a red traffic signal indication, needs to be estimated for each recorded violation. In order to establish the position of the vehicle when the signal turned red, a calculation is performed that uses the vehicle speed from the first loop to the second loop and applies that speed to the known distance of the leading edge of the second loop to the trailing edge of the stop line. A grace time period, that varies from intersection to intersection and according to the vehicle speed, is allowed before a citation is prepared.

- The camera unit software used for monitoring red light running violations will not generate photographs on either the green or yellow traffic signal light phases, provided that the connections between the traffic signals and camera unit are correctly made. If these connections were not correctly made, the problem would be readily apparent on the photographs taken. Violations are only photographed after the traffic signal has changed to red.

- The vehicle detectors provide a separate output to the camera unit in the event that an in-ground loop become shorted or defective so that baseline inductance changes by more than pre-determined amount. In these instances, the camera unit software used for monitoring red light running violations will not permit photographs to be taken. Again, any problem would be readily apparent on the photographs taken.

1.1.3 Red Light Photo Enforcement Locations

Table 1 below lists the 19 locations where the City has deployed photo enforcement cameras. The table shows the date on which operations were commenced at each location, the location identifier, the direction of lane enforcement at each location, and the approximate number of months in service through May 2001. The phased introduction of the photo enforcement cameras was intentional to smooth the gradual increase in workload for the courts as an increasing number of citations were issued.

Table 1-1
PHOTO ENFORCEMENT LOCATIONS

Ref	Code	Description	Effective Date	Approx Months
1	1404	WB El Cajon Boulevard at 43rd Street	07/30/98	34
2	1444	WB Harbor Drive at 32nd Street	12/07/98	30
3	1454	WB Garnet Avenue at Ingraham Street	12/07/98	30
4	1484	WB Imperial Avenue at Euclid Avenue	04/02/99	26
5	1504	WB F Street at 16th Street	04/02/99	26
6	1523	EB A Street at10th Avenue	02/24/00	14
7	1534	WB Miramar Road at Camino Ruiz	02/24/00	14
8	1542	SB Mission Boulevard at Garnet Avenue	05/19/00	12
9	1551	SB Black Mountain Road at Gemini Avenue	04/20/00	13
10	1553	EB Mira Mesa Boulevard at Scranton Road	04/20/00	13
11	1414	NB Bernardo Center Drive to WB Rancho Bernardo Road	07/30/98	34
12	1422	WB Aero Drive to SB Murphy Canyon Road	07/30/98	34
13	1462	SB College Avenue to Montezuma Road	12/07/98	30
14	1474	WB La Jolla Village Drive at Towne Center Drive	12/07/98	30
15	1492	SB Black Mountain Road to EB Mira Mesa Boulevard	04/02/99	26
16	1513	EB Garnet Avenue to NB Mission Bay Drive	04/02/99	26

Table 1-1 (Continued)
PHOTO ENFORCEMENT LOCATIONS

Ref	Code	Description	Effective Date	Approx Months
17	1533	SB Harbor Drive to EB Grape Street	10/07/99	20
18	1541	NB Mission Bay Drive to WB Grand Avenue	05/19/00	12
19	1543	EB Carmel Mountain Road to NB Rancho Carmel Drive	02/24/00	14

1.2 REPORT ORGANIZATION

The report presents the results of the work tasks conducted for the analysis and re-assessment of the City's photo enforcement program. The report has been organized into seven sections, with certain supporting data contained in report appendices. The sections address the City's list of the 11 areas to be reviewed that have served as the basis for the analysis and re-assessment work tasks. Table 1-2 summarizes the correspondence between the report sections and the areas to be reviewed.

Table 1-2
REPORT ORGANIZATION

	Areas To Be Reviewed	1 -Introduction	2 – Red Light Running and Accidents	3 – Camera Equipment Installations	4 – Camera Unit Setups	5 – Review of Photographic Data	6 – Traffic Engineering and Traffic Operations Improvements	7 – System Polices and Management
1	Determine if Photo Red Light enforced intersections are safer since the inception of the program		•					
2	Determine if the Photo Red Light Program is the most effective way tom promote traffic safety, and if so, how the program can be expanded		•				•	•
3	Determine criteria and selection process for future locations		•					•
4	Survey the Photo Red Light locations and verify "As Built" documentation which validates or invalidates the fact that the system is functional			•				
5	Inspect and verify the workings of the "Gatsometer" systems and provide documentation which validates or invalidates the fact that the system is functional				•			
6	Provide Recommendations and Cost Analysis on ways to improve the system		•	•	•	•	•	•
7	Provide recommendations and cost analysis as to the feasibility of continuing with the Photo Red Light Program			•	•	•		•
8	Provide information on the most cost effective manner for future deployment of the Photo Red Light Program							•
9	Determine if the timing of the traffic signals is appropriate for the Photo Red Light locations						•	
10	Determine if the Photo Red Light Program is achieving the goal of reducing collisions and educating the public		•					•
11	Survey the system protocols and determine if the system is effectively managed							•

2.0 RED LIGHT RUNNING AND ACCIDENTS

According to the Fatality Analysis Reporting System (FARS) and the General Estimate System (GES) for the year 1997, approximately 800,000 motor vehicle collisions occurred at signalized intersections for the year 1997. The estimated result was over one half million injuries and several thousand fatalities. Collisions at intersections are reported to be increasing. At least one study has shown that motorists involved in red light running collisions are more likely to be injured than in other types of collisions - 45 percent of the collisions resulting from red light running caused injuries, compared to 30 percent for all other collision types.

Comprehensive traffic safety improvement programs are normally built around the three E's of Enforcement, Engineering, and Education and all can be expected to play a role in improving traffic safety. Red light running is clearly one example of risky driving behavior that impacts traffic safety and should be modified but how can this best be achieved? How can intersection safety best be improved? The use of photo enforcement systems is an approach that, with an increasing number of system deployments throughout California and other States, has proven to be effective in reducing the number of red light running violations that can lead to collisions and, more directly, in reducing the number of accidents caused by red light running.

Two of the most direct measures that are commonly applied to evaluate the effectiveness of photo enforcement programs and may be applied for the City's Photo Enforcement Program are the following:

- Reductions in the number of accidents after the installation and operation of photo enforcement cameras; and
- Reductions in the number of red light running violations after the installation and operation of photo enforcement cameras.

2.1 RED LIGHT RUNNING VIOLATIONS BEFORE AND AFTER ENFORCEMENT

In addressing the important question of safety improvements and the effectiveness of the City's Photo Enforcement Program, it is necessary to establish whether the implementation of the program has indeed reduced red light running. Unfortunately, there is no photographic or other evidence that reflects the true "before" situation. For analysis purposes, the level of violations recorded for the first three months of the program at each location has been considered as the "before" condition. This assumption that the initial three-month period accurately reflects the "before" situation is a reasonable one as completed studies where actual "before" data has been available have indicated that approximately three months is typically required before the hoped-for driver behavior modifications are observed and reductions in the number of violations are recorded. However, there are difficulties with the first month of data since the program was started on different days of the month at each of the photo-enforced locations. To adjust for this data analysis problem, the first month of violations data reported for each location was dropped and the only violations data for the second and third months, the first two full months of operation, has been used.

The comparison of before and after violations data is based on the monthly violations data reported for each photo-enforced intersection by LM/ACS. The number of violations reported for each location by LM/ACS is determined from the photographic record of drivers triggering the cameras according to the agreed-upon parameters for the operation of the cameras.

Intersections were made operational one at a time over a period of nearly three years. The length of the period of operation varies from as long as 34 months to as little as 12 months. Due to these different data collection periods, the intersections have been classified into three groups so that the comparisons can be made for equal periods of time in operation. Table 2-1 summarizes the number of intersections and intersections identifiers for the three time periods, 12 months, 24 months, and 30 months.

Table 2-1
PHOTO-ENFORCED INTERSECTIONS
GROUPED BY NUMBER OF MONTHS IN OPERATION

Data Collection Period	Number of Intersections	Photo Enforced Intersection Identifiers
12 months	8	1523, 1533, 1534, 1541, 1542, 1543, 1551, 1553
24 months	4	1484, 1492, 1504, 1513
30 months	7	1404, 1414, 1422, 1444, 1454, 1462, 1474

Figure 2-1 summarizes the trends observed in the violations data for each of the three groups of intersections. The average number of “before” violations (as measured for the first two full months of operation) and average number of “after” violations are shown in Figure 2-1.

From Figure 2-1, it may be observed that:

- Photo enforcement results in a significant reduction in the number of red light running violations;
- The measured reduction in red light running violations at intersections where cameras have been operational for six months varies from 20 percent to nearly 24 percent; and
- The measured reductions in red light running violations remain constant as the cameras are operated for longer periods of time.

Using violations data for months after nine months of photo enforcement operations, there is a slightly greater reduction in the number of violations but the difference is marginal when compared with those after six months.

Figure 2-1 also illustrates that the decreasing patterns of the violation numbers are consistent over the three different intersection groups that indicates that the drivers' behavior has been influenced in a similarly consistent manner over the different intersections. The measured changes in the average number of violations at each photo-enforced intersection are attached as Appendix C.

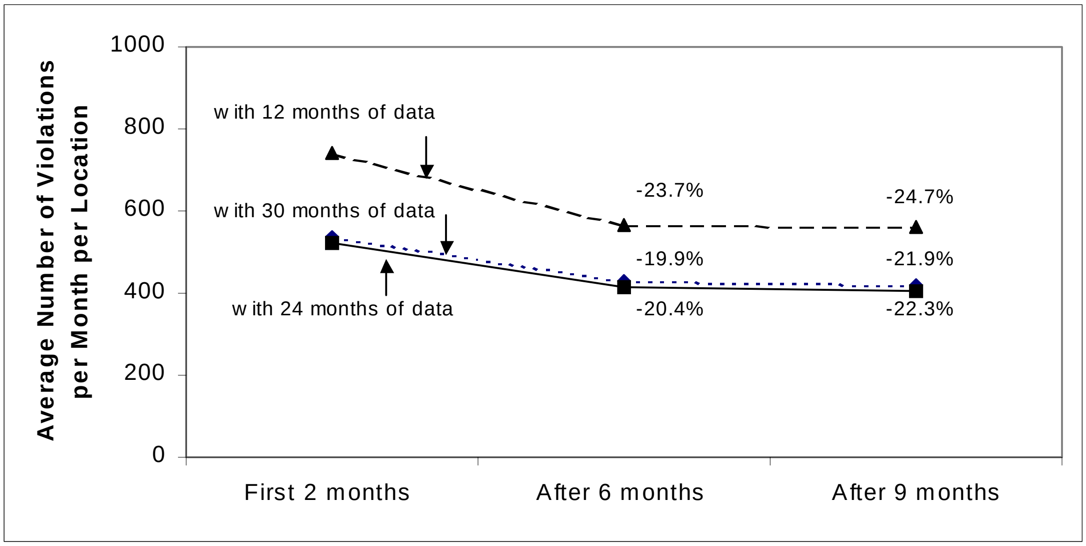


Figure 2-1
OBSERVED REDUCTIONS IN RED LIGHT RUNNING VIOLATIONS

Figure 2-2 provides a different view of the same violations data trends, showing the average number of violations per month for the following four groups of intersections:

Table 2-2
PHOTO-ENFORCED INTERSECTIONS GROUPED BY LEFT TURN VERSUS THROUGH ENFORCEMENT AND NUMBER OF MONTHS IN OPERATION

Data Collection Period	Number of Intersections	Photo Enforced Intersection Identifiers
12 months Left Turns (LT12)	3	1533, 1541, 1543
24 months Left Turns (LT24)	6	1414, 1422, 1462, 1474, 1492, 1513
12 Months Through (TH12)	5	1523, 1534, 1542, 1551, 1553
24 Months Through (TH24)	5	1404, 1444, 1454, 1484, 1504

From Figure 2-2, it is noted that the reductions observed in the number of violations over time are distributed between intersections where left turns and through enforcement is being done. A very large reduction, 54 percent, is noted for the group consisting of five intersections where the through traffic movements are enforced. This rate of reduction is not observed for the other group of intersections where there is through enforcement so that a more general conclusion regarding the larger drop in the number of violations for intersections with through enforcement cannot be made.

Figure 2-2 also illustrates the very high number of violations being generated by the three intersections with left turn enforcement where 12 months of violations data is available. Further examination of the violations data indicates that the very high number of violations for this group is attributable to one location, left turns from North Harbor Drive to Grape Street.

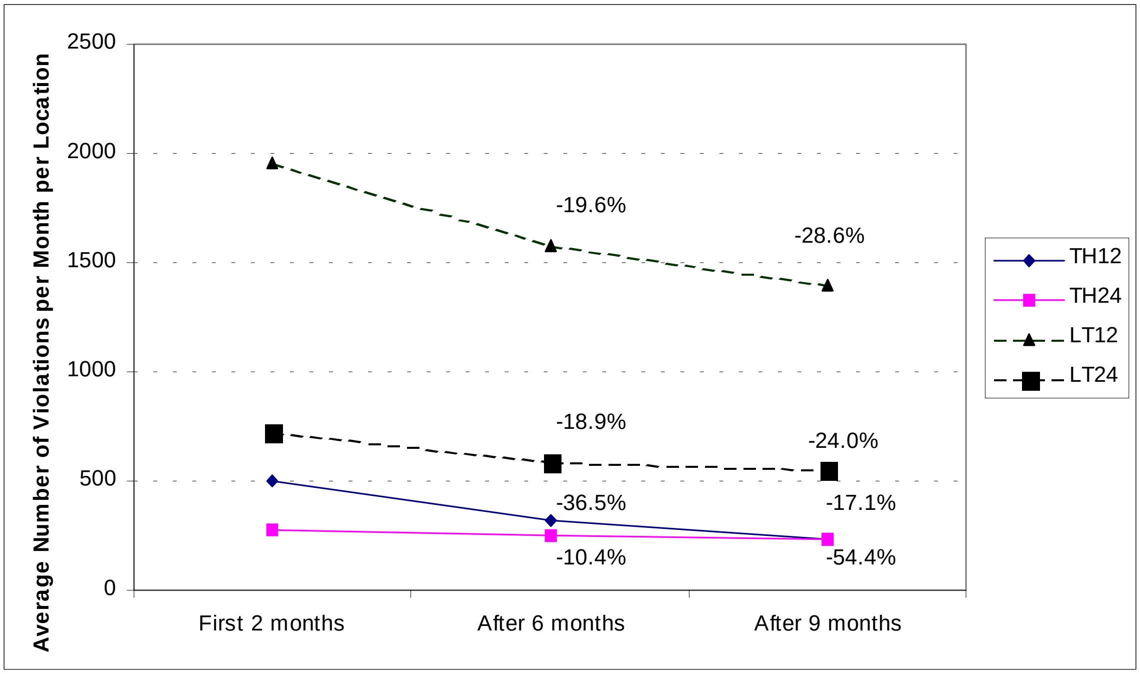


Figure 2-2
AVERAGE NUMBER OF VIOLATIONS PER MONTH BY LEFT TURN VERSUS THROUGH ENFORCEMENT

2.2 ACCIDENTS BEFORE AND AFTER PHOTO ENFORCEMENT

The overall objective of the City's photo enforcement program is to improve traffic safety at signalized intersections by reducing the number of red light running violations and collisions attributable to red light running. "Before" and "after" accident data was provided by the City's Traffic Engineering Department and has been analyzed. While the accident data analysis indicates that the number of accidents attributable to red light running has been significantly reduced for the photo-enforced intersection approaches, it needs to be noted that reported accidents are statistically rare occurrences that require long monitoring periods in order to generate sample sizes that are sufficiently large to determine changes with complete certainty.

The accident data analysis has not accounted for any Citywide trends or changes in the incidence of accidents attributable to red light running. Additionally, the accident data analysis has not made any adjustments in the accident data for changes in traffic volumes.

For the study, accident records for the all photo-enforced intersections were provided by the City's Traffic Engineering Department. The accident data covered the time period from April 1995 through October 2001. Since the photo enforcement program was initially deployed in July 1998, accident data is available the time periods before and after the startup of the photo enforcement program.

Two accident types, Right Angle (RA) and Ran Signal (RS), are treated as the principal types of accidents associated with red light running. The effectiveness of the photo enforcement cameras was evaluated by comparing the average numbers of RA/RS accidents before and after photo enforcement. Since the actual enforcement start dates of the photo-enforced intersections are different by location, it was necessary to break out the accident data for each intersection accordingly.

To get a perspective on the overall accident rate change at the 19 photo-enforced intersections, the change of all types of accidents before and after photo enforcement was compared (see Figure 2-3). The annual average accident rate at each intersection increased from 7.6 to 7.8 after photo enforcement. However, the increased accident rate after photo enforcement resulted from the large increase of non-RA/RS accidents, which increased by one-third from 4.7 accidents per year to 5.8 accidents per year on the average (see Section 2.4). At the same time, the average accident rate for RA/RS accidents, accidents that are attributable to red light running, dropped by 30 percent (see Section 2.3).

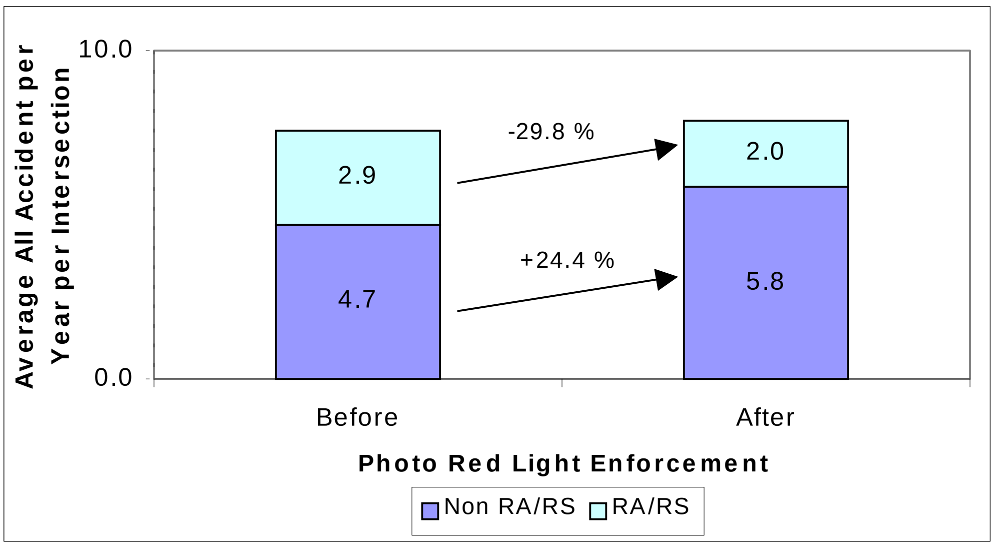


Figure 2-3

CHANGE IN ACCIDENT RATES BEFORE AND AFTER PHOTO ENFORCEMENT BY TYPE OF ACCIDENT

For the photo-enforced intersections, the accident data analysis indicates that the overall accident rate increased by about three percent at the photo enforced intersections but that the accidents related to red light running by motorists dropped by 30 percent after photo enforcement.

2.3 RA/RS ACCIDENTS BEFORE AND AFTER PHOTO ENFORCEMENT

The average accident rate for RA/RS accidents, accidents that are attributable to red light running, dropped by 30 percent for the 19 photo-enforced intersections after the introduction of the photo enforcement cameras.

2.3.1 RA/RS Accident Rate Changes By Movement Type

In order to investigate the RA/RS accident rate changes in greater detail, they were classified into two groups: accidents for photo-enforced traffic movement and for non-enforced movement. Figure 2-4 shows the average RA/RS accident rates for both groups before and after photo enforcement. Before photo enforcement, there was an average of 2.9 accidents per year at the photo-enforced intersections and this rate dropped by about 33 percent to 1.9 accidents per year after photo enforcement. At the same time, the accident rates for the photo-enforced traffic movements dropped by nearly 46 percent while the accident rate for the movements that are not photo-enforced declined by a smaller amount, about 25 percent.

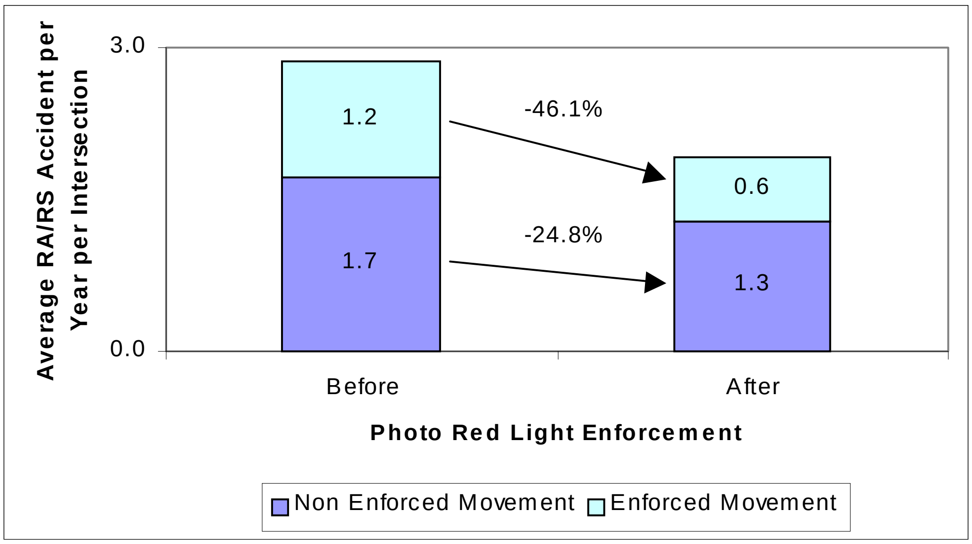


Figure 2-4
RA/RS ACCIDENTS BY MOVEMENT TYPE

2.3.2 RA/RS Accident Rate Changes By Intersection Type

The accident data was analyzed to determine if there were differences in the accident rate changes for photo-enforced intersections where the Through Movement (THM) is enforced in comparison with intersections where Left Turn Movement (LTM) is enforced. Before photo enforcement, the average RA/RS accident rate of the THM intersections was 3.1 accidents per year, which is slightly higher than for LTM intersections where the RA/RS accident rate was 2.6 accidents per year. After photo enforcement, the average RA/RS accident rates dropped by 44 percent for THM intersections and by 20 percent for LTM intersections, respectively, meaning that photo enforcement is about twice as effective in reducing the rate of accidents at intersections where the through traffic movements are enforced.

The accident rate changes for enforced traffic movement and other movements of the THM-type intersections have been compared. As shown in Figure 2-6, the accident rates for both types of traffic movements before photo enforcement was introduced were similar. However, photo enforcement reduced the accident rate of enforced movement by 60 percent while, at the same time, there was a reduction of about 30 percent in the accident rate for the non-enforced movements at the photo-enforced intersections.

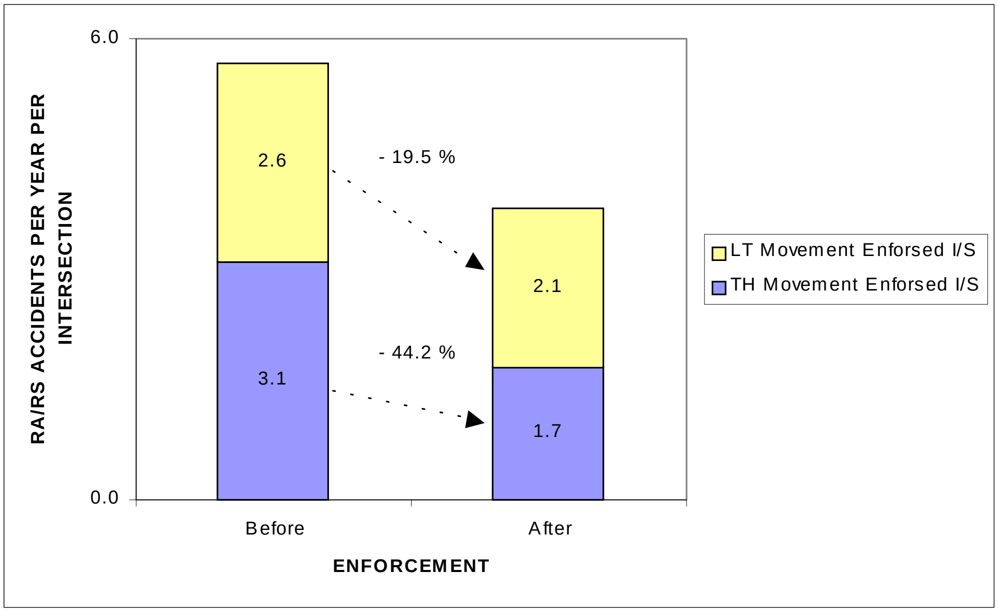


Figure 2-5
ACCIDENT RATES FOR INTERSECTIONS WHERE THROUGH MOVEMENTS ENFORCED AND LEFT TURN MOVEMENTS ENFORCED

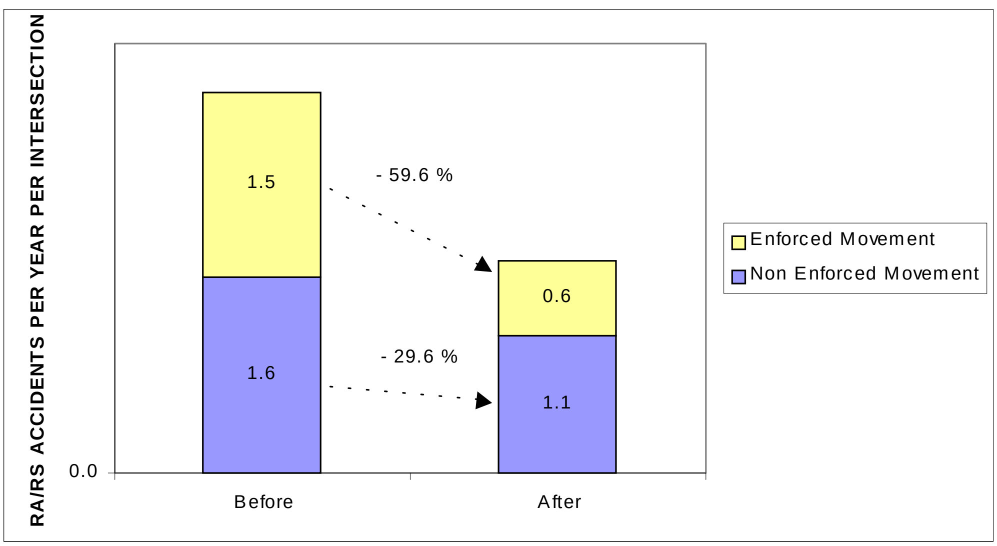


Figure 2-6
ACCIDENT RATES FOR ENFORCED AND NON-ENFORCED MOVEMENTS AT INTERSECTIONS WHERE THROUGH MOVEMENTS ENFORCED

The average accident rate for the enforced movements at LTM intersections before photo enforcement was not high. After photo enforcement, it was found that the average accident rate for the photo-enforced movement was reduced by about 12 percent.

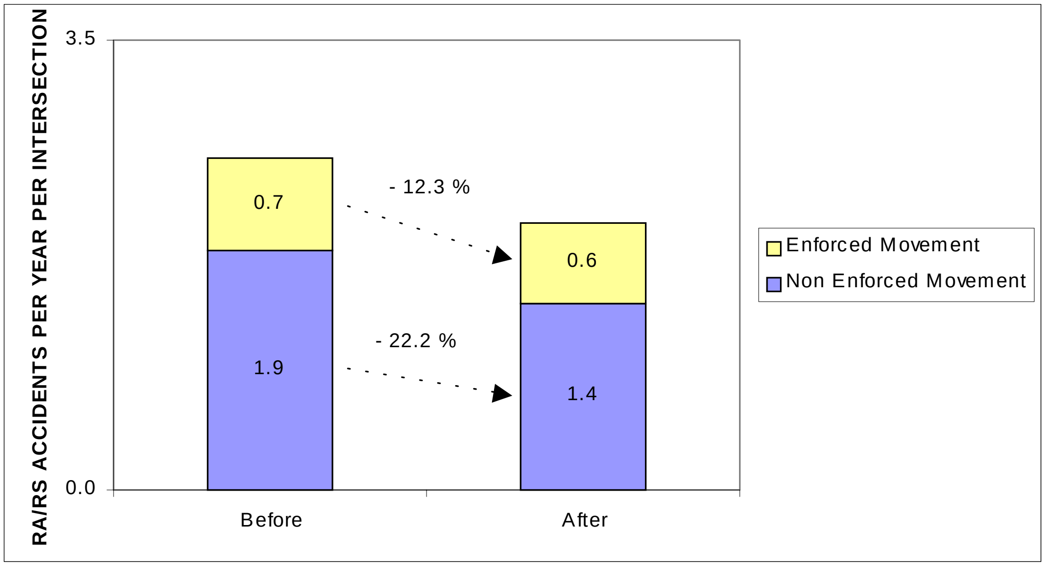


Figure 2-7
ACCIDENT RATES FOR ENFORCED AND NON-ENFORCED MOVEMENTS AT INTERSECTIONS WHERE LEFT TURN MOVEMENTS ENFORCED

2.3.3 Before And After RA/RS Accident Rates By Intersection

Figure 2-8 summarizes the accident rates for each of the photo-enforced intersections before photo enforcement. From this summary, it is noted that the RA/RS accident rate before photo enforcement was remarkably low at the following three intersections:

NB Bernardo Drive to WB Rancho Bernardo Drive (1414)
SB Harbor Drive to EB Grape Street (1533)
SB Mission Boulevard at Garnet Avenue (1542)

One of these locations, at North Harbor Drive and Grape Street has accounted for nearly one-quarter of the recorded violations and citations issued under the City's photo enforcement program.

As the program moves forward, intersections experiencing the highest number of RA/RS accidents should be considered first for photo enforcement. Locations where the accident rates are not high, even locations where there may be high numbers of red light running violations, should not be enforced except to achieve a uniform geographic distribution of the photo-enforced intersections.

Figure 2-9 summarizes the accident rates for each of the photo-enforced intersections after photo enforcement. The RA/RS accident rates for the three intersections noted above remained low after photo enforcement.

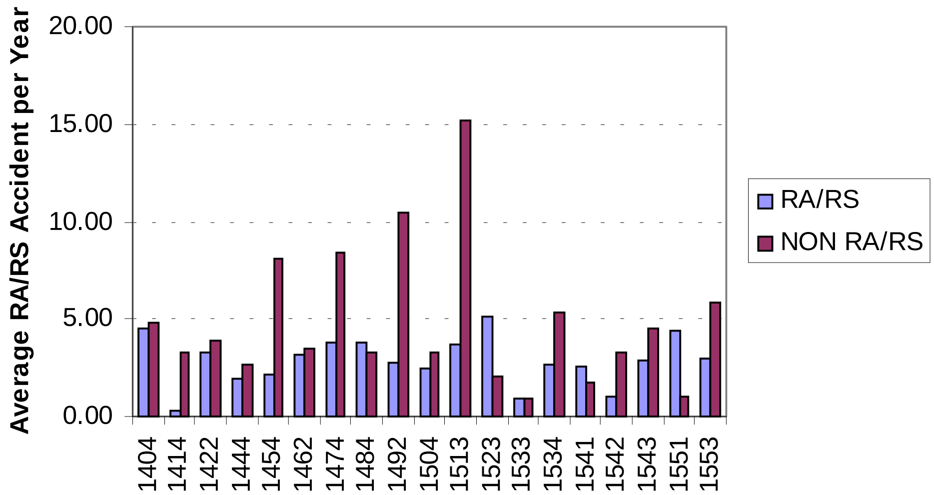


Figure 2-8
BEFORE PHOTO ENFORCEMENT ACCIDENT RATES
AT PHOTO-ENFORCED INTERSECTIONS

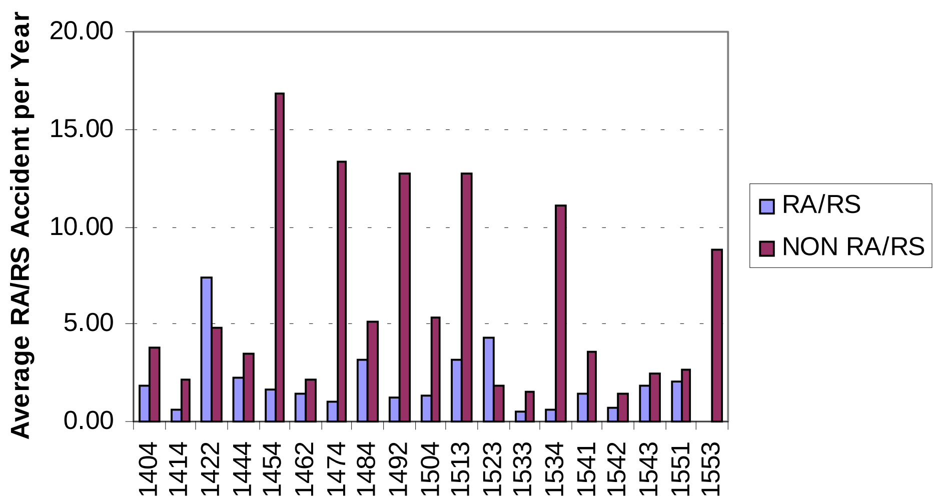


Figure 2-9
AFTER PHOTO ENFORCEMENT ACCIDENT RATES
AT PHOTO-ENFORCED INTERSECTIONS

2.4 NON-RA/RS ACCIDENTS BEFORE AND AFTER PHOTO ENFORCEMENT

The analysis of before and after RA/RS accidents showed that photo enforcement reduced the RA/RS accidents significantly at the photo-enforced intersections. However, it was also noted that the overall accident rate at the photo-enforced intersections increased by about three percent. An analysis of the non-RA/RS accidents by type has shown that the increased accident rate is the result of an increased number of real end (RE) collisions at the photo-enforced intersections.

This section compares the average RE accident rates before and after photo enforcement. The same data provided by the City Traffic Engineering Department and used for the RA/RS accidents comparison was employed for this analysis.

2.4.1 Overall RE Accident Rate Change

Figure 2-10 illustrates the changes in the overall intersection accident rates broken down by RA/RS accidents, RE accidents, and other types of accidents. According to Figure 2-10, RA/RS accidents decreased by 31 percent or 0.9 accidents per year per intersection on the average while RE accidents increased by 37 percent or 1.2 accidents per year per intersection on the average. Other types of accidents, non-RE/RA/RS accidents, remained virtually unchanged, dropping by about 0.1 accidents per year per intersection. It should be noted that no change in the number or rate of other types of accidents should be expected and none was measured from the before and after data for the photo-enforced intersections.

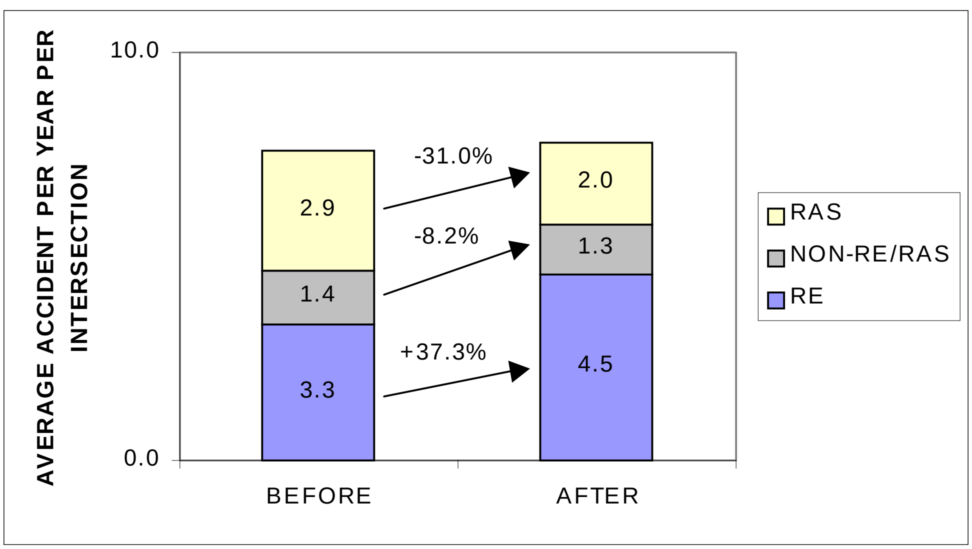


Figure 2-10
AVERAGE ACCIDENT RATE CHANGE BY ACCIDENT TYPES

2.4.2 Average Rear End Accident Rate Change by Traffic Movement

The RE accident rate changes were compared for two groups, RE accidents for the photo-enforced traffic movement and RE accidents for the non-enforced movements. Figure 2-11 shows the average RE accident rates for both groups before and after photo enforcement. Before photo enforcement, there was an average of 3.3 accidents per year at the photo-enforced intersections and this rate increased to 4.5 accidents per year after photo enforcement. The average annual rate of RE accidents for the photo-enforced traffic movements increased by nearly 45 percent and the annual rate of RE accidents for the movements that are not photo-enforced increased by a smaller amount, 31 percent.

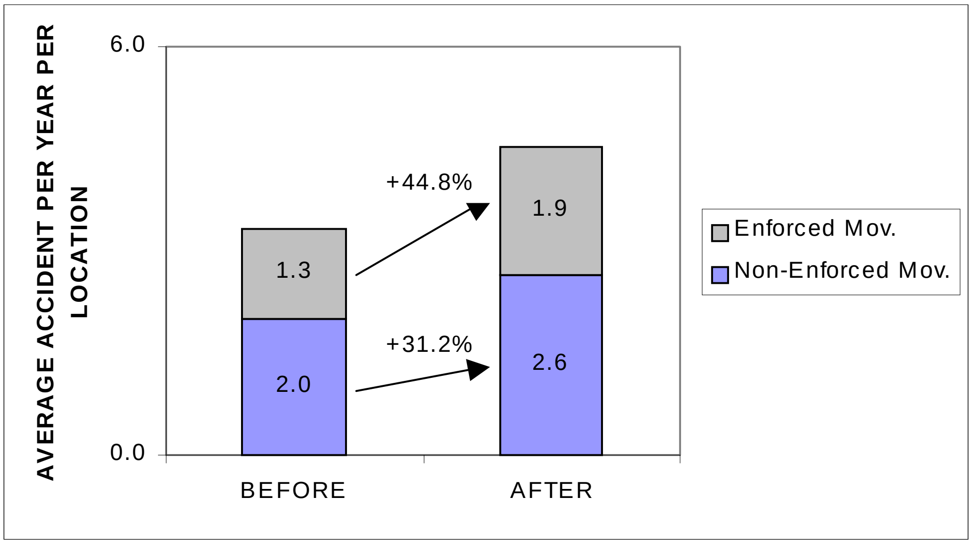


Figure 2-11
AVERAGE REAR END ACCIDENT RATE CHANGE BY TRAFFIC MOVEMENT

2.4.3 Average Rear End Accident Rate Change For Through Movement Enforced Intersections

The RE accident data was analyzed to determine if there were differences in the RE accident rate changes at the Through Movement (THM) enforced intersections.

Before photo enforcement, the average RE accident rate of the THM intersections was 2.6 accidents per year but the rate increased to 3.8 accidents per year after photo enforcement. Figure 2-12 shows that, after photo enforcement, the average RE accident rates increased by 62 percent for the enforced movement and by nearly 43 percent for the non-enforced movements, respectively. Photo enforcement resulted in significantly higher RE accident rates at photo-enforced intersections where a THM was enforced, especially for the enforced THM movement.

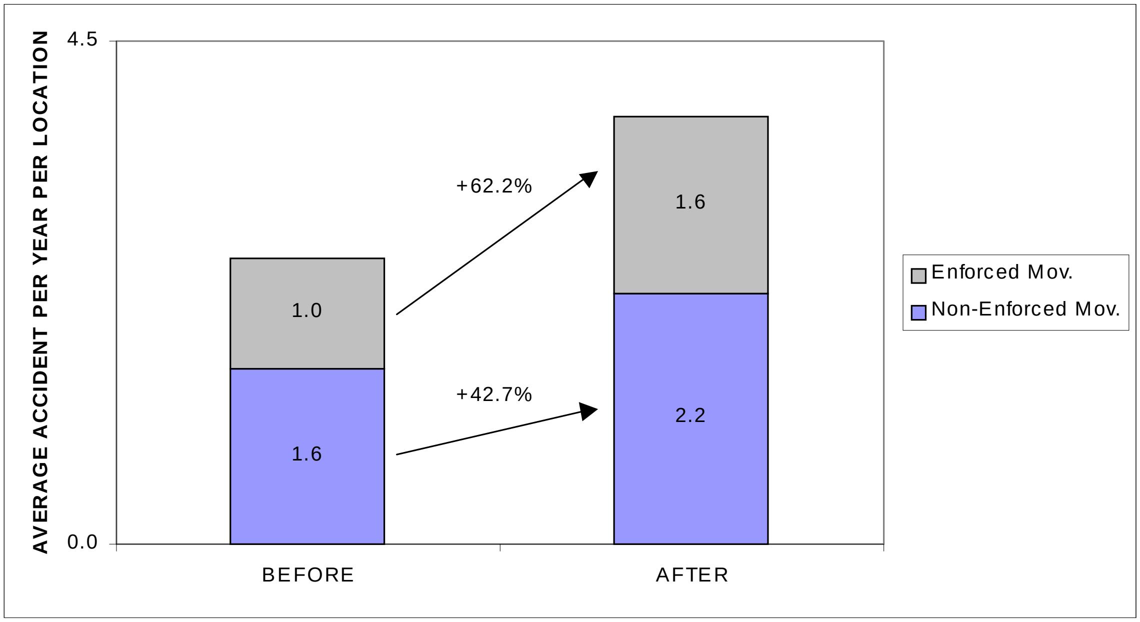


Figure 2-12
REAR END ACCIDENT RATES FOR ENFORCED AND NON-ENFORCED MOVEMENTS AT INTERSECTIONS WHERE THROUGH MOVEMENTS ENFORCED

2.4.4 Average Rear End Accident Rate Change For Left Turn Enforced Intersections

Figure 2-13 shows the RE accident rate changes for Left Turn Enforced (LTM) intersections. Before photo enforcement, the average RE accident rate of the LTM intersections was 4.3 accidents per year. After photo enforcement, the RE accident rate increased to 5.2 accidents per year on the average, by 28 percent for the enforced movement and by about 19 percent for the non-enforced movements, respectively. When compared with those at THM enforced intersections, the RE accident rate changes at LTM intersections are not as large. The slower approach speeds that are typical for left turn lane traffic movements could be a possible explanation for the lower increase in the RE accident rate at LTM enforced intersections.

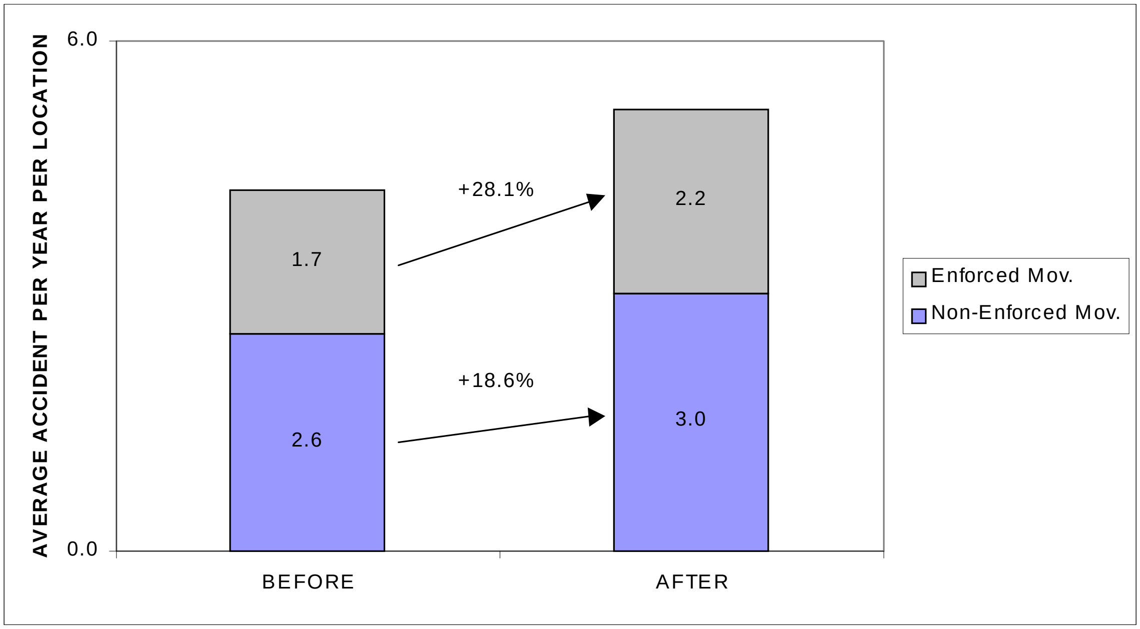


Figure 2-13
REAR END ACCIDENT RATES FOR ENFORCED AND NON-ENFORCED MOVEMENTS AT INTERSECTIONS WHERE LEFT TURN MOVEMENTS ENFORCED

2.4.5 Longer Run Rear End Accident Rate Changes

It may be reasonable to assume that motorists will adapt to the new driving environment over time. After a number of months of photo enforcement operations, motorists may pay more attention to vehicles stopping more often in front of them at signalized intersections. As a result, it might be expected that the observed increases in the rate of RE accidents after photo enforcement will decline over time and, eventually, may approach to the RE accident rate observed before photo enforcement was commenced. To assess this possibility, the RE accident rates after photo enforcement have been computed separately for the photo-enforced intersections according to the length of time that the intersections have been enforced.

Figure 2-14 shows the variation in the overall RE accident rate for the photo-enforced intersections over time. The RE accident rate during the first year of photo enforcement increased from 3.3 accidents per year, before photo enforcement, to 5.2 accidents per year. During the second and third enforcement years, the rates fluctuated but they were not greater than that of the first year. During the fourth enforcement year, the RE accident rate dropped to near the rate observed before photo enforcement.

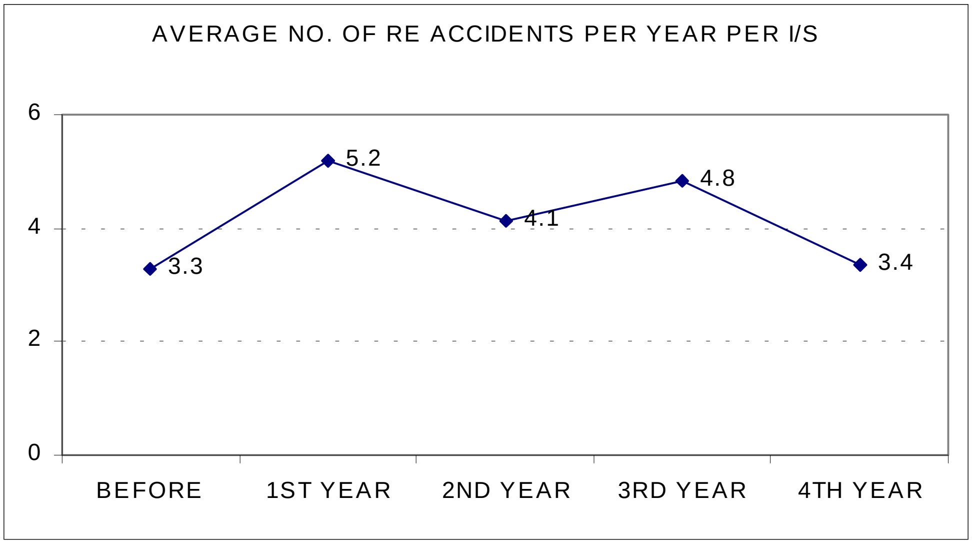


Figure 2-14
LONGER RUN REAR END ACCIDENT RATES CHANGES

Due to data limitations, the RE accident rates could not be computed for more years. However, Figure 2-13 indicates the decreasing trend in the RE accident rates at the photo-enforced intersections as the length of the photo enforcement period increases. It remains to be determined if the downward trend is maintained for longer time periods.

2.5 COMPARISON WITH OTHER PHOTO ENFORCEMENT PROGRAMS

Table 2-3 provides a summary of the changes in red light running violations, accidents attributable to red light running violations, and rear end collisions. Care must be taken in using the data presented in this table as the data sources and methods used for analysis are varied and, in some instances, taken from reports by third parties.

Table 2-3
REDUCTIONS IN RED LIGHT RUNNING VIOLATIONS AND COLLISIONS FOR SELECTED PHTO ENFORCEMENT PROGRAMS

Jurisdiction	State	Number of Intersections	Percent Change In Red Light Running Violations	Percent Change In Rear End Collisions	Percent Change In RLR-Related Collisions
Charlotte	North Carolina	27	(20)	N/A	(24)
Fairfax	Virginia	9	(44)	N/A	N/A
Howard County	Maryland	2	(42)	(30)	(21-44)
Los Angeles	California	1	(34)	N/A	N/A
New York City	New York	30	(34)	N/A	(60-70)
Oxnard	California	15	(42)	N/A	(29-32)
Polk County	Florida	N/A	N/A	N/A	(7)
San Francisco	California	5	(42)	N/A	N/A
San Diego	**California**	**19**	**(20-24)**	**+37**	**(30)**
Scottsdale	Arizona	N/A	(62)	N/A	N/A
Washington	DC	N/A	(56)	N/A	N/A
Wilmington	North Carolina	N/A	(40-60)	+8	(26)

2.6 FINDINGS AND RECOMMENDATIONS

- The City's photo enforcement program has resulted in a significant reduction in the number of red light running violations at the photo-enforced intersections. The measured reduction in red light running violations at intersections where cameras have been operational for six months varies from 20 percent to nearly 24 percent. Furthermore, the measured reductions in red light running violations have remained about the same as the cameras have been operated for longer periods of time.

  The reduction in red light running violations is generally not as high as reported for other photo enforcement programs.

  Generally, reductions in the number of violations are about the same for photo-enforced intersections where through red light running violations are being monitored and locations where left turn movements are being enforced.

- The City's photo enforcement program has resulted in significant reductions in the number of collisions attributable to red light running at the photo-enforced intersections, especially on the photo-enforced approaches where an overall reduction of 46 percent has been measured. This is an important finding and indicates that the program, on the whole, has been effective in reducing the number of accidents resulting from red light running at signalized intersections.

  For intersections where through red light running violations are being monitored, the accident rate for accidents attributable to red light running has declined by 44 percent. For the photo-enforced approaches only at these intersections, the reduction in collisions is an impressive 60 percent.

For intersections where left turn red light running violations are being monitored, the accident rate for accidents attributable to red light running has declined by 20 percent. For the photo-enforced approaches only at these intersections, the number of collisions due to red light running dropped by only 12 percent, less than for all intersection approaches.

Overall, the analysis of the accident data indicates that the photo enforcement program has generated significant reductions in the number of accidents attributable to red light running. The accident rate reductions have been highest for intersections where through traffic movements are being monitored.

- The number of accidents attributable to red light running was found to be remarkably low at three photo-enforced intersections: NB Bernardo Drive to WB Rancho Bernardo Drive (1414); SB Harbor Drive to EB Grape Street (1533); and SB Mission Boulevard at Garnet Avenue (1542).

  One of these locations, at North Harbor Drive and Grape Street, has accounted for nearly one-quarter of the recorded violations and citations issued under the City's photo enforcement program. This location has not experienced a high number of accidents attributable to red light running either before or after photo enforcement. Generally, the locations selected for photo enforcement should be intersections where there are higher numbers of collisions resulting from motorists running red lights.

- Overall, the accident rate at the photo-enforced intersections increased by three percent after the installation of the photo enforcement cameras. This finding is not consistent with the program's overall objective of improving traffic safety for the City's motorists.

  The increase in the overall accident rate has resulted directly from an increase in the number of rear end collisions, an increase that has more than offset the reduced number of collisions resulting from motorists running red lights. After photo enforcement, the average rate of rear end accidents increased by 37 percent after photo enforcement.

  Rear end accidents increased by the largest amount, about 62 percent, for enforced through movements. Rear end accidents increased by the least amount, about 19 percent, for non-enforced left turn movements.

  While the rate of rear end collisions increased for the photo-enforced intersections, it was noted that the rate of rear end collisions dropped over time and, for those intersections where photo enforcement cameras have been in place for about three years, returned to the before enforcement level. This finding, based on limited data, suggests that the increased rate of rear end collisions will not be sustained over time. Additional data is needed to confirm that the increased rate of rear end collisions will not be sustained over time.

3.0 PHOTO ENFORCEMENT EQUIPMENT INSTALLATIONS

Field inspections were also carried out to verify the placement of the photo enforcement equipment and vehicle detection loops at each of the 19 intersections. From these field inspections, special attention was directed to the placement of the vehicle detection loops at each intersection was determined including the length and width of each loop, distances of the loops from the stop line, and the loop-to-loop separation distances or, when measured from center to center, the pitch. The field measurements were compared with the improvement plans prepared when the loops were installed and differences noted. Field measurements for the placement of other photo enforcement equipment were also made and compared against the measurements shown on the intersection improvement plans.

3.1 VERIFICATION METHODOLOGY

The City of San Diego provided copies of the improvement plans for each intersection showing the proposed improvements, showing the proposed locations for the installation of the photo enforcement equipment at each of the 19 intersections. None of the improvement plans were signed and sealed by a Registered California Civil or Electrical Engineer.

Visual inspection and detailed measurements of loop, loop connections, camera and flash unit placement, and photo enforcement signs were conducted at each intersection. Loop detector placement measurements were established on the leading edge of the crosswalk or stop line of the movement monitored. This location is considered to be the point at which a vehicle is within the intersection when the light changes from yellow to red, and consequently, running the red light. The details of loop placement, camera, and flash unit placement are presented on a drawing for each intersection in Appendix A. The drawings show the intersection and locations for the loop detector, camera, flash unit placement, and the photo enforcement signs. The drawings show the loop placement detail as shown in the intersection improvement plans as well as the actual “as installed” dimensions.

3.2 VERIFICATION OF IMPROVEMENT PLANS BY LOCATION

Review of the drawings, compared with the field measurements, finds that the improvements required to operate the system were installed but that the actual placement of the loop detectors varied by location from the placements shown on the improvement plans. The variations are shown on the intersection drawings and are discussed in the following discussions for each intersection.

Generally, details of the field measurements and comparison to the installation plans found several deviations to each plan with the exact placement of the loops and in some cases rerouting of conduits and wiring. Two significant differences were observed in the placement of the camera equipment. At Harbor Drive and 32nd Street, the camera was moved to the center median on the northwest leg of Harbor Drive. At Mission Boulevard and Garnet Avenue, the flash unit is missing.

Field inspections of wiring and loop detectors found them to be generally consistent with that shown in the plans except for rerouting of conduit runs around intersections.

WB El Cajon Boulevard At 43rd Street (1404)

The field conditions show a significant difference between the installed loops and the proposed loops. The installed loops measure 73" x 31" and were placed 30" in front of the limit line.

The proposed loops measure 72" x 30" and were to be placed 12" behind the limit line.

The camera unit is installed in the general vicinity as shown on the plans.

WB Harbor Drive At 32nd Street (1444)

The field conditions show differences between the installed loops and the proposed loops. The installed loops measure 99" x 40" and were placed 48" in front of the limit line.

The proposed loops shown on the plan measure 72" x 30" and were to be placed 12" in front of the limit line.

The camera unit was installed on the Harbor Drive center median on the northwest leg of the intersection. The original plans called for the camera to be installed on the northwest corner of the intersection.

WB Garnet Avenue at Ingraham Avenue (1454)

The field conditions show some differences between the installed loops versus the proposed loops. The installed loops measure 92" x 40" and were placed 35" in front of the limit line. A second set of loops, which appear to be inactive, is located approximately 1-inch in front of the first loop and 11 inches in front of the second loop.

The proposed loops measure 99"" x 40" and are to be placed 48" in front of the limit line.

The camera unit was installed in the general vicinity as shown on the plans.

NB Imperial Avenue At Euclid Avenue (1484)

The field conditions show significant differences between the installed loops and the proposed loops.

The installed loops measure 90" x 40" and were placed skewed to the limit line and range from 12" to 40" in front of the limit line.

The proposed loops measure 99" x 40" and were to be placed 48" in front of the limit line.

The camera unit was installed in the general vicinity as shown on the plans.

WB F Street At 16th Street (1504)

The field conditions show differences between the installed loops and the proposed loops. The installed loops measure 90" x 40" and are placed 36" in front of the limit line.

The proposed loops were shown to be 90" x 40". Placement of the loops in relation to the limit line is not given.

The camera unit was installed in the general vicinity as shown on the plans.

WB A Street At 10th Avenue (1523)

The field conditions show some differences between the installed loops and the proposed loops. The installed loops measure 92.5" x 40" and are placed 60" behind the trailing edge of the limit line.

The proposed loops measure 99" x 40" and were to be placed 12" behind the limit line.

The camera unit and flash units were installed in the general vicinity as shown on the plans.

WB Miramar Road At Camino Ruiz (1534)

The field conditions show differences between the installed loops and the proposed loops. The installed loops measure 90" x 40" and were placed 48" in front of the limit line.

The proposed loops measure 92" x 40" and were to be placed 40" in front of the limit line.

The camera unit and flash unit were installed in the general vicinity as shown on the plans.

SB Mission Boulevard At Garnet Avenue (1542)

The field conditions show differences between the installed loops and the proposed loops. The installed loops measure 90" x 40" and were placed 48" in front of the limit line.

The proposed loops measure 99" x 40" and were to be placed 36" in front of the last traffic signal loops. The traffic signal loops are located at the front edge of the limit line.
The camera unit and flash unit were installed in the general vicinity as shown on the plans. However, the flash unit is presently missing from its mounting.

SB Black Mountain Road At Gemini Avenue (1551)

The field conditions show some differences between the installed loops and the proposed loops. The installed loops measure 90" x 40" and were placed 48" in front of the limit line.

The proposed loops measure 95" x 40" and were to be placed 36" in front of the last traffic signal loop. The traffic signal loop locations cannot be precisely determined because the road has been resurfaced since the loops were installed.

The camera unit and flash unit were installed in the general vicinity as shown on the plans.

EB Mira Mesa Boulevard At Scranton Road (1553)

The field conditions show some differences between the installed loops and the proposed loops. Two (2) sets of loops are cut in the number 1 lane. One (1) loop is 2" closer to the limit line. It is not known which loop is the active loop. The installed loops measure 90" x 40" and were placed 48" in front of the limit line. The two-inch difference will not significantly change the operating conditions.

The proposed loops measure 99" x 40" and were to be placed 36" in front of the last traffic signal loop. The traffic signal loops vary in location. One (1) loop is 24" in front of the limit line while another is 12" in front of the limit line.

The camera unit and flash unit were installed in the general vicinity as shown on the plans.

NB Bernardo Center Drive To WB Rancho Bernardo Road (1414)

The field conditions show some differences between the installed loops and the proposed loops. The installed loops measure 72" x 30" and were placed 32" in front of the limit line.

The proposed loops measure 72" x 30" and were to be placed 12" behind the limit line.

The camera unit was installed in the general vicinity as shown on the plans.

WB Aero Drive At SB Murphy Canyon Road (1422)

The field conditions show differences between the installed loops and the proposed loops. The installed loops measure 72" x 31" and were placed 31" in front of the limit line.

The proposed loops measure 72" x 30" and were to be placed 12" in front of the limit line.

The camera unit was installed in the general vicinity as shown on the plans.

SB College Avenue To Montezuma Road (1462)

The field conditions show differences between the installed loops and the proposed loops. Two (2) loops were cut at the location of the furthest loop from the limit line, which measure a 9" difference. It is not known at this time which loop is active. The installed loops measure 100" x 39" and were placed 50" in front of the limit line.

The proposed loops measure 99" x 40" and were to be placed 48" in front of the limit line.

The camera unit was installed in the general vicinity as shown on the plans.

WB La Jolla Village Drive To Towne Center Drive (1474)

The field conditions show two sets of loops overlapping each other. The active set of loops is not known at this time. The larger set of loops will be referenced as Detail B and the smaller set of loops referenced as Detail C on the intersection drawing. The loops identified as Detail B measure 99" x 40" and were placed 35.5" in front of the limit line. The loops identified as Detail C measure 72" x 31" and were placed 24" in front of the limit line.

The proposed loops measure 99" x 40" and are to be placed 48" in front of the last traffic signal loops. The traffic signal loop locations cannot be determined due to the fact the road has been resurfaced since the loops were installed.

The camera unit was installed in the general vicinity as shown on the plans.

SB Black Mountain Road To EB Mira Mesa Boulevard (1492)

The field conditions show differences between the installed loops and the proposed loops. Two (2) sets of loops were cut at this location. Field investigations located the operating loops. The installed operating loops measure 90" x 40" and were placed skewed to the limit line. The placement ranges from 30" to 44" from the limit line as shown in the plan.

The proposed loops measure 99" x 40" and were to be placed 48" in front of the last traffic signal loops. The exact location of the traffic signal loops has not been determined due to the fact the road has been resurfaced since the loops were installed.

The camera unit was installed in the general vicinity as shown on the plans.

NB Garnet Avenue To NB Mission Bay Drive (1513)

The field conditions show some differences between the installed loops versus the proposed loops. The installed loops measure 90" x 40" and were placed 36" in front of the limit line.

The proposed loops measure 99" x 40" and were to be placed 48" in front of the last traffic signal loop. The existing traffic signal loop locations cannot be determined due to the fact the road has been resurfaced since the installation of the traffic signal loops.

The camera unit and flash units are installed in the general vicinity as shown on the plans.

SB Harbor Drive To EB Grape Street (1533)

The field conditions show a significant difference between the installed loops and the proposed loops. The installed loops measure 90' x 40" and were placed skewed to the limit line and range from 11" to 45" in front of the limit line. The precise dimensions are shown in the intersection drawing.

The proposed loops measure 99" x 40" and were to be placed 35" in front of the last traffic signal loop. One signal loop is located at the front of the limit line while the other is located at the back of the limit line.

The camera unit and flash unit were installed in the general vicinity as shown on the plans.

NB Mission Bay Drive To WB Grand Avenue (1541)

The field conditions show some differences between the actual loops versus the proposed loops. The installed loops measure 90" x 40" and were placed skewed to the limit line and range from 44" to 50.5" in front of the limit line. The precise dimensions are shown in the intersection drawing.

The proposed loops measure 90" x 40" and were to be placed 36" in front of the limit line

The camera unit and flash unit were installed in the general vicinity as shown on the plans.

EB Carmel Mountain Road To NB Rancho Carmel Drive (1543)

The field conditions show some differences between the installed loops versus the proposed loops. The installed loops measure 98" x 40" and were placed 28" in front of the limit line.

The proposed loops measure 99" x 40" and were to be placed 40" in front of the last traffic signal loop. The traffic signal loop locations have not been determined due to the fact the road has been resurfaced since the loops were installed.

The camera unit and flash unit are installed in the general vicinity as shown on the plans.

3.3 WARNING SIGNS

All photo-enforced intersections are signed as required by the California Vehicle Code. The signs have been installed for each intersection approach at, but not of in advance of, the photo-enforced intersections. Typically, the signs are installed on the photo-enforced approaches only.

3.4 LOOP PLACEMENT MEASUREMENTS

A key measurement for the Red Light Camera Program is the center-to-center distance between the loops in each lane, that is, the pitch measurement. A second critical measurement is the distance from the stop line to the leading edge of the second vehicle detection loop. These measurements are especially important for the San Diego system since vehicle speeds based on the pitch measurement are used to estimate the time when motorists actually entered the intersection.

Table 3-1 presents the field measurements of the pitch and distance from the stop line to the leading edge of the first vehicle detector for each intersection. Note that the distance used to compute the speed that vehicles enter the intersection is the distance from the stop line to the leading edge of the second loop.

Table 3-1
CAMERA LOOP PLACEMENT MEASUREMENTS

Code	Location	Camera Pitch (cm)	Distance From Limit Line to Loop Detector (a)
1404	WB El Cajon Boulevard at 43rd Street	201	30”/76 cm
1444	WB Harbor Drive at 32nd Street	225/230 (d)	48”/122 cm
1454	WB Garnet Avenue at Ingraham Avenue	201	35”/89 cm
1484	WB Imperial Avenue at Euclid Avenue	229	12“ to 40”/ 30 cm to 102 cm (c)
1504	WB F Street at 10th Street	203	36”/91 cm
1523	EB A Street at 10th Avenue	204.5	60” /152 cm (e)
1534	WB Miramar Road at Camino Ruiz	202	48”/122 cm
1542	SB Mission Boulevard at Garnet Avenue	205	48”/122 cm
1551	SB Black Mountain Road at Gemini Avenue	203	48”/122 cm
1553	EB Mira Mesa Boulevard at Scranton Road	218.5	48”/122 cm
1414	NB Bernardo Center Drive to WB Rancho Bernardo Road	223	32”/81 cm
1422	WB Aero Drive to SB Murphy Canyon Road	199.5	31”/79 cm
1462	SB College Avenue to EB Montezuma Road	230/235 (b)	50”/127 cm
1474	WB La Jolla Village Drive at Towne Center Drive	200/231 (b)	31.5” to 40.5”/ 79 cm to 103 cm (b)
1492	SB Black Mountain Road to Mira Mesa Boulevard	203	30” to 44” / 76 cm to 112 cm (c)
1513	EB Garnet Avenue to NB Mission Bay Drive	225	36”/91 cm
1533	North SB Harbor Drive to EB Grape Street	203	11” to 45” / 28 cm to 114 cm (c)
1541	NB Mission Bay Drive to WB Grand Avenue	203	44” to 50.5” / 112 cm to 128 cm (c)
1543	EB Carmel Mountain Road to NB Rancho Carmel Drive	203	28”/71 cm

NOTES:
(a) Distance from leading edge of first loop to limit line.
(b) Set or sets of overlapping loops, active loops not shown.
(c) Loops skewed at limit line
(d) Two (2) sets of loops
(e) Loops are installed upstream of the limit line.

3.5 VEHICLE DETECTION RELATED ERRORS

As already noted, the vehicle detection loops used to determine vehicle speeds and trigger the photo enforcement cameras have been installed downstream of the point of violation at all but one of the photo-enforced intersections. When situated upstream of the stop line in accordance with the manufacturer’s recommended configuration, the first photograph will clearly show the vehicle before it has entered the intersection on the red traffic signal so that there is no uncertainty regarding the nature of the violation. If the first photograph does not clearly show that the vehicle has not entered the intersection, it may be determined from an examination of the photograph not to cite the motorist.

With the loops situated on the downstream side of the point of violation, the time that the vehicle entered the intersection and its speed at that point is estimated based on the vehicle speed when it traverses the photo enforcement loops. This configuration introduces the possibility that errors in the vehicle speed estimates may result in motorists being improperly cited. This section presents a review of the possible errors that could occur from the use of loops to estimate vehicle speeds and the loop placement at the photo-enforced intersections.

A number of loop detection related errors are possible. Certain errors could be caused by the operation of the loops themselves; other errors could result from the placement of the loops.

The loops installed in the photo enforcement intersections of San Diego are typically rectangular shaped. A loop detector senses a vehicle when parts of the vehicle that have ferromagnetic properties (engine block, front axle) disturb the magnetic flux of the loop in the pavement, changing the resonant frequency of the loop circuit. Typically, the magnetic field created by a rectangular loop will extend above the outside perimeter of the loop, to a height of approximately two-thirds of the width of the loop (about two feet for a 40-inch loop width). The magnetic field also spills outside of the loop perimeter at a height of a few inches above the pavement surface to a distance of about one-half of the loop width (about 20 inches for a 40-inch loop). This spillover effect can result in two adjacent loops interacting with each other (referred to as crosstalk), causing false detects and frequently resulting in the detectors locking up in detect mode. The change in the resonant frequency of the loop circuit is measured by the loop detector electronics and, when greater than a pre-determined amount, is recognized as a vehicle detect. By its nature and method of operation, loop detectors do not provide pinpoint accuracy and consistency in the point of the loop where detection is actuated. These characteristics can result in possible errors.

Followings are the examples of such errors that can occur when a motor vehicle is detected by loops.

3.5.1 Long Pitch Error

Figure 3-1 illustrates a possible error condition where a vehicle is detected on the leading edge of the first loop and on the trailing edge of the second loop.. In Note that this error condition is possible but is not likely as evaluated this instance, the vehicle actually travels a distance of 120 inches, from the first loop to the second loop, but the camera unit calculates the vehicle speed based on a pitch measurement of 80 inches. This error results in the vehicle speed being underestimated.

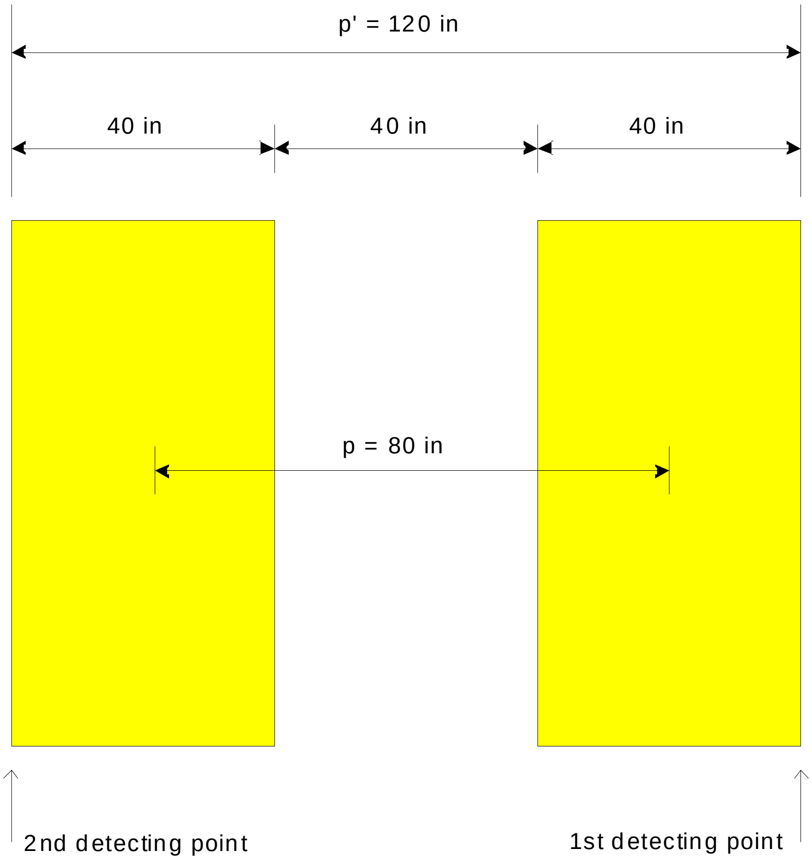


Figure 3-1
LONG PITCH LENGTH ERROR

In this case, the travel time from the first loop to the second loop is:

$$t_{est} = \frac{p'}{p} \times t_{true} \qquad (1)$$

The estimated speed, v_{est}, can be computed as follows;

$$v_{est} = \frac{p}{t_{est}} = \frac{p}{\frac{p'}{p} t_{true}} = \frac{p}{p'} \times v_{true} \qquad (2)$$

Since p is 80 inches and p' is 120 inches under the typical loop alignment conditions, equation 2 can be rewritten as follows:

$$v_{est} = 0.67 \times v_{true} \qquad (3)$$

Equation 3 indicates that the estimated speed will underestimate the true speed by 33 percent. For vehicles where the speed is incorrectly calculated at less than the minimum speed threshold, the camera will not be triggered and no violation will be recorded. For vehicles where the speed is calculated at more than the minimum speed threshold, the estimated time that the vehicle entered the intersection will be miscalculated as earlier than the actual time. Both of these errors result in motorists who ran a red light not being photographed or, in other words, the possible error condition is in the motorists' favor and cannot result in motorists being improperly cited.

3.5.2 Short Pitch Error

Figure 3-2 illustrates a possible error condition where a vehicle is detected on the trailing edge of the first loop and at the center of the second loop. In this instance, the vehicle actually travels a distance of 60 inches, from the first loop to the second loop, but the camera unit calculates the vehicle speed based on a pitch measurement of 80 inches. This error results in the vehicle speed being overestimated.

Since p is 80 inches and p' is 60 inches, equation 2 can be rewritten as follows:

$$v_{est} = 1.33 \times v_{true} \qquad (4)$$

Equation 4 indicates that the estimated speed will be higher the true speed by 33 percent. For vehicles where the speed is incorrectly calculated at more than the minimum speed threshold, the camera will be triggered and a violation will be recorded. For all vehicle photographed, the estimated time that the vehicle entered the intersection will be miscalculated as later than the actual time.

In the worst case of a vehicle actually traveling at 11.6 miles per hour (estimated speed calculated to be 15 miles per hour), the estimated time that the vehicle entered the intersection will be calculated in error by approximately 0.14 seconds. For a vehicle actually traveling at 30 miles per hour, the magnitude of the error would be approximately 0.06 seconds. The magnitude of this error is less than that the length of the minimum grace periods being used and, consequently, would not result in motorists being improperly cited.

It is possible that a vehicle could be detected on the trailing edge of the first loop and at the leading edge of the second loop, meaning that the vehicle has only traversed a distance of 40 inches and that the vehicle speed would be overestimated by 100 percent. With errors of this magnitude, it is possible that motorists could be improperly cited. However, given that the vehicle detection loops are configured the same, this possible error condition is considered to be extreme and not applicable for this analysis.

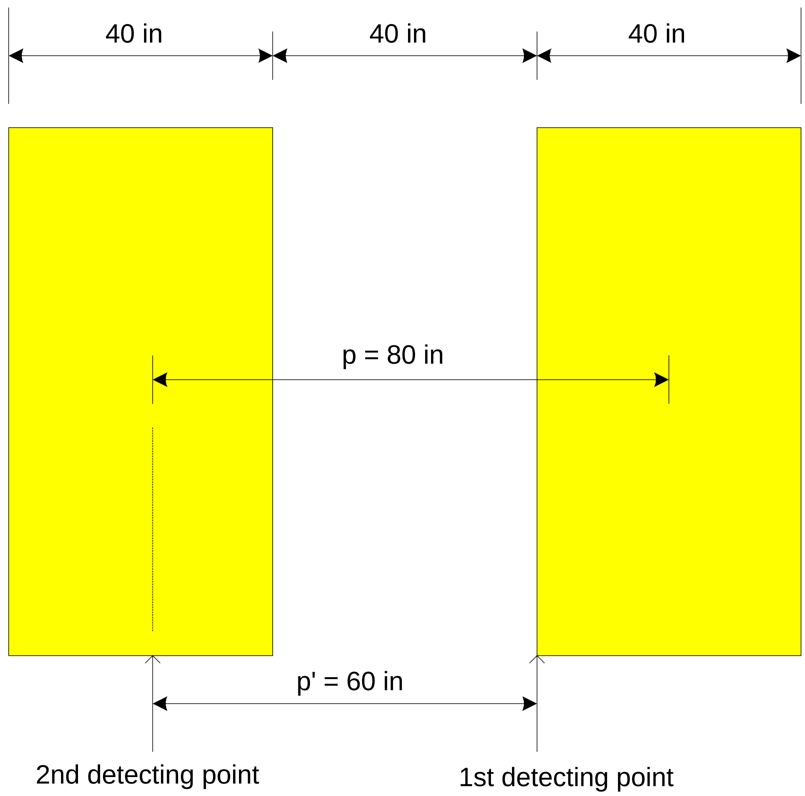


Figure 3-2
SHORT PITCH LENGTH ERROR

3.5.3 Cosine Error

Errors referred to as cosine errors may occur when a vehicle passes the loops with an angle against the loop alignment axis as illustrated in Figure 3-3.

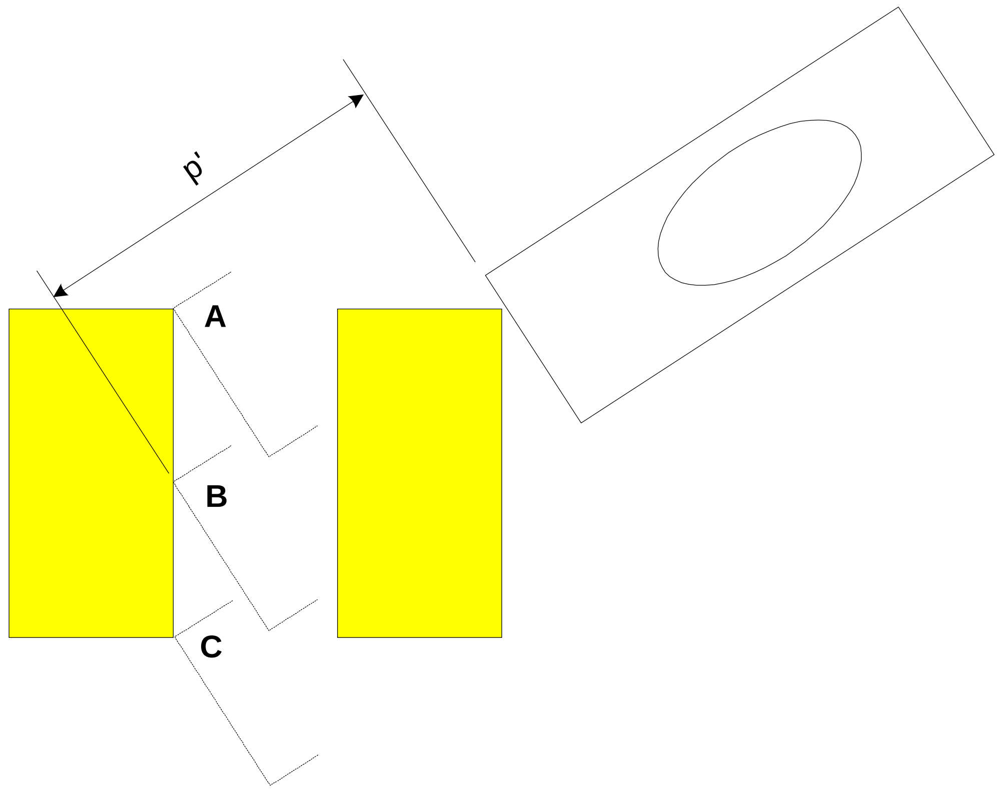


Figure 3-3
EXAMPLES OF POSSIBLE COSINE ERRORS

The actual pitch length (p') depends on the detecting point of the second loop (points A, B, or C in Figure 3-3). The minimum pitch length (p') occurs when the vehicle meets the second loop at point A while the maximum pitch length (p") occurs when the vehicle is detected at point C of the second loop as illustrated in Figure 3-3.

p' and p'' can be computed from the geometric configuration as shown on Figure 3-4:

$$p' = \sqrt{40^2 + 45^2} = 60.2 \quad (5)$$

$$p'' = \sqrt{80^2 + 90^2} = 120.4 \quad (6)$$

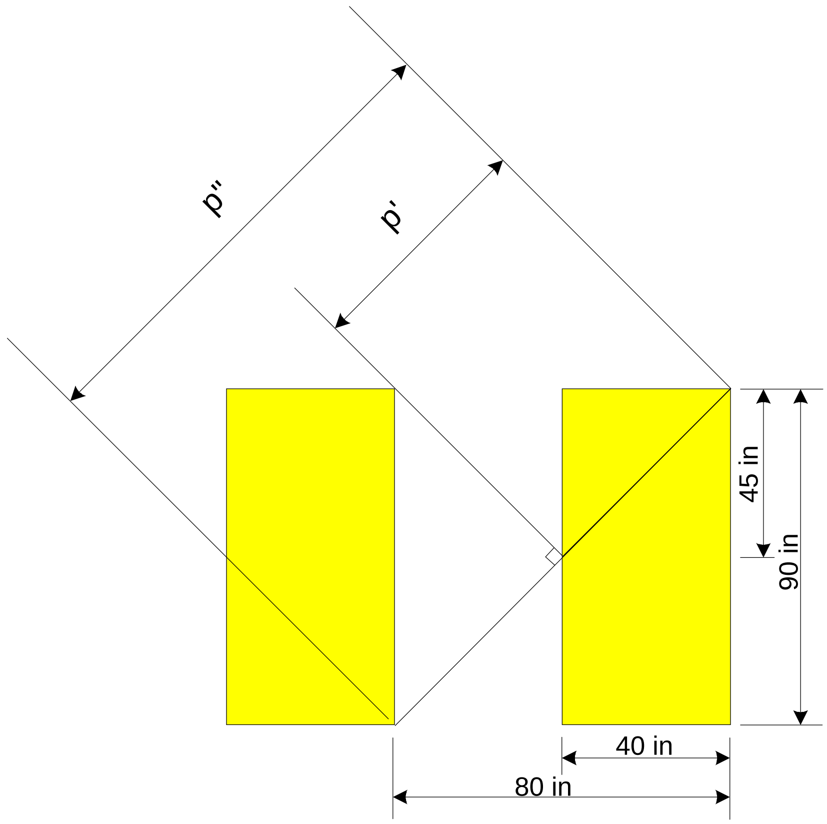


Figure 3-4
MINIMUM AND MAXIMUM PITCH LENGTHS OF COSINE ERROR

From Equations 2, 5, and 6, the relationships between the true speed and the estimated speeds can be obtained as follows:

$$v'_{est} = \frac{p}{p'} \times v_{true} = 1.33 v_{true} \quad (7)$$

$$v''_{est} = \frac{p}{p''} \times v_{true} = 0.67 v_{true} \quad (8)$$

When the speed is estimated with the minimum pitch length p', it is overestimated by 33 percent due to the underestimated travel time between the loops. Where the speed is incorrectly calculated at more than the minimum speed threshold, the camera will be triggered and a violation will be recorded although the vehicles actual speed was less than the threshold.

For all vehicles photographed, the estimated time that the vehicle entered the intersection will be miscalculated as later than the actual time. The magnitude of this error is the same as calculated for the short pitch length error, up to about 0.14 seconds, and is smaller than the grace time periods. Consequently, this error would not result in motorists being improperly cited.

When the vehicle speed is estimated with the maximum pitch length, it will be underestimated by 34 percent due to the overestimated travel time between the loops. In this case, motorists who might be cited based on their actual vehicle speeds will not be photographed. The error is in the motorists' favor and motorists will not be improperly cited.

3.5.4 Errors Due to Acceleration Between Stop Bar and Second Loop

Most of the photo enforcement loops are located on the downstream side of the stop bar. The distances between stop bar and leading edge of the second loop, which may be considered to be the triggering loop, range from between 8.5 feet and 12.1 feet. The distance may be sufficient for some vehicles to change their speed from below the minimum threshold speed, say 15 mph, to above it.

Acceleration performance of a passenger car can reach up to 9.3 ft/sec^2 (ITE Traffic Engineering Handbook). Table 3-2 illustrates the relationship between the starting speed at the stop bar and distance needed to achieve 15 mph at an acceleration rate of 9.3 ft/sec^2.

Table 3-2
MINIMUM DISTANCE FOR SPEEDING UP TO 15 MPH (A = 9.3 FT/SEC^2)

Starting Speed at Stop Bar (mph)	10.2	11.6	12.3	12.8	13.0	13.6	14.3
Distance from Stop Bar (feet)	13.9	10.5	8.6	7.0	6.6	4.5	2.3

It is shown in the Table 3-2 that, when the starting speed on the stop bar is more than 12.8 mph, a vehicle can traverse the second loop with a speed of 15 mph or faster and, thus, may be cited although their approaching speed is slower than 15 mph. For the computation, it was assumed that the average distance between stop bar and second loop is 10.5 feet.

In this case, the vehicle speed is being overestimated by up to about 15 percent for the worst case of the starting speed at the stop bar being 12.8 miles per hour. This error results in the time that the vehicle entered the intersection being later than the actual time by up not more than 0.1 seconds which less than the amount of the grace times being applied and, therefore, would not result in motorists being improperly cited for a red light running violation.

3.5.5 Errors Due to Deceleration Between Stop Bar and Second Loop

In this case, the vehicle speed from the first loop to the second loop will be slower than the actual speed and any errors will be in the motorists' favor. No motorists will be improperly cited as the result of this error condition.

3.5.6 Examples for the Worst Case Errors

Combinations of the short pitch length error, cosine error, and vehicle speeding up error at the same time have not been analyzed. The worst cases may be possible when two different types of speed estimation errors have occurred simultaneously. For example, a vehicle's approaching speed can be overestimated due to the acceleration between stop bar and second loop and, at the same time, the speed can be overestimated again by up to one-third due to the vehicle traversing the loops at an angle. For locations where left turns are being enforced, this particular combination is clearly one that is possible although it appears that the combined error is generally less than provided by the grace times.

For all possible error conditions or combinations of error conditions where vehicle speeds are overestimated, it is apparent that the minimum speed thresholds are not being applied on a consistent basis and that the actual grace periods may be less than planned when errors are being covered but it may also be concluded that motorists are not being improperly cited for red light running violations.

3.6 FINDINGS AND RECOMMENDATIONS FOR PHOTO ENFORCEMENT EQUIPMENT INSTALLATION

- Generally at all locations, the “as built” placement of the photo enforcement system improvements do not correspond with the intersection improvement plans, especially with regard to the placement of the vehicle detection loops. At most locations, the “as built” camera pole locations were found to be reasonably consistent with the intersection improvement plans.

  It is an important finding that the intersection improvement plans were not prepared by a California Registered Civil or Electrical Engineer and were not subject to the City’s plan check, permitting, and inspection procedures. Related to this finding, “as built” plans were not prepared for any of the 19 photo-enforced intersections.

  It is an important recommendation of this interim report that the City should require that any further photo enforcement system installations be done in accordance with the City’s plan check, permitting, and inspection procedures; that the intersection improvement plans be prepared by a California Registered Engineer; and that “as built” plans be prepared and then maintained to reflect any subsequent upgrades or adjustments.

- It is a general recommendation, the most important one of the project report, that the City not re-start its photo enforcement program without the relocation of the vehicle detection loops to locations where the first photograph is taken immediately before the vehicle crosses the stop line, instead of after the vehicle has already entered the intersection. This approach will eliminate the uncertainties associated with the measurement of vehicle speeds using the vehicle detection loop pairs.

  The implementation of this recommendation will require that the vehicle detection loops are re-cut and that camera unit settings be adjusted at 18 intersections. Vehicle detection required for the operation of the traffic signals may also need to be installed at selected locations. At these locations, it is recommended that video-based vehicle detection systems be employed for traffic signal control purposes.

The estimated cost for re-cutting the photo enforcement loops and for installing video detection equipment at 18 intersections is $220,000.

- In conjunction with the relocation of the vehicle detection loops, it is recommended that enhanced advanced warning signs be installed at each intersection to supplement the standard photo enforcement signs currently installed at the photo-enforced intersections. Figure 3-5 shows the advance warning sign currently used by the City of Ventura. This sign could be employed at the City's photo enforced intersections.

  The estimated cost for the purchase and installation of the enhanced advance warning signs for the 19 photo-enforced approaches is $3,800, assuming that the signs can be installed on existing poles.

Figure 3-5
PHOTO ENFORCEMENT ENHANCED ADVANCE WARNING SIGN

- The vehicle detection loop configuration employed at 18 of the 19 photo-enforced intersections requires that the time when motorists entered the intersection against a red light is estimated based on the measured speed over the vehicle detection loops. Errors in the estimated vehicle speeds may result from this configuration as well as from the inherent operating characteristics of inductive vehicle detection loops.

  The possible errors resulting from the loop configuration and loop operating characteristics have been analyzed. From the analysis, it appears that the grace periods being applied before citations are issued are sufficiently long to compensate for any errors and that the City should be confident that all citations issued to date under the photo enforcement program have been properly issued with regard to possible errors resulting from the configuration of the vehicle detection loops.

4.0 CAMERA UNIT SETUPS

In September 2001, site visits were made to the 19 photo-enforced intersections within the City of San Diego. These site visits were made to inspect and verify the operability and settings of the automated red light enforcement equipment (e.g. camera, camera unit, camera poles and housings, and loop detectors) used to detect red light violators at these intersections. The successful operation of camera enforcement is dependent on the reliable operation of the vehicle detection loops that trigger the first and second photographs for each violation and, if not properly configured and adjusted, may result in operational problems and questionable data. This section will describe the methodology used and results obtained from data collection.

4.1 METHODOLOGY FOR FIELD INSPECTIONS

Site visits to the 19 photo-enforced intersections were made over three days in late September 2001 (See Table 3). Prior to these site visits, all cameras had been turned off at the request of the San Diego Police Department on June 1, 2001. It was reported that they had not been checked during this period by maintenance staff.

A PBF representative inspected each red light camera unit at least once over this period. A second site visit was required for two intersections since equipment to test loop circuitry was unavailable at the time of the initial inspection.

Table 4-1
INSPECTION RECORD

Date of Inspection	Intersection
9/25/01	Aero Drive at Murphy Canyon Road
9/25/01 and 9/27/01	Carmel Mountain Road at Rancho Carmel Drive
9/25/01	Bernardo Center Drive at Rancho Bernardo Road
9/25/01	Mira Mesa Boulevard at Black Mountain Road
9/25/01	Miramar Road at Camino Ruiz
9/25/01 and 9/27/01	Towne Center Drive at La Jolla Village Drive
9/25/01	Mission Bay Drive at Garnet Avenue
9/25/01	Garnet Avenue at Ingram Street
9/26/01	Black Mountain Road at Gemini Avenue
9/26/01	“F” Street at 16th Street
9/26/01	10th Avenue at “A” Street
9/26/01	Garnett Avenue at Mission Boulevard
9/26/01	Mission Bay at Grand Avenue
9/26/01	Grape Street at Harbor Street
9/26/01	32nd Street at Harbor Drive
9/26/01	Imperial Avenue at Euclid Avenue
9/26/01	El Cajun at 43rd Street
9/27/01	College Avenue at Montezuma Road
9/27/01	Mira Mesa Boulevard at Scranton Road

During each site visit the PBF representative was accompanied by a representative from Lockheed Martin IMS/ACS. LM/ACS staff assisted with the provision of camera unit access and operation. The representative from LM/ACS was asked by the evaluator to perform a series of tasks needed to properly inspect and verify the operational status and settings of the camera unit, and other associated field equipment.

Data collection at each site focused on the camera pole and cabinet, camera unit, camera unit settings, auxiliary flash, and loop detectors. Among the more important data collected for each site were loop to loop pitch setting, which should match the loop center to loop center measurement (pitch) taken in the field; the minimum speed; and the interval distance, which is the distance that a violating vehicle will travel before the second photograph is taken. The minimum speed is the lowest speed at which the vehicle must travel to activate the camera. The interval distance is measured from the leading edge of the second loop to a position in the intersection which it has been determined will produce a second photograph showing the vehicle better than half way through the intersection. This distance is determined so that second photograph will provide the best possible view of the vehicle and driver. The interval distance is entered into the camera unit in meters. The verification of pitch, minimum speed, and interval distance along with a series of other checks on settings were performed through a process established between the PBF and LM/ACS representative.

4.2 DATA COLLECTION PROCEDURES

The procedures used to collect data at each intersection can be broken down into internal and external camera unit measurements. Internal camera measurements are those settings that were programmed into the camera unit prior to each intersection visit. External measurements, were those that were collected through visual inspection or tests conducted outside the camera unit (e.g. tests made at the terminal block and loop detector locations).

4.2.1 Internal Measurements

First, internal measurements were collected to determine if settings programmed into the camera unit match those that established by LM/ACS for the correct functioning of the camera system. These settings were available to PBF staff and were also reported on the data sheets located in each camera housing. Difference in settings that were programmed and those that were reported may identify the source of the problem, if a problem with the recording of violations were detected. Second, internal settings were reviewed to determine if the cameras were properly set to cite motorists.

Since internal measurements were programmed into the camera unit, the LM/ACS representative was called upon to assist in this effort. The LM/ACS representative provided access to the camera unit housing, and provided proof of settings programmed into the camera unit. Proof of settings was shown only after a series of steps were undertaken by the LM/ACS representative to activate the system.

To visually show programmed settings on the LCD display of the camera unit, the LM/ACS representative had to power up the system connect the plug for the detectors to the camera unit and calibrate the loop sensors before information programmed into the unit could be read. In most cases this process was completed effortlessly, in a few cases however, loop detectors failed to respond in a timely fashion and had to be removed, reattached to the camera unit and recalibrated. Loop detectors, at several intersections failed to respond after several attempts were made to re-calibrate the loops. Intersections where loops failed to release i.e. be recognized as fully operational, were noted and attempts to solve the problem were briefly conducted by the LM/ACS representative. A more through analysis of calibration difficulties is provided in the results section.

At intersections where loops responded correctly, steps to visually observe the programmed settings were completed. The Lockheed representative moved through each of the programmed settings and information was obtained from the LCD display on the camera unit. Measurements that were collected and were deemed "internal" are provided below.

- Camera location code,
- Date and Time,
- Image capture delay,
- Loop to loop pitch,
- Detection location,
- Minimum detection speed,
- Interval, and
- Sleep/active days and times (capability for the camera to start and stop at specific times)

4.2.2 External Measurements

Similar to the internal measurements, external measurements of the camera unit were taken to determine if settings were proper and reported correctly. External measurements, however, were also conducted for associated red light enforcement equipment installed at each of the 19 intersections. Equipment, beside that of the camera unit, in which external measurements were made include; the camera pole and housing, loop detectors, camera, auxiliary flash, and intersection environment.

4.2.3 Camera Pole and Housing

The camera pole (See Figure 4-1) and housing (See Figure 4-2) were visually examined to determine the type and condition of the unit. In addition, the pole model was obtained from the LM/ACS representative.

Figure 4-1
CAMERA POLE AND HOUSING

Figure 4-2
CAMERA HOUSING

4.2.4 Camera Unit Information and Settings

The external information and settings on the camera unit were visually observed, verified and recorded. Information was obtained shortly after the camera unit housing was opened and before any alterations were made to the camera unit. Intervention of the LM/ACS representative was needed to obtain the camera lens information (e.g. aperture, focal length, and filters). In the process of obtaining this information, the camera unit installed within the camera unit was removed, and settings were shown to the PBF representative. The type of information that was recorded is provided below. The inside of the camera unit and camera are shown in Figure 4-3.

- Camera unit type,
- Camera unit model,
- Manufacturer property tag,
- Lockheed (USPT) property tag,
- Presence of filters and type,
- Lens focal length,
- Lens aperture,
- Flash power status, and Flash intensity

Figure 4-3
INSIDE VIEW OF CAMERA HOUSING SHOWING CAMERA UNIT

4.3 FIELD INSPECTION RESULTS

This section summarizes the findings of the field inspections conducted by the PBF project team.

4.3.1 Camera Pole and Cabinet

Three different camera poles (models 200, 300, and 400) were found at the 19 locations studied in this evaluation. Of these three models, the 200 model pole is the oldest and most frequently used model used at the 19 photo-enforced intersections. The model 200 pole is unique from the other two types of poles in the manner in which access to the camera housing is obtained. With the 200 model, the camera housing is lowered through a manual process whereas the lowering process for the other two models is automatic and similar to that of an elevator. The "elevator" poles (models 300 and 400) look and act similar to each other, with the 400 model being the most recently released model used in San Diego. Figures 4-4 and 4-5 show the position of the lowered camera housing for the hinged and elevator models respectively.

The camera pole and cabinet model are made out of steel, are painted, and are fully resistant to vandalism. The units are bolted onto a foundation located in the sidewalk or adjacent to the sidewalk and are generally located at least two feet and not more than a few feet from the edge of the roadway.

At each of the 19 camera locations, a considerable amount of dirt was found on the exterior surfaces of the camera pole and cabinet. At several of the locations, some rust formation and graffiti including stickers were also observed on the surface of the units. Besides the dirt and occasional rust, the camera pole and cabinets were in good physical condition. The conditions are recorded in Table 4-2.

Figure 4-4
LOWERED HINGED POLE

Figure 4-5
LOWERED ELEVATOR POLE

Camera unit identification data, including camera unit type and model, and both the manufacturer and USPT (now LM/ACS) serial tag numbers were collected and summarized in Table 4-3. From the data collected, it was determined that three different types of GATSO camera units are installed at the 19 photo-enforced intersections. The three camera unit models used were the 36mST-MC, 36mST-MC3P, and RLC-36 models.

The RLC-36 model is the most recently developed GATSO photo enforcement camera unit used in San Diego. The 36mST-MC and 36mST-MC3P camera units are similar with the main difference being the number of lanes each unit can be configured to enforce. The 36mST-MC3P model includes a third port that allows for a third lane to be monitored and enforced. The 36mST-MC3P model has only been deployed at the intersection of “F” Street and 16th Avenue. Although the camera unit at this intersection was able to enforce three lanes and loops for each lane were installed, the camera unit was not configured properly to enforce red light compliance for the third lane.

A Robot 36DAT-P255761 camera was installed in 18 of 19 camera units inspected. At the time of inspection, the camera at the intersection of “F” Street and 16th Avenue was missing or not been installed. The cause of the missing camera is not known, but it is believed that vandalism or theft was not an issue. Since the camera at this intersection was missing, camera measurements were only reported for the 18 intersections with cameras installed.

The factory inspection records prepared by the camera unit manufacturer, GATSO, were obtained from LM/ACS and reviewed. These records indicated that all camera units had been fully tested and met the manufacturer’s specification before being shipped from the Netherlands. The records indicated that the following functions had been tested under 110 VAC, 120 VAC and 100 VAC loads at high temperature high temperature +50°C and low temperature –10°C:

- Operational conditions, including time/date, times, counter status, and film transport operation;
- All adjustment functions;
- Supply red/yellow and check monitor and simulate offences;
- Check photo display (LED);
- Check detector; and
- Check flash functions.

The factory inspection tests provided for the verification of the following camera unit components and operations:

- Film transport;
- Camera;
- Automatic diaphragm control;
- Flash print;
- Detector;
- Monitor;
- Interface;
- Power supply 24-12 volt;
- Camera stop after 1 minute; and
- Up to three exposures per direction.

4.3.2 Internal Camera Unit Settings

Internal camera unit settings are summarized in Table 4-4. Not reported in the table are the date, time, sleep/active times, and detection location settings recorded during the site visit. For all locations, the date and time displayed on the LCD panel of the camera unit was accurate. All camera units were programmed to operate 24 hours a day/seven days a week, thus sleep/active time settings were disabled. Lastly, front detection was enabled for all units.

Two camera unit settings are of particular importance for the San Diego photo enforcement program, the pitch measurement and the delay time. These settings are reviewed in more detail in the following sections.

Table 4-2
POLE TYPE MODEL AND CONDITIONS

Intersection	Pole Type	Pole Model	Conditions
Aero Drive at Murphy Canyon Road	Hinged	200 Series	Rust Present
Carmel Mountain Road at Rancho Carmel Drive	Elevator	300 Series	A little Rust Present
Bernardo Center Drive at Rancho Bernardo Road	Hinged	200 Series	Dirty
Mira Mesa Boulevard at Black Mountain Road	Hinged	200 Series	A little rust and dirty
Miramar Road at Camino Ruiz	Elevator	300 Series	Needs paint touch up and has rust
Towne Center Drive at La Jolla Village Drive	Hinged	200 Series	Good
Mission Bay Drive at Garnet Avenue	Hinged	200 Series	Marked up and needs paint touch up
Garnet Avenue at Ingram Street	Hinged	200 Series	Graffiti in the form of stickers and dirty
Black Mountain Road at Gemini Avenue	Elevator	400 Series	Dirty
“F” Street at 16th Street	Hinged	200 Series	Needs paint touch up, has rust and is dirty
10th Avenue at “A” Street	Elevator	300 Series	Good
Garnett Avenue at Mission Boulevard	Elevator	400 Series	Marked up, has graffiti and is dirty
Mission Bay at Grand Avenue	Elevator	400 Series	Good
Grape Street at Harbor Street	Elevator	300 Series	Extremely dirty
32nd Street at Harbor Drive	Hinged	200 Series	Needs paint touch up and is dirty
Imperial Avenue at Euclid Avenue	Hinged	200 Series	Dirty
El Cajun at 43rd Street	Hinged	200 Series	Graffiti, dirty, and has a little rust
College Avenue at Montezuma Road	Hinged	200 Series	Graffiti and dirty
Mira Mesa Boulevard at Scranton Road	Elevator	400 Series	Dirty

Table 4-3
PHOTO ENFORCEMENT CAMERA TYPES AND IDENTIFICATION

Intersection	Camera Unit Type	Camera Unit Model	Manufacturer Tag Number	USPT Tag Number
Aero Drive at Murphy Canyon Road	GATSO	36mST-MC	957	E 0025
Carmel Mountain Road at Rancho Carmel Drive	GATSO	RLC-36	1100	E 0488
Bernardo Center Drive at Rancho Bernardo Road	GATSO	36mST-MC	856	00609
Mira Mesa Boulevard at Black Mountain Road	GATSO	RLC-36	1188	???
Miramar Road at Camino Ruiz	GATSO	RLC-36	1356	A 1123
Towne Center Drive at La Jolla Village Drive	GATSO	RLC-36	1186	E 0990
Mission Bay Drive at Garnet Avenue	GATSO	RLC-36	1066	E 0454
Garnet Avenue at Ingram Street	GATSO	36mST-MC	847	00889
Black Mountain Road at Gemini Avenue	GATSO	RLC-36	1064	E 0442
“F” Street at 16th Street	GATSO	36mST-MC3P	899	00912
10th Avenue at “A” Street	GATSO	RLC-36	1094	E 0509
Garnett Avenue at Mission Boulevard	GATSO	RLC-36	1101	E 0527
Mission Bay at Grand Avenue	GATSO	RLC-36	1357	A 1129
Grape Street at Harbor Street	GATSO	RLC-36	1105	E 0628
32nd Street at Harbor Drive	GATSO	RLC-36	1058	E 0448
Imperial Avenue at Euclid Avenue	GATSO	RLC-36	1102	E 0533
El Cajun at 43rd Street	GATSO	RLC-36	1057	E 0459
College Avenue at Montezuma Road	GATSO	RLC-36	1055	E 0436
Mira Mesa Boulevard at Scranton Road	GATSO	RLC-36	1359	A 1141

Table 4-4
INTERNAL CAMERA UNIT SETTINGS

Intersection	Camera Location Code	Date	Time	Delay	Interval	Pitch	Minimum Detection Speed
Aero Drive at Murphy Canyon Road	1422	Correct	Correct	0.4sec	22m	198cm	15mph
Carmel Mountain Road at Rancho Carmel Drive	1543	Correct	Correct	0.4sec	28m	203cm	12mph
Bernardo Center Drive at Rancho Bernardo Road	1414	Correct	Correct	0.4sec	20m	198cm	15mph
Mira Mesa Boulevard at Black Mountain Road	1492	Correct	Correct	0.4sec	27m	203cm	15mph
Miramar Road at Camino Ruiz	1534	Correct	Correct	0.4sec	21m	202cm	15mph
Towne Center Drive at La Jolla Village Drive	1474	Correct	Correct	0.4sec	18m	231cm	15mph
Mission Bay Drive at Garnet Avenue	1513	Correct	Correct	0.4sec	16m	228cm	15mph
Garnet Avenue at Ingram Street	1454	Correct	Correct	0.4sec	17m	204cm	15mph
Black Mountain Road at Gemini Avenue	1551	Correct	Correct	0.4sec	8m	202cm	12mph
“F” Street at 16th Street[1]	1504	Correct	Correct	0.4sec	14m	203cm	15mph
10th Avenue at “A” Street	1523	Correct	Correct	0.1sec	17m	205cm	12mph
Garnett Avenue at Mission Boulevard	1542	Correct	Correct	0.4sec	13m	203cm	12mph
Mission Bay at Grand Avenue	1541	Correct	Correct	0.4sec	33m	202cm	15mph
Grape Street at Harbor Street	1533	Correct	Correct	0.5sec	18m	203cm	12mph
32nd Street at Harbor Drive	1444	Correct	Correct	0.4sec	16m	227cm	15mph
Imperial Avenue at Euclid Avenue	1484	Correct	Correct	0.4sec	13m	228cm	15mph
El Cajun at 43rd Street	1404	Correct	Correct	0.4sec	11m	202cm	15mph
College Avenue at Montezuma Road	1462	Correct	Correct	0.4sec	21m	234cm	15mph
Mira Mesa Boulevard at Scranton Road	1553	Correct	Correct	0.4sec	14m	203cm	15mph

4.3.3 Camera Unit Pitch Settings

A key measurement for the Red Light Camera Program is the center-to-center distance between the loops in each lane, that is, the pitch measurement.

Table 4-5 provides a comparison of the measured pitch distances to the pitch values observed in the camera units at each intersection. The measurements are within close tolerances at all intersections. It would be useful if the abandoned loops were cut at right angles at two or more sides so that it is clear that the abandoned loops are not functioning.

Minor differences on the order of one percent or less in the pitch measurements may be disregarded. It is not possible to cut loops to tolerances where small differences in the loop-to-loop separation are present, depending on where the measurement is made. Where there is any uncertainty in the pitch measurements, a lower value should be used for the camera unit setting as this adjustment will provide motorists with a small “benefit of doubt” factor when speeds are being calculated.

Table 4-5
COMPARISON OF CAMERA SETUP PITCH SETTINGS AND FIELD MEASUREMENTS

Code	Location	Measured Camera Pitch (cm)	Camera Pitch Setting (cm)	Difference (c), (d), (e)
1404	WB El Cajon Boulevard at 43rd Street	201	202	+1
1444	WB Harbor Drive at 32nd Street	225/230 (a)	227	-2/+3
1454	WB Garnet Avenue at Ingraham Avenue	201	204	+3
1484	WB Imperial Avenue at Euclid Avenue	229	228	+1
1504	WB F Street at 16th Street	203	203	-
1523	EB A Street at 10th Avenue	204.5	205	+0.5
1534	WB Miramar Road at Camino Ruiz	202	202	-
1542	SB Mission Boulevard at Garnet Avenue	205	203	-2
1551	SB Black Mountain Road at Gemini Avenue	203	202	-1
1553	EB Mira Mesa Boulevard at Scranton Road	203	203	-
1414	NB Bernardo Center Drive to WB Rancho Bernardo Road	198	198	-
1422	WB Aero Drive to SB Murphy Canyon Road	199.5	198	+1.5
1462	SB College Avenue to EB Montezuma Road	230/235	234	-4/+1
1474	WB La Jolla Village Drive at Towne Center Drive	200/231 (b)	231	-31/-
1492	SB Black Mountain Road to Mira Mesa Boulevard	203	203	-
1513	EB Garnet Avenue to NB Mission Bay Drive	225	228	+3
1533	North SB Harbor Drive to EB Grape Street	203	203	-
1541	NB Mission Bay Drive to WB Grand Avenue	203	202	-1
1543	EB Carmel Mountain Road to NB Rancho Carmel Drive	203	203	-

NOTES: (a) Two sets of loops with different pitches are installed at these locations.
(b) Two sets of loops, only one of which is operational, are installed at these locations.
(c) Differences of less than one percent are not significant.
(d) Minus differences will result in vehicle speeds being calculated lower than actual speeds, in favor of the motorist.
(e) Plus differences will result in vehicle speeds being calculated higher than actual speeds, not in the favor of the motorist.

4.3.4 Camera Unit Delay Time Settings

The camera unit delay time settings are 0.4 seconds, except at one intersection where the delay time is set at 0.5 seconds and one intersection where the loops are situated on the upstream side of the stop line (A Street and 10th Street) and the delay time has been set at 0.1 seconds.

For most photo enforcement system installations, the delay time represents a “grace” period for motorists entering the intersection against a red traffic signal indication. For the San Diego intersections where the vehicle detection loops have been installed on the downstream side of the stop line, the delay time is not the length of the grace period and direct comparisons with delay time settings by other photo enforcement programs are not applicable. At the A Street and

10th Street intersection where the loops are located on the upstream side of the stop line, the delay time accurately reflects the grace period given to motorists before being photographed.

The actual grace periods being applied the 19 photo-enforced intersections, except for the A Street/10th Street intersection, varies according to vehicle speed and the distance of the leading edge of the second loop from the stop line. In other words, the grace period is not consistent from intersection to intersection nor, for the most part, from vehicle to vehicle. The actual grace times may be determined by examining the tables developed by LM/ACS for each intersection and used to determine whether a citation should be issued for each photographed violation. From an examination of these tables, the actual grace periods applied in issuing citations vary from 0.25 seconds to 0.57 seconds.

Table 4-6 summarizes the delay times, being applied as grace times for motorists, for selected photo enforcement programs.

Table 4-6
CAMERA UNIT DELAY TIME SETTINGS
FOR SELECTED PHOTO ENFORCEMENT PROGRAMS

Jurisdiction	Delay Time (Seconds)
Fairfax	0.4
Howard County	0.5
New York City	0.3
Howard County	0.5
Oxnard	0.4
San Francisco	0.3
San Diego	*0.1-0.55*

4.3.5 Camera Unit Minimum Speed Settings

Depending on the location, the red light cameras are programmed to capture violators exceeding minimum speeds of 12 or 15 mph. This minimum speed threshold appears to be similar but slightly lower than the minimum speed settings used by other photo enforcement programs as found in the literature. The lowest minimum speed setting reported for other photo enforcement programs was 15 mph, which is the highest speed used in San Diego. The highest minimum speed reported in the literature was 19 mph (see Table 4-7). The impact of using a lower minimum speed, such as 12 mph that is used at five out of the 19 photo-enforced intersections in San Diego, is that more violators will be cited than if a higher minimum speed was used. However, it should be remembered that the primary purpose of the minimum speed is to avoid the inclusion of stationary or near stationary vehicles in the intersection that are stuck for whatever reason. From the point of view of using the same rules for issuing citations at all locations, it may be argued that the use of the same minimum speed setting at all photo-enforced intersections is appropriate.

4.3.6 External Camera Unit Settings and Data

Settings for flash units and vehicle detector equipment that is external to the camera unit but inside the camera unit housing are summarized in Table 4-8. In all cases, the flash contained within the camera housing was deactivated but shown to work for all locations. The flash intensity was found to be set equally between the high and medium settings.

Table 4-7
CAMERA UNIT MINIMUM SPEED SETTINGS
FOR SELECTED PHOTO ENFORCEMENT PROGRAMS

Jurisdiction	Minimum Speed (mph)
Fairfax	15
Howard County	19
New York City	15
Howard County	19
Oxnard	15
San Francisco	15
San Diego	*12 or 15*

4.3.7 Camera Settings and Data

The camera at each location was removed from its respective camera unit and observed to determine the lens aperture and focal length. Typically, the lens aperture was either set at 75mm or 90mm, with the exception of the unit located at the intersection of Carmel Mountain Road and Rancho Carmel Drive where an aperture of 45mm was observed. The lens focal length was frequently found to be set at 20m, although this was not the case for all intersections. Excluding the camera unit with a missing camera, lens focal length data was not obtained for five intersections.

During the observation of camera settings, it was noted that polarizing filters were used on six units. Polarizing filters help reduce glare from the sun and light reflected off vehicle windshields. With reduced glare, the camera can more effectively capture the identity of the driver who had committed a red light violation.

Camera settings and filter information are summarized for each intersection in Table 4-9 on the second following page.

Table 4-8
EXTERNAL CAMERA UNIT SETTINGS AND DATA

	Flash Settings		Detector Settings[1]			
Intersection	Status	Power	Frequency	Sensitivity	Mode	Detectors Active for all lanes
Aero Drive at Murphy Canyon Road	Off	High	High	Low	Pulse	Yes
Carmel Mountain Road at Rancho Carmel Drive	Off	High	-	-	-	No
Bernardo Center Drive at Rancho Bernardo Road	Off	Medium	High	Low	Presence	Yes
Mira Mesa Boulevard at Black Mountain Road	Off	Medium	-	-	-	Yes
Miramar Road at Camino Ruiz	Off	High	-	-	-	Yes
Towne Center Drive at La Jolla Village Drive	Off	Medium	-	-	-	Yes
Mission Bay Drive at Garnet Avenue	Off	High	-	-	-	Yes
Garnet Avenue at Ingram Street	Off	High	High	Low	Presence	Yes
Black Mountain Road at Gemini Avenue	Off	High	-	-	-	No
"F" Street at 16th Street	Off	Medium	High	Low	Presence	Yes
10th Avenue at "A" Street	Off	High	-	-	-	Yes
Garnett Avenue at Mission Boulevard	Off	Medium	-	-	-	Yes
Mission Bay at Grand Avenue	Off	High	-	-	-	Yes
Grape Street at Harbor Street	Off	High	-	-	-	Yes
32nd Street at Harbor Drive	Off	High	-	-	-	Yes
Imperial Avenue at Euclid Avenue	Off	Medium	-	-	-	Yes
El Cajun at 43rd Street	Off	Medium	-	-	-	Yes
College Avenue at Montezuma Road	Off	Medium	-	-	-	Yes
Mira Mesa Boulevard at Scranton Road	Off	High	-	-	-	Yes

[1] The Frequency, Sensitivity, and Mode settings can only be manually set and observed for the Red Light Camera Model 36mST-MC. Detector settings were reported for these models only.

Table 4-9
CAMERA SETTINGS

Intersection	Lens Aperture	Lens Focal Length	Filters	Camera Activation
Aero Drive at Murphy Canyon Road	75mm	NA	Polarizer	Pass
Carmel Mountain Road at Rancho Carmel Drive	45mm	NA	-	Fail
Bernardo Center Drive at Rancho Bernardo Road	75mm	20m	-	Pass
Mira Mesa Boulevard at Black Mountain Road	90mm	NA	-	Pass
Miramar Road at Camino Ruiz	75mm	NA	-	Pass
Towne Center Drive at La Jolla Village Drive	90mm	NA	-	Fail
Mission Bay Drive at Garnet Avenue	75mm	20m	-	Pass
Garnet Avenue at Ingram Street	90mm	20m	Polarizer	Pass
Black Mountain Road at Gemini Avenue	75mm	20m	-	Fail
"F" Street at 16th Street[1]	NA	NA	NA	Fail
10th Avenue at "A" Street[2]	90mm	20+m	Polarizer	Pass
Garnett Avenue at Mission Boulevard	75mm	22m	Polarizer	Pass
Mission Bay at Grand Avenue	75mm	21m	Polarizer	Pass
Grape Street at Harbor Street	75mm	20m	-	Pass
32nd Street at Harbor Drive	90mm	20m	Polarizer	Pass
Imperial Avenue at Euclid Avenue	90mm	20m	-	Pass
El Cajun at 43rd Street	75mm	20m	-	Pass
College Avenue at Montezuma Road	75mm	20m	-	Pass
Mira Mesa Boulevard at Scranton Road	75mm	20m	-	Pass

4.3.8 Auxiliary Flash

An auxiliary flash(s) were installed at eight locations to help illuminate the interior cabin of the vehicle committing a red light violation (see Table 4-10). Auxiliary flashes were not installed at the other eleven intersections because either they were not needed or the intersection geometry prevented the installation of units at locations close enough to the intersection where the flash would be beneficial. In most instances, the EL 250 (250 indicates the flash's intensity in watts) model flash was used (see Figure 4-6). The exception would be the intersection of Aero Drive at Murphy Canyon Road where the EL 500 model flash was used (see Figure 4-7).

Figure 4-6
EL 250 AUXILIARY FLASH

Figure 4-7
EL 500 AUXILIARY FLASH

Table 4-10
AUXILIARY FLASH DATA

Intersection	Flash Type	Flash Power
Aero Drive at Murphy Canyon Road	EL 500	500 W
Carmel Mountain Road at Rancho Carmel Drive	EL 250	250 W
Bernardo Center Drive at Rancho Bernardo Road	-	-
Mira Mesa Boulevard at Black Mountain Road	-	-
Miramar Road at Camino Ruiz	EL 250	250 W
Towne Center Drive at La Jolla Village Drive	-	-
Mission Bay Drive at Garnet Avenue	-	-
Garnet Avenue at Ingram Street	-	-
Black Mountain Road at Gemini Avenue	EL 250	250 W
"F" Street at 16th Street[1]	-	-
10th Avenue at "A" Street[2]	EL 250	250 W
Garnett Avenue at Mission Boulevard	-	-
Mission Bay at Grand Avenue	EL 250	250 W
Grape Street at Harbor Street	EL 250	250 W
32nd Street at Harbor Drive	-	-
Imperial Avenue at Euclid Avenue	-	-
El Cajun at 43rd Street	-	-
College Avenue at Montezuma Road	-	-
Mira Mesa Boulevard at Scranton Road	EL 250	250 W

4.3.9 Camera and Detector Operations

Loop detectors are installed at each photo-enforced intersection to detect vehicles that commit a red light violation and enable the camera unit to take two pictures of the vehicle as it traverses the intersection. At all but one of the photo-enforced intersections ("A" Street at 10th Avenue), loop detectors were placed on the intersection side of the approach stop bar. If a stop bar is not present for a monitored intersection approach, the crosswalk striping was used. Each lane that is enforced has one pair of loop detectors.

Figure 4-8, illustrates the typical placement of loop detectors.

The loop detectors are used to determine the speed of vehicles as they cross over the detectors. Either a 12 mph or 15 mph minimum speed threshold is used as the basis for determining that a violation had occurred. In other words, motorists traversing the set of loop detectors at speeds lower that the minimum speed threshold against a red traffic signal are not recorded as violations.

Violations where the minimum speed threshold is not exceeded may occur by the intentional red light runner. There may be instances where a motorist may have a lengthy wait at a red light when there is little to no cross-traffic. In these situations, frustrated motorists may think that there is no apparent danger and will disregard the red light. These violations are likely to occur in the very early morning hours when traffic volumes are at their lowest.

Figure 4-8
TYPICAL LOOP ARRANGEMENT

The operation of the loop detectors was inspected at each of the photo-enforced intersections. First, the operation of the camera units in their "test" mode was observed to verify that vehicles crossing over the detector loops were actually triggered the camera unit to take photographs (this testing was completed without film in the camera). Second, each of the loop detector circuits was tested by measuring the leakage resistance or the electrical resistance between the detector circuit and earth ground. Test measurements were conducted at the camera pole terminal block, where each loop circuit including the three turns of loop wire and detector lead-in cable (DLC), was individually tested. To perform the test, the loop was disconnected from the detector card and one lead of the tester was attached to one of the DLC loop wire and the other to an earth ground. A leakage resistance, measured in this manner, of greater than 100 megohms is required for loop detector circuits per Caltrans standards.

During the inspection of the camera operations, it was found that the vehicle detection loops could not be automatically tuned at certain locations due to bad loops or for other reasons. When this occurred, it was not possible to test the camera operation. Failures of this type result in the camera unit not operating. There were four locations where problems with loops were encountered and camera testing could not be done as listed in Table 4-8. Problems with loop calibration were also experienced at the 10th Avenue and "A" Street location, but troubleshooting efforts were successful and the camera subsequently functioned properly.

4.4 FINDINGS AND RECOMMENDATIONS FOR CAMERA UNIT SETUPS

- Besides a few difficulties encountered during the inspection and testing of camera systems as described in the report, the camera equipment appeared to function properly and be well maintained. Appropriate camera unit settings were generally in place for all locations.

- The loop-to-loop pitch values, as input to the camera units at the 19 intersections, generally correspond very closely with the measured pitch dimensions. Small differences, up to one percent, were found between the camera unit and measured pitch values at selected locations. Any difference up to one percent should not be viewed as a significant difference and is well within the tolerances for cutting loops and for vehicle detection as vehicles pass over loops.

At certain locations, it is difficult to determine with certainty what pitch measurement should be used for the camera unit setting due to the skewed installation of the vehicle detection loops and skewed intersection geometries. At these locations, it was necessary to make judgments regarding the expected paths of motor vehicles entering the intersection.

The pitch measurements will continue to be important when the vehicle detection loops are re-located, as they will be the basis for established vehicle speeds for the application of the minimum speed threshold, but not nearly as critical as under the current configurations.

The City should establish a written policy regarding pitch measurements and how pitch measurements are to be made where there are unusual or irregular loop configurations. For all cases, the policy should state that the shortest pitch dimension, where more than one pitch measurement may be applicable, should always be used for the camera unit setting (that is, in order that the measurement be in the favor of the motorist)

- At certain locations, two sets of loops are in place making it difficult to determine with certainty which set of loops are currently operational for the photo enforcement system. In the future, as built drawings should be maintained so that the operational loops can be readily identified. Abandoned loops should be intentionally cut on two sides so that it is clear that the loops have been abandoned as well as to eliminate any possibility of loop-to-loop crosstalk. Crosstalk between active loops and abandoned loops that have not been cut is possible and can result in unreliable loop detector performance.

- The delay time represents a "grace" period for motorists entering the intersection against a red traffic signal indication. The actual grace periods being applied the 19 photo-enforced intersections, except for the A Street/10th Street intersection, varies according to vehicle speed and the distance of the leading edge of the second loop from the stop line. In other words, the grace period is not consistent from intersection to intersection nor, for the most part, from vehicle to vehicle. The actual grace times may be determined by examining the tables developed by LM/ACS for each intersection and used to determine whether a citation should be issued for each photographed violation. From an examination of these tables, the actual grace periods applied in issuing citations vary from 0.25 seconds to 0.57 seconds.

  For the future when the vehicle detection loops have been re-located in accordance with the manufacturer's recommended configuration and industry practice, the City needs to establish its policy for delay times at photo-enforced intersections. Delay times ranging between 0.3 seconds and 0.5 seconds are typically used.

5.0 REVIEW OF PHOTOGRAPHIC DATA

The photographs taken by the photo enforcement cameras systems are a most valuable source of information for the evaluation of the operation of the camera system. Unfortunately, photographs of violations where citations are not issued are not saved. Consequently, it was not possible to review photographs and related data for discarded violations for the evaluation. Aggregate data documenting the reasons why citations were not issued for certain photographs was available and have been analyzed for all intersections. In addition, the photographs and related data for citations issued were reviewed for a random sample of citations issued.

The data analyzed contains all red light violations made at all photo-enforced intersections throughout the entire enforcement period. Each individual violation candidate was either cited or not. If a photographed violation was not cited, it was classified with a label that identified the reason for not being cited. By analyzing the violation data for each intersection, it is possible to quantify the performance of the intersection-based camera equipment for each individual intersection.

5.1 VIOLATIONS DATA BASE

The violations data base is a complete data set that contains data for all photographed or potential violations. The term “potential violation” is used because a number of them were subsequently determined not to be violations. The enforcement starting dates of 19 photo-enforced intersections differed from location to location, and the data collection periods for each intersection therefore vary accordingly. The longest data collection period is 32 months while the shortest period is 14 months.

The cases that are classified as “No Violation” are those that failed to satisfy, at least one of preset violation criteria. The majority of those classified under this category were motorists who entered the intersection within the grace period used by the Police Department. “Total Violations” represents the total number of photographed violations that met the violation criteria. The number of “Total Violations” is then further classified again into three groups: Citations Issued, Citations Not Issued For Uncontrollable Factors, and Citations Not Issued For Controllable Factors. The violations data shows a total of 273,471 potential violations for the entire enforcement period; 233,308 of which were classified as violations and counted under “Total Violations”; and 83,931 violations where motorists were cited. This means that citations were issued for only 36 percent of all violations and that over 60 percent of the photographed violations were discarded for a variety of reasons.

Table 5-1 and Figure 5-1 show the detailed breakdown of the possible violations for the entire enforcement period. It should be noted that the reasons assigned for rejecting violations are the result of subjective evaluations of different LM/ACS processing staff.

Table 5-1
DISPOSITION OF PHOTOGRAPHED VIOLATIONS FROM SEPTEMBER 1998 THROUGH JUNE 2001

Disposition Category	Number	Percent
TOTAL VIOLATIONS	233,308	100.0
CITATIONS ISSUED FOR NON-CONTROLLABLE FACTORS		
No Front Plate	38,139	16.3
Out of State Plate	2,710	0.1
Glare on Plate	24	-
Illegible Plate	869	-
Plate Obstructed	6,323	2.7
Windshield Glare	3,972	1.7
Driver Obstructed	16,597	7.1
Car Obstructed	8,019	3.4
Emergency Vehicle	2,018	0.8
Expired USPT	202	-
Police Return	2,598	1.1
No DMV Match Found	3,521	1.5
Other	2,185	0.9
No Violation Occurred	39,203	16.8
Total Not Issued For Non-Controllable Factors	87,177	
CITATIONS NOT ISSUED FOR CONTROLLABLE FACTORS		
Framing of Plate	4,230	1.8
Clarity of Plate	1,726	0.7
Dark Interior	9,500	4.1
Framing of Driver	3,772	1.6
Clarity of Driver	19,898	8.5
Framing of Car	15,789	6.7
Data Error	5,202	2.2
Exposure	1,159	0.5
Total Not Issued For Controllable Factors	61,276	26.4
Not Issued Due To Moratorium	960	0.4
CITATIONS ISSUED	83,931	36.0
Hours of Enforcement	204,290	

In Figure 5-2, the overall percent of recorded violations being converted to citations is presented for each of the photo-enforced locations. The percent of citations issued varies from a low level of about 21 percent for the Imperial Avenue/Euclid Street (1484) and Miramar Road/Camino Ruiz (1534) intersections to a high level of about 54 percent at the intersection of Mission Boulevard and Garnet Avenue (1542). More than 50 percent of the violations recorded at the College Avenue/Montezuma Road (1462) and Black Mountain Road/Gemini Avenue (1551) intersections are cited.

Figure 5-1
BREAKDOWN OF CITATIONS NOT ISSUED BY FACTOR

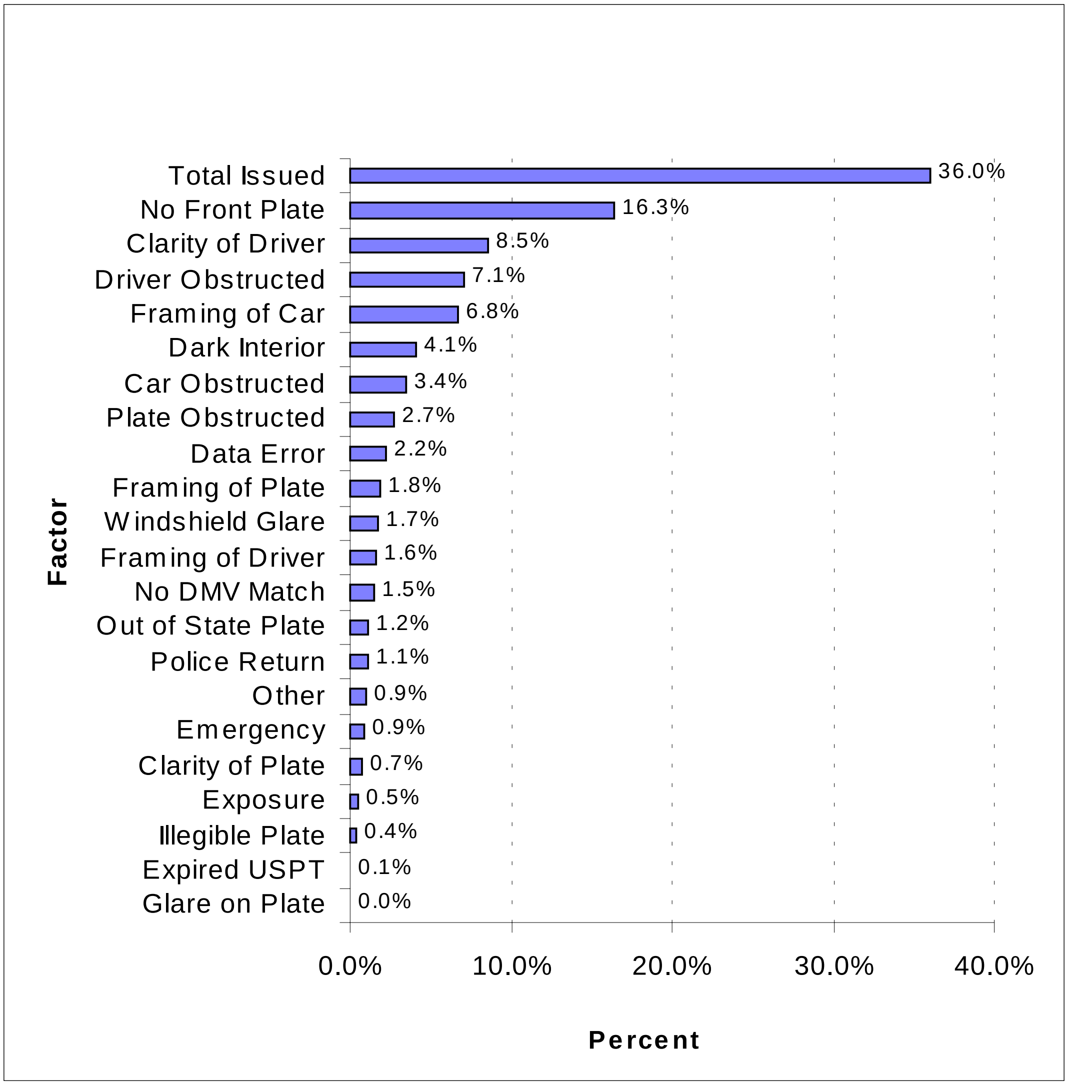


Figure 5-2
PERCENT CITATIONS ISSUED BY INTERSECTION

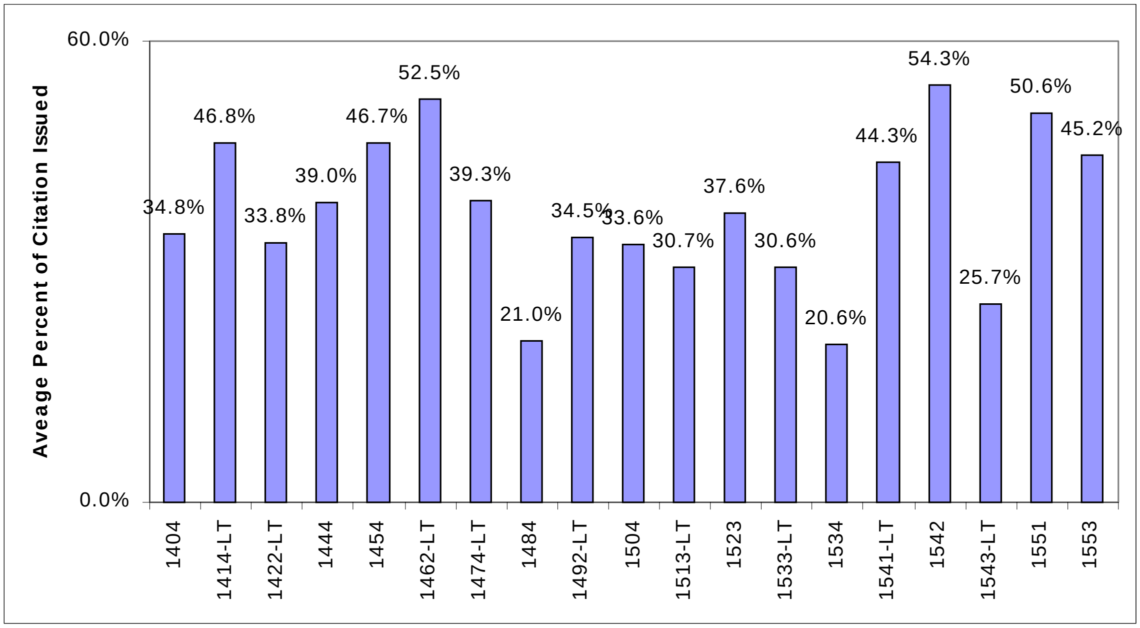


Figure 5-3 shows the same data for the photo-enforced intersections, but with the average monthly number of violations and citations depicted instead of the percentage of violations being cited. From this data, it is easily remarked that intersection of North Harbor Drive and Grape Street (1533) experiences a much higher incidence of red light running violations that any of the other photo enforced intersections. At this intersection, left turn violations are enforced. It may also be noted that there are very low levels of red light running at the Harbor Drive/32nd Street (1444) and F Street/Tenth Street (1504) intersections as well as moderately low levels at the Imperial Avenue/Euclid Avenue (1484), Miramar Road/Camino Ruiz (1484), and Black Mountain Road/Gemini Avenue (1551) intersections. Through red light running violations are monitored at each of these intersections where there are low levels of red light running violations.

5.2 DATA ANALYSIS METHOD

The overall contribution of each factor that prevented violations from being cited can be seen in Figure 5-1. It should be noted that, out of the 21 factors shown, some factors are clearly independent of the performance of intersection equipment. For example, “No Front Plate”, which is the largest factor for the citation failure, is not affected by the camera placement or equipment settings. On the other hand, “Clarity of Driver” may be highly correlated with the lighting conditions and the camera settings. To analyze the photographic results from each intersection, the factors shown in Figure 4-1 have been re-classified into two new groups: Intersection Related Factors and Intersection Independent Factors. Only Intersection Related Factors are used in this analysis. Intersection Related Factors are those factors that appear to influenced by the lighting, filter, shutter speed, and other optical aspects of a camera equipment or those factors affected by the geometric relation between the picture object and camera such as camera location, height, focal length and perspective (angle and framing) of the camera.

Specific features of an individual intersection such as intersection length, alignment, slope, loop placement, and obstacle structures and traffic conditions such as the direction of movement, proportions of heavy or large vehicles, and overall traffic demand can all contribute to the performance of the installed camera system.

Figure 5-3
AVERAGE MONTHLY NUMBER OF VIOLATIONS AND CITATIONS ISSUED BY PHOTO ENFORCED INTERSECTION

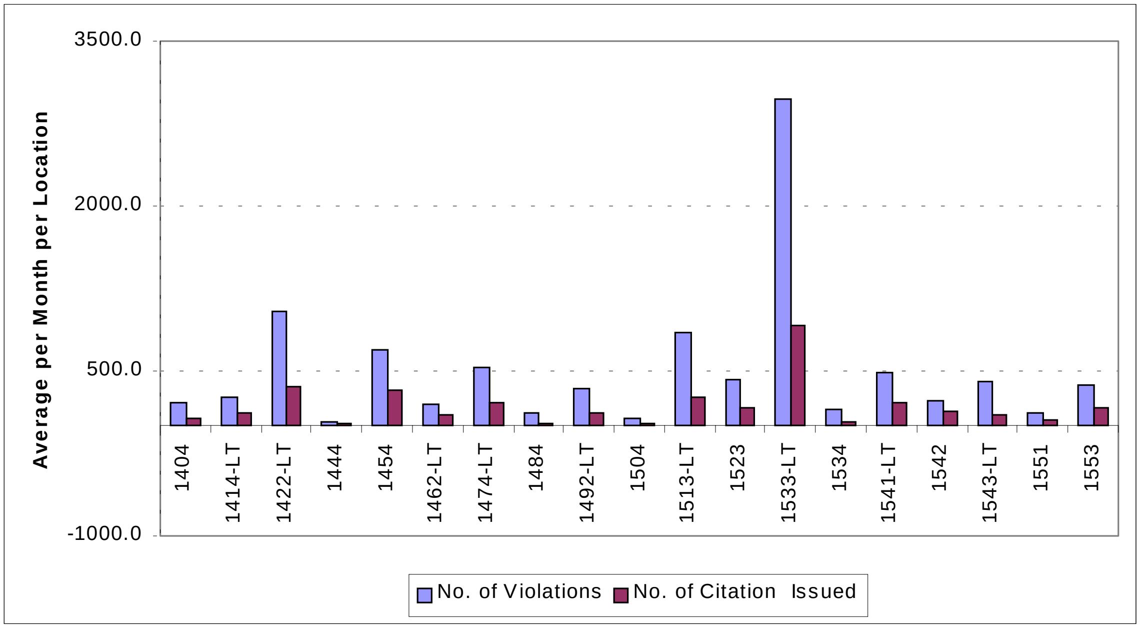


Table 5-2 summarizes the classification of intersection related factors. For the analysis, only factors accounting for more than one percent of the citations not issued were considered.

Table 5-2
RECLASSIFICATION OF INTERSECTION RELATED FACTORS

Category		Factor	Percent Citations Not Issued
Lighting And Optical Factors	Glare	Windshield Glare	1.7
	Clarity	Clarity of Driver	8.5
		Dark Interior	4.1
Geometric Factors	Obstruction	Driver Obstruction	7.1
		Car Obstruction	3.4
		Plate Obstruction	2.7
	Framing	Framing of Car	6.8
		Framing of Plate	1.8
		Framing of Driver	1.6

The re-classified data was tabulated into a set of tables, identical in format to Table 5-1. In total, nineteen tables one for each photo-enforced intersection were created and the results reviewed to check for differences among intersections or groups of intersections.

5.3 ANALYSIS OF LIGHTING/OPTICAL FACTORS

Citations not issued for lighting and optical factors included citations not issued as the result of windshield glare, clarity of the driver's face, and dark vehicle interiors where the driver's face could not be clearly identified.

5.3.1 Windshield Glare

Windshield glare is caused by the sunlight reflecting off the windshield that prevents the camera view from penetrating the interior of a vehicle. Windshield glare is closely related to the time of day and the direction of vehicle movement as well as with the angle between the camera and the sun. Not surprisingly, the analysis of the windshield glare indicates that the percent of citations not used due to windshield glare is highly related to the direction of movement (see Figure 5-2). Of the nine photo-enforced intersections where the percent of citations not issued are greater than 2.0 percent, seven intersections are oriented westbound or eastbound and only two intersections are northbound. It is also noted that four of the intersections with the higher rates of citations not issued for windshield glare do not have cameras equipped with polarizing filters.

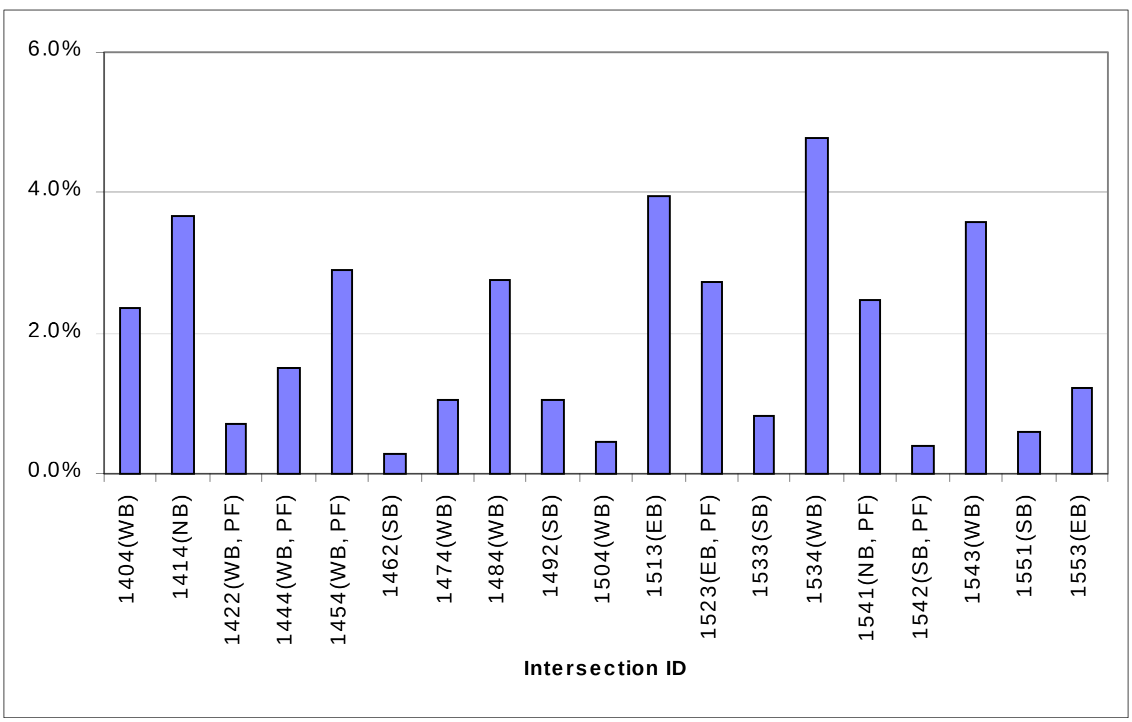


Figure 5-4
CITATIONS NOT ISSUED DUE TO WINDSHIELD GLARE

5.3.2 Clarity of Driver/Dark Vehicle Interiors

The percent of citations not issued due to dark vehicle interiors and poor clarity of driver's face were analyzed. The results for these factors by intersection are highly correlated as shown in Figures 5-3 and 5-4. A total of 4.1 percent of all recorded violations could not cited due to dark vehicle interiors. This problem results from the high degree of contrast between the vehicle interior lighting and the ambient outside lighting under strong daylight conditions. The camera exposure is adjusted automatically for the dominant ambient brightness outside the vehicle and, therefore, the interior of a vehicle tends to be under-exposed. This problem is more pronounced for vans and passenger cars with tinted windows where outside backlighting is blocked from the vehicle interior. Auxiliary flash units may be employed to mitigate the problem and reduce the number of citations not issued for this reason. The installation of auxiliary flash units at the intersections with the highest number of citations being not issued for dark vehicle interiors should be investigated.

The analysis of citations not issued for dark interiors also suggested that the problem could be related to the direction of travel being enforced. Six intersections that show higher percents of citations not issued due to dark interiors are oriented either westbound or eastbound. Cameras at four of these intersections are not equipped with polarizing filters.

The problem of poor clarity of the driver's face was the most common factor for not issuing citations, accounting for 8.5 percent of the total violations. California law requires that the driver's face be clearly visible in one of the photographs, usually the second photograph, in order for a citation to be issued. The direction of travel for the photo-enforced approaches at the intersections with the three highest citations not issued rates for poor clarity of the driver's face are either westbound or eastbound. None of the cameras at these intersections are equipped with polarizing filters.

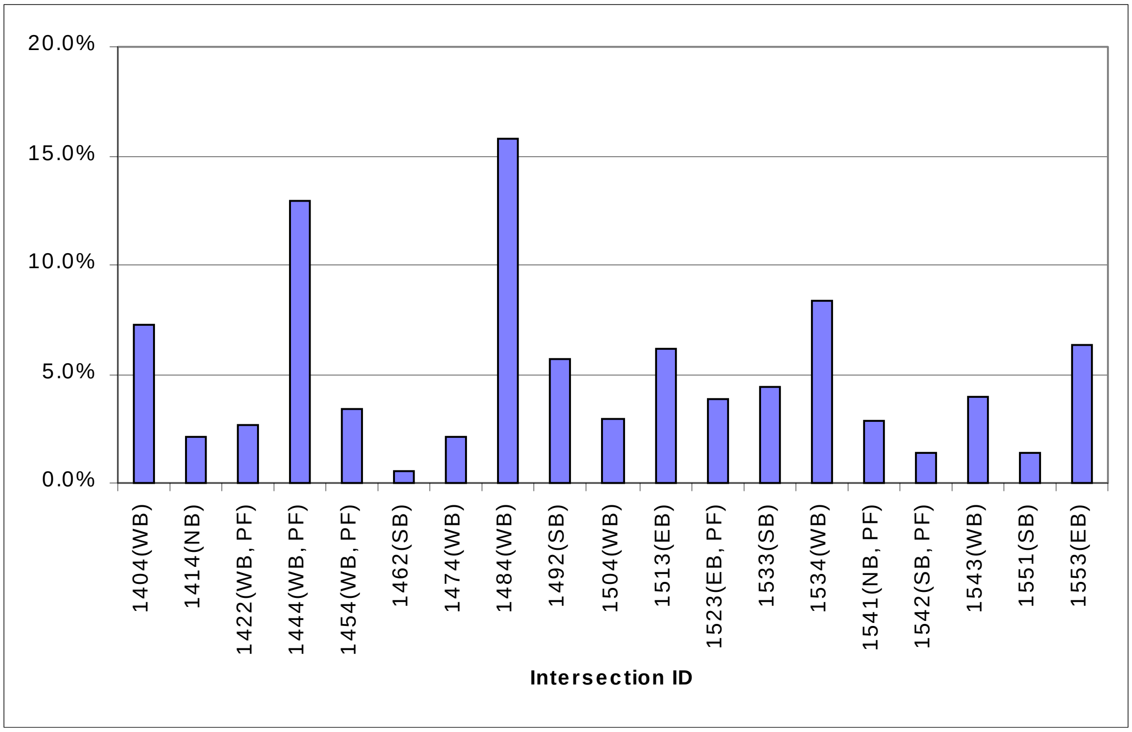


Figure 5-5
CITATIONS NOT ISSUED DUE TO DARK VEHICLE INTERIOR

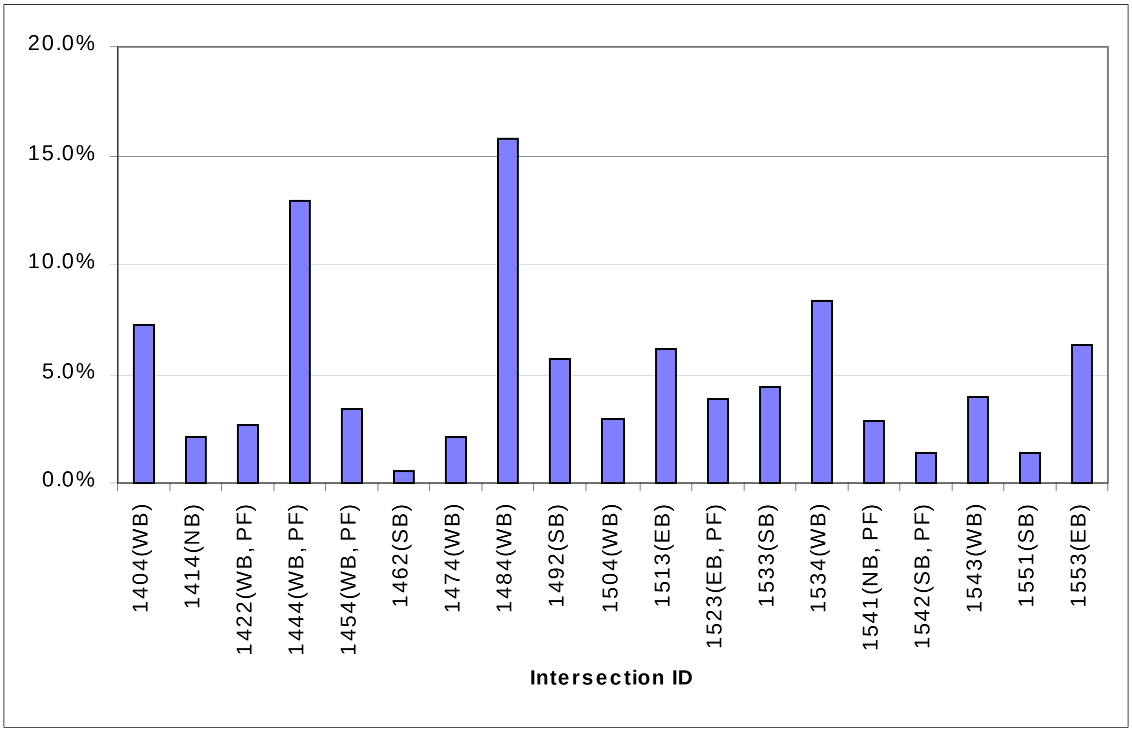


Figure 5-7
CITATIONS NOT ISSUED DUE TO POOR CLARITY OF DRIVER

5.4 ANALYSIS OF GEOMETRIC FACTORS

Problems of obstruction and framing are affected by the geometric relation between the picture object and camera such as camera location, height, focal length and perspective (angle and framing) of the camera. Specific features of an individual intersection such as intersection length, alignment, slope, loop placement, and obstacle structures and traffic conditions such as moving direction, proportions of heavy or large vehicles, and overall traffic demand can all affect the performance of the installed camera system.

5.4.1 Driver Obstruction

Driver obstruction is the second most common reason among the Intersection Dependant Factors that result in citations not being issued. Driver obstruction occurs when the driver's face is blocked by another vehicle, rear view mirror, sun visor, or vehicle roof. Figure 5-5 shows the percent of citations not issued due to obstructed views of the driver for each of the photo-enforced intersections. Intersections 1404 and 1504 show the highest percent values. The crossing streets of both of these intersections are narrow. The distances between the camera and violating vehicle at these intersections are relatively short and the vertical camera angle to the driver's face is steeper than those of other intersections with broader crossing streets.

It is possible that using a lower camera pole or relocating it further downstream from the intersection might provide an improvement for these intersections.

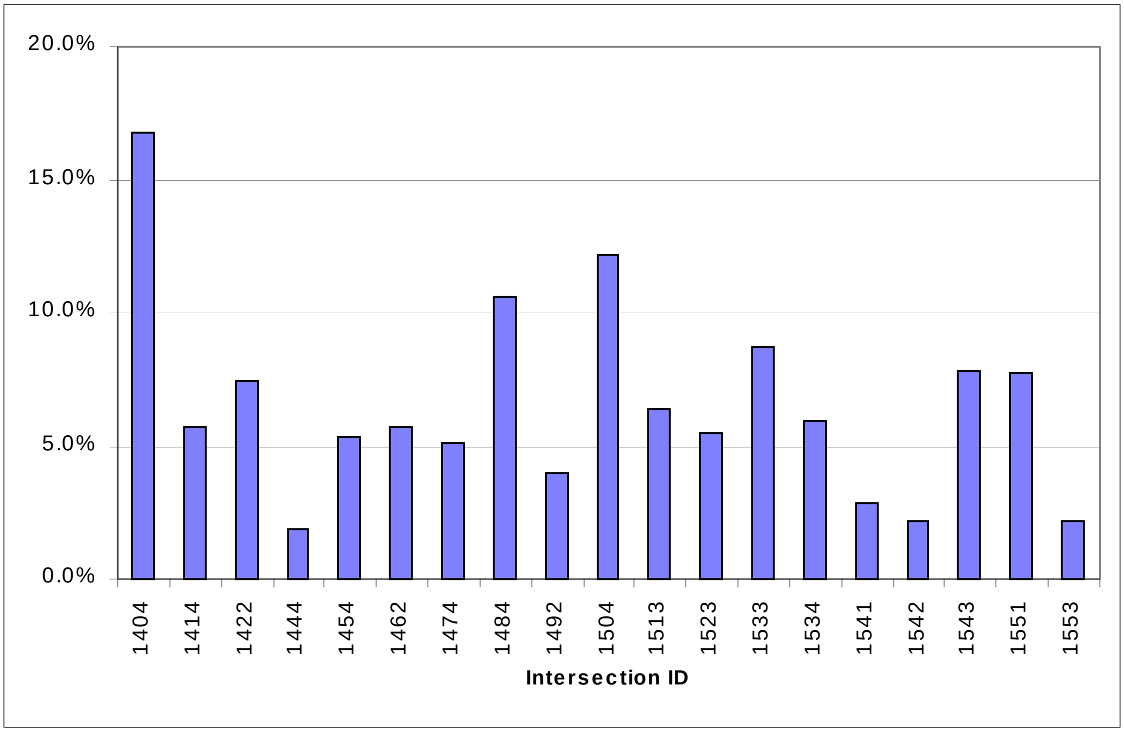


Figure 5-8
CITATIONS NOT ISSUED DUE TO DRIVER OBSTRUCTED

5.4.2 Vehicle And License Plate Obstruction

When the view of the license plate or vehicle is blocked by another vehicle further ahead in the intersection, it may not possible to issue a citation. Obstructed views of the vehicle and plate occur more frequently at locations where left-turn movements are being enforced. Figure 5-7 shows that the intersections where the highest percent of citations not issued due to obstructed views of the vehicle or license plate are 1474, 1492, 1513, 1533, and 1543, all locations where left-turn enforcement is being done.

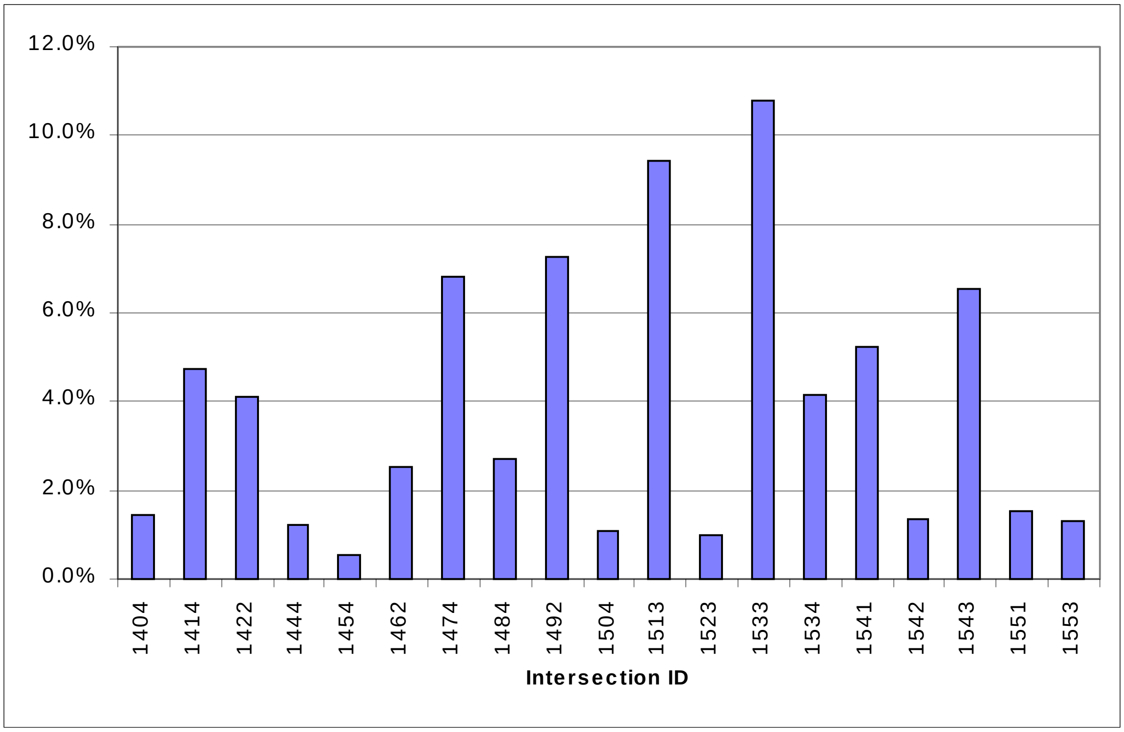


Figure 5-9
CITATIONS NOT ISSUED DUE TO LICENSE PLATE AND VEHICLE OBSTRUCTION

5.5 ANALYSIS OF FRAMING FACTORS

The license plate, vehicle, or driver's face is outside of the frame of the second photograph. Poor framing may be caused by a camera lens with a focal length that is too long, poor camera angle alignment, or intersection geometric factors that result in motorists speeding up, making irregular turning movements, or being close to the camera when the second photograph is taken. Figure 5-7 shows the variations in the citations not issued for framing reasons by intersection.

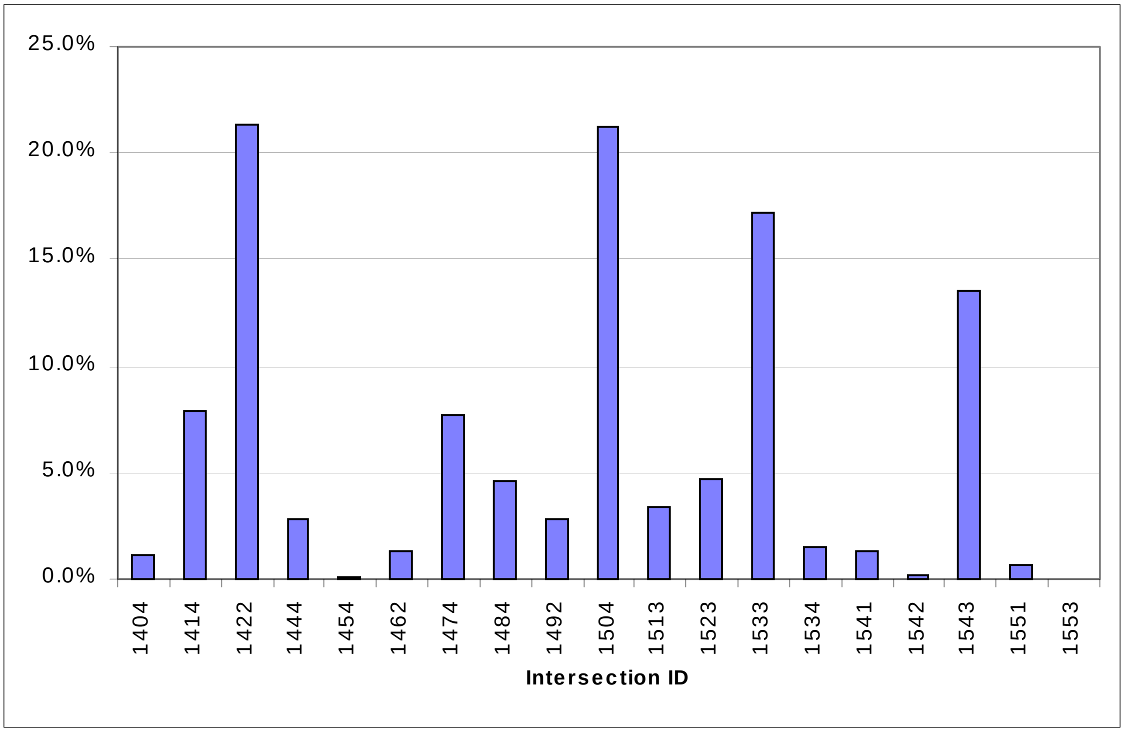


Figure 5-10
CITATIONS NOT ISSUED DUE TO FRAMING

Intersections 1422, 1533, and 1543 have experienced higher rates of citations not being issued due to framing problems. Enforcement at each of these intersections is for double left-turn lanes. For these locations, factors contributing to the higher rates of citations not issued are motorists speeding up as left turn movements are being completed (especially if being done against as red traffic signal), irregular turning movements, and a relatively shorter distance from the camera to the point where the second photograph is taken. Figure 5-8 summarizes the citations not issued data combined for obstruction and framing factors for this type of left turn lane enforcement, showing higher rates of citations not issued for left turns and left turns combined with through traffic enforcement.

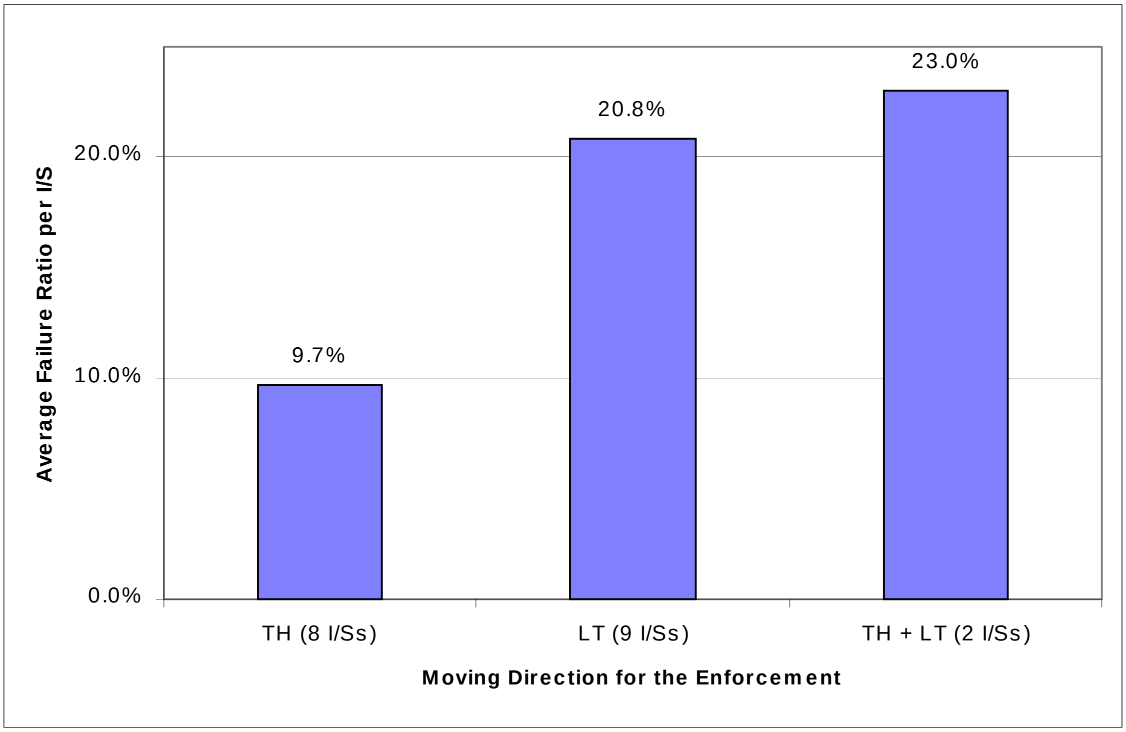


Figure 5-11
CITATIONS NOT ISSUED FOR OBSTRUCTION AND FRAMING FACTORS BY TYPE OF ENFORCEMENT

5.6 FINDINGS AND RECOMMENDATIONS FROM REVIEW OF PHOTOGRAPHIC DATA

- A total of 83,931 citations have been issued to motorists under the City's photo enforcement program. About one quarter of the citations have been issued for violations at one intersection, at North Harbor Drive and Grape Street, where the photo enforcement cameras monitor left turn movements.

  Citations are issued for approximately 36 percent of the possible violations recorded at the photo-enforced intersections. Accounting for the number of possible violations that are discarded after the grace period time allowances are applied, the percentage of recorded violations that are converted to citations is increased to 43 percent.

  The percent of citations issued varies from a low level of about 21 percent for the Imperial Avenue/Euclid Street (1484) and Miramar Road/Camino Ruiz (1534) intersections to a high level of about 54 percent at the intersection of Mission Boulevard and Garnet Avenue (1542). More than 50 percent of the violations recorded at the College Avenue/Montezuma Road (1462) and Black Mountain Road/Gemini Avenue (1551) intersections are cited.

- The largest number of citations not issued, amounting to 16.3 percent of the possible violations, is for no front license plate. This percentage is consistent with the levels reported by other photo enforcement programs. A portion of these violations could be cited with the installation of nearside cameras that are able to photograph the rear license plates of red light runners. With nearside cameras at each photo-enforced intersection, the number of issued citations each month would increase by approximately seven percent.

- Approximately 14 percent of the possible violations are discarded due to lighting and optical problems where the driver's face is not clearly visible in the second photograph as required by the California Vehicle Code. Auxiliary flash units could be installed to provide additional vehicle interior lighting at photo-enforced intersections where dark vehicle interiors are a recurring problem. It is also possible that polarizing filters could be employed at additional locations, especially for intersection approaches that are oriented east and west, to increase the number of citations issued.

  Approximately 23 percent of the possible violations are not cited because the driver's face, vehicle, or license plate is out of the frame of the photograph or is obstructed. These factors are more common at intersections where double left turn lane movements are being enforced.

  The City and its contractor, LM/ACS, should address these various problems at the photo-enforced intersections, one at a time, using photographic data to analyze the nature of problems, to develop improvement strategies, and to evaluate whether the improvements have been effective.

- The City should review the other photo enforcement systems that are currently being deployed in California and other States. New photo enforcement technologies have become available over the past five years, most notably technologies that employ digital camera equipment where photographic data, including streamed video clips, may be immediately downloaded for processing using T-1 telephone line or microwave communications. Additionally, photo enforcement systems that use non-intrusive vehicle detection methods as well as systems that employ overhead camera placements and floodlighting equipment as an alternative to the curb-based placements used for the San Diego program are being tested by cities throughout California and elsewhere.

6.0 TRAFFIC ENGINEERING AND TRAFFIC OPERATIONS IMPROVEMENTS

The deployment of photo enforcement cameras is one approach available to traffic engineering and law enforcement professionals to enhancing safety at signalized intersections by reducing the number of red light running violations. Data from other photo enforcement programs, as well as data from the City's program as reported in Section 2 of this report, indicates that photo enforcement is effective in reducing red light running violations and accidents caused by motorists running red lights.

However, photo enforcement cameras need to be viewed as one element of the overall traffic operations management infrastructure at the signalized intersections where they are installed. Changes in traffic signal timing, done to enhance traffic operations and safety, may significantly impact the operation of the photo enforcement system. This has occurred in connection with the City's photo enforcement program where changes in the yellow change interval times, implemented by the City's Traffic Engineering Department under that Department's on-going program to review and adjust yellow times, resulted in substantial reductions in the number of red light running violations and questions from ticketed motorists about the program's overall fairness and objectives.

Additionally, changes in traffic signal timing as well as other traffic engineering improvements may also be applied to reduce the incidence of red light running at signalized intersections and, more generally, to enhance public safety at intersections equipped with traffic signals. There are other alternatives to the installation of photo enforcement cameras as a deterrent to red light running at signalized intersections. While photo enforcement cameras will serve to reduce the incidence of red light running violations, comprehensive traffic safety improvement programs are normally built around the three E's of Enforcement, Engineering, and Education and all can be expected to play a role in improving traffic safety. Red light running is clearly one example of risky driving behavior that impacts traffic safety and should be modified but how can this best be achieved? How can intersection safety best be improved?

In this section, the interrelationships between photo enforcement systems and traffic engineering and traffic operations improvements are reviewed. Specifically, the section addresses the following items:

- Yellow change intervals;
- Red clearance intervals; and
- Alternative traffic engineering improvements to reduce red light running.

6.1 YELLOW CHANGE INTERVAL

The purpose of the yellow signal indication is to warn approaching traffic of the imminent change in the assignment of right-of-way. The length of the yellow change interval is determined in such a way that the interval provides enough time for a vehicle to travel at its initial speed through the intersection before the traffic signal turns red or to allow a motorist to stop at a comfortable average deceleration before entering the intersection. Generally, long yellow times are not favored since they may encourage drivers to use it as part of the green time. The Millennium Manual On Uniform Traffic Control Devices (MUTCD) provides that yellow change should be between three and six seconds with the longer intervals being reserved for approaches with higher speeds.

The value chosen should account for driver perception and reaction times, traffic speeds, typical deceleration rates, and grades on the intersection approaches. The City's Traffic Engineering Department employs a method for calculating yellow change intervals that accounts for each of the relevant variables.

It is required that the yellow times at photo-enforced intersections be in compliance with Caltrans Traffic Manual standards for the determination of yellow change intervals. With the release of the Millennium MUTCD, Caltrans standards are the same as those provided by the Millennium MUTCD.

6.1.1 Verification of Yellow Change Intervals

As part of this review, the length of the yellow change intervals at each of the 19 photo-enforced intersections were measured in the field and the field measurements were compared against the both the City's standard and Caltrans Traffic Manual guidelines for yellow change intervals at signalized intersections.

The City of San Diego Traffic Engineering Department provided PBF with the data required to apply the City's standard for yellow times and to verify the actual yellow times. The data presented on Table 6-1 summarizes the data required to calculate yellow times using the City's standard. The data in Table 6-1 includes the yellow times before and after the effective startup date of the photo enforcement system, yellow times taken from the City's traffic signal timing charts, the 85th percentile speeds taken from the most recent speed survey, the posted speed limits, and the range of cycle lengths for the coordinated signal operations. Only one of the 19 photo-enforced intersections, Bernardo Center Drive at Rancho Bernardo, is not included in a coordinated signal system. This intersection operates under fully actuated traffic signal control.

The yellow times at each of the intersections was checked using a stopwatch and collection of 10 samples for each of the red light enforcement movements. Table 6-2 presents the results of the field measurements and provides a comparison of the field measured yellow times to yellow times shown on the City's signal timing charts. A review of Table 6-2 shows that the yellow times observed in the field are generally the same the times shown on the City's timing sheets.

Also shown on Table 6-2 is the yellow time based on the City's adopted guideline for the determination of yellow times. The City's guideline is taken from Determining Vehicle Signal Change and Clearance Intervals prepared by the ITE Technical Council Task Force 4TF-1, dated August 1994. The formula used by the City is as follows:

$$y = t + \frac{V}{2a + 2Gg}$$

where: y = length of the yellow time change interval, to the nearest 0.1 second;

t = driver perception/ reaction time, generally assumed as 1.0 second;

V = speed of approaching vehicle, in ft/sec (m/sec), input as the higher of the 85th percentile speed or posted speed limit;

a = average deceleration, assumed for 10 ft/sec^2 (3.0 m/sec^2) to 15 ft/sec^2 (4.5 m/sec^2) (City uses 10 ft/sec^2);

Table 6-1
SUMMARY OF SIGNAL TIMING, SPEED AND SIGNAL CYCLES AT PHOTO-ENFORCED INTERSECTIONS

Code	Location	Effective Turn On Date	Yellow Time Prior To Turn On Date	Yellow Time After Turn On Date	Traffic Speed - 85th Percentile	Posted Speed Limit	Signal Cycle Length
1404	WB El Cajon Boulevard at 43rd Street	07/30/98	3.50	3.70	34	35	120 to 140
1444	WB Harbor Drive at 32nd Street	12/07/98	4.50	4.50	50	40	110 to 120
1454	WB Garnet Avenue At Ingraham Avenue	12/07/98	3.00	3.20	27	30	100 to 120
1484	WB Imperial Avenue at Euclid Avenue	04/02/99	4.10	4.10	42	35	110 to 120
1504	WB F Street at 16th Street	04/02/99	3.30	4.90	N/A	25	70
1523	EB A Street at 10th Avenue	02/24/00	4.90	3.30	N/A	25	70
1534	WB Miramar Road at Camino Ruiz	02/24/00	4.80	4.80	48	45	96 to 130
1542	SB Mission Blvd. at Garnet Avenue	05/19/00	3.00	3.70	37	35	100 to 120
1551	SB Black Mountain Road at Gemini Avenue	04/20/00	3.80	3.80	43	35	120 to 160
1553	EB Mira Mesa Boulevard at Scranton Road	04/20/00	3.90	4.30	40	45	180
1414	NB Bernardo Center Drive to WB Rancho Bernardo Road	07/30/98	3.00	3.00	39	35	Fully Actuated
1422	WB Aero Drive to SB Murphy Canyon Road	07/30/98	3.00	3.00	49	45	100 to 120
1462	SB College Avenue to Montezuma Road	12/07/98	3.00	3.00	38	35	104 to 110
1474	WB La Jolla Village Drive to Towne Center Drive	12/07/98	3.00	3.00	50	45	138 to 150
1492	SB Black Mountain Road. to Mira Mesa Boulevard	04/02/99	3.00	3.00	43	35	120 to 160
1513	EB Garnet Avenue to NB Mission Bay Drive	04/02/99	3.00	3.00	31	35	150 to 200
1533	North SB Harbor Drive to EB Grape Street	10/07/99	3.00	3.00	43	35	80 to 105
1541	NB Mission Bay Drive to WB Grand Avenue	05/19/00	3.00	4.70	50	45	75 to 100
1543	EB Carmel Mountain Road to NB Rancho Carmel Drive	02/24/00	3.00	3.00	38	45	120 to125

N/A = Not Available (Business District)

Table 6-2
SUMMARY OF YELLOW CHANGE INTERVALS

Code	Location	Field Survey Dates	Average Yellow Time (a)	Yellow Time After Turn On Date	Caltrans Traffic Manual	Yellow Time Equals Or Exceeds Caltrans Standard	City Standard Yellow Time	Yellow Time Equals Or Exceeds City Standard
1404	WB El Cajon Boulevard at 43rd Street	09/27/01	3.75	3.7	3.5	YES	3.6	YES
1444	WB Harbor Drive at 32nd Street	10/01/01	4.52	4.5	4.7	NO	4.7	NO
1454	WB Garnet Avenue at Ingraham Avenue	09/26/01	3.25	3.2	3.1	YES	3.2	YES
1484	WB Imperial Avenue at Euclid Avenue	10/01/01	4.07	4.1	4.0	YES	4.1	YES
1504	WB F Street at 16th Street	09/26/01	4.91	4.9	3.1 (b)	YES	3.1	YES
1523	EB A Street at 10th Avenue	10/01/01	3.33	3.3	3.1 (b)	YES	3.0	YES
1534	WB Miramar Road at Camino Ruiz	09/25/01	4.79	4.8	4.5	YES	4.5	YES
1542	SB Mission Boulevard at Garnet Avenue	09/26/01	3.63	3.7	3.7	YES	3.7	YES
1551	SB Black Mountain Road at Gemini Avenue	09/25/01	3.69	3.8	4.1	NO	4.2	NO
1553	EB Mira Mesa Boulevard at Scranton Road	09/25/01	4.12	4.3	3.9	YES	4.3	YES
1414	NB Bernardo Center Drive to WB Rancho Bernardo Road	09/25/01	3.01	3.0	3.1 (c)	NO	3.0	YES
1422	WB Aero Drive to SB Murphy Canyon Road	09/25/01	3.08	3.0	3.1 (c)	NO	3.0	YES
1462	SB College Avenue to Montezuma Road	09/26/01	3.03	3.0	3.1 (c)	NO	3.0	YES
1474	WB La Jolla Village Drive at Towne Center Dr.	10/03/01	3.01	3.0	3.1 (c)	NO	3.0	YES
1492	SB Black Mountain Road to Mira Mesa Blvd.	09/26/01	3.07	3.0	3.1 (c)	NO	3.0	YES
1513	EB Garnet Avenue to NB Mission Bay Drive	09/25/01	3.07	3.0	3.1 (c)	NO	3.0	YES
1533	North SB Harbor Drive to EB Grape Street	10/01/01	3.03	3.0	3.1 (c)	NO	3.0	YES
1541	NB Mission Bay Drive to WB Grand Avenue	09/25/01	4.67	4.7	3.1 (c)	YES	3.0	YES
1543	EB Carmel Mountain Road to NB Rancho Carmel Drive	09/25/01	3.20	3.0	3.1 (c)	NO	3.0	YES

NOTE: (a) Average yellow time represents the average of the field measurement of ten (10) yellow times collected in the field using a digital stopwatch.
(b) Based on posted speed limit, not on 85th percentile speed.
(c) Based on estimated 25 miles per hour for protected left turn movements.

g = acceleration due to gravity, 32 ft/sec^2 (9.81 m/sec^2); and

G = grade of approach, in percent divided by 100 (downhill is negative grade).

As shown in Table 6-2, it was determined that the actual yellow times were equal to or higher than the actual yellow times at all but two intersections where photo enforcement cameras are installed. The intersections where the yellow times were lower than the City's guideline were at Harbor Drive and 32nd Street (4.5 seconds actual versus 4.7 seconds per City's guideline) and Black Mountain Road and Gemini Avenue (3.7 seconds actual versus 4.2 seconds per City's guideline).

It was also observed that the measured time at the intersection of Mira Mesa Boulevard and Scranton Road was slightly lower than the yellow time shown on the City's signal timing sheets but this difference is not significant.

6.1.2 Longer Yellow Change Intervals

Findings from the studies conducted by the Insurance Institute For Highway Safety indicate that increasing the length of the yellow change interval significantly decreased the frequency of red light running, at least in the short term after the length of the yellow change interval was increased. These and other research studies have reported between 70 and 82 percent of all red light violations happen in less than 1.5 seconds after the yellow signal indication. Longer yellow change intervals serve to reduce red light violations and the potential that they introduce for collisions.

The research studies also found that intentional violators are not deterred by the length of the yellow change interval and red light running is still frequent at intersections, where the yellow change interval is as much as 40 percent greater than the intervals recommended by the ITE guidelines. Intentional violators use the yellow change interval intentionally and recurrently as a part of the green interval. On the other hand, longer yellow change intervals do serve to reduce the number of violations by unintentional violators. Although compliance with the longer yellow change intervals may eventually deteriorate, it is believed that the reductions observed for unintentional violators are sustained over extended time periods.

The yellow change intervals were modified at six photo-enforced intersections after the startup of the City's photo enforcement program. These modifications were done as part of the City Traffic Engineering Department's on-going review and adjustment of the yellow change intervals throughout the City and were not related to the photo enforcement program.

A comparison of the numbers of red light running violations before and after the modifications in the yellow change intervals at the five photo enforced intersections confirms the findings of the Insurance Institute's research studies. The before and after violations data is shown in Figure 6-1.

The most significant change in the number of violations occurred at the intersection of Mission Bay Drive and Grand (1541) where the yellow change interval was extended from 3.1 seconds to 4.7 seconds. This change resulted in an 88-percent decrease in the number of violations. At the five other intersections, the number of violations dropped significantly in response to longer yellow times.

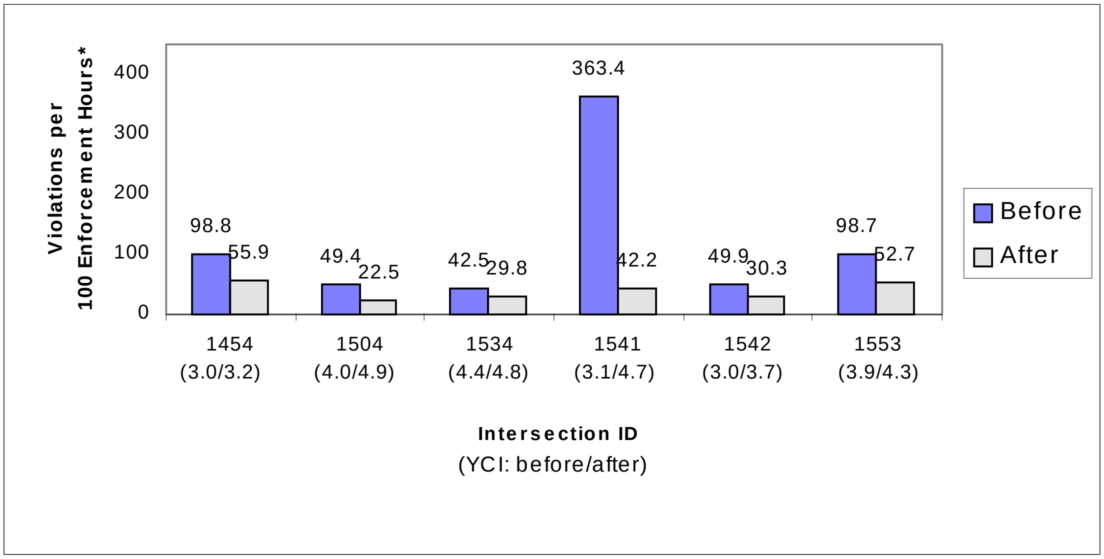


Figure 6-1
VIOLATIONS DATA FOR SELECTED PHOTO ENFORCED INTERSECTIONS BEFORE AND AFTER YELLOW CHANGE INTERVAL MODIFICATIONS

6.2 RED CLEARANCE INTERVAL

All traffic signals in the City employ a one-second red clearance interval at the end of each phase, before green signal indications are given to the opposing traffic phase. For purposes of photographing violators and issuing citations, the one-second red clearance interval is considered as a red signal.

The red clearance interval is not intended to reduce the incidence of red light running; it is a safety measure that separates the last red light runner from the first green light runner for one or two critical seconds, which is sufficient to prevent a collision in most cases. Studies conducted by the Insurance Institute For Highway Safety found that the use of the red clearance interval appeared to be effective in reducing the number of right angle collisions, also noting that a large proportion of red light runners tend to be shortly after the red light is displayed.

The Millennium MUTCD guidance is that the red clearance interval should not exceed six seconds in length.

6.3 RED LIGHT RUNNING ALTERNATIVE MEASURES

One of the recent studies of red light running by the Insurance Institute For Highway Safety determined that red light running tends to be recurrent among certain drivers. The study found that the typical red light runner was younger, less likely to wear safety belts, have a poorer driving record, and drove smaller and older vehicles than drivers who stopped for red lights. They were more than three times as likely to have multiple speed convictions on their driving records. The study concluded that red light violators are a "higher risk group" that merits enforcement resources not only because of the violation itself and its danger, but also because of their higher risk characteristics in general.

The existence of this intentional red light running group of drivers indicates that engineering countermeasures would have limited ability to change this behavior. For this group, enforcement and education need to be pursued with determination. Unintentional red light runners may however be assisted by traffic engineering or operational improvements to intersections. These should also be identified, prioritized, and implemented as appropriate.

Researchers at the Texas Transportation Institute classified red light runners as shown in Table 6-1. This table also summarizes the expected effectiveness of countermeasure alternatives for the types of red light runners and the conditions contributing to red light running.

Table 6-3
RED LIGHT RUNNING DRIVER TYPES AND POSSIBLE COUNTERMEASURES

<table>
<tr><th colspan="2" rowspan="2">Red Light Running Driver Type</th><th rowspan="2">Possible Scenario</th><th colspan="2">Type Of Countermeasure</th></tr>
<tr><th>Engineering</th><th>Enforcement</th></tr>
<tr><td colspan="2">Intentional</td><td>Congested, Cycle Overflow, Habitual</td><td>Less Effective</td><td>Most Effective</td></tr>
<tr><td rowspan="2">Unintentional</td><td>Type A</td><td>Unable To Stop Due To Speed Or Other Factors</td><td rowspan="2">Most Effective</td><td rowspan="2">Less Effective</td></tr>
<tr><td>Type B</td><td>Inattentive</td></tr>
</table>

Source: Texas Transportation Institute

The literature suggests a broad consensus that automated enforcement is a practical means of reducing red light running and increasing safety at intersections. However, it should not be introduced in isolation from a package of measures all aimed at improving intersection safety. Additional countermeasures that may be considered as an alternative to or in addition to the use of photo enforcement cameras are the following.

6.3.1 Enhanced Advance Warning Signs

Caltrans standard photo enforcement signs are located at each of the photo-enforced intersections. However, warning signs installed in advance of the intersections on the photo-enforced approaches can also be used to alert motorists and this approach is more commonly used by cities in the State of California. The sign at the intersection serves as an additional reinforcement that photo enforcement cameras are being used. Advance warning is of importance to both intentional and unintentional violators and should contribute to a reduction in the number of violations by both groups as well as providing additional public education and fair warning that photo enforcement cameras are being used.

6.3.2 Advanced Flashing Yellow Light Installation.

Where motorists unintentionally enter an intersection on a yellow or red signal indication, some of the factors that may contribute to this action may include the following:

- Weather conditions;
- Pavement conditions;
- Inattention or distractions;
- Vehicle speed;

- Vehicle distance from intersection; and
- Vehicle type.

The use of advanced yellow flashing lights may reduce the number of red light violations at an intersection. These traffic control devices are situated well in advance of an intersection and only flash at approaching motorists when the signal indication is about to turn yellow. This operation is different than the typical flashing yellow light in advance of an intersection that simply warns of the existence of the signalized intersection or a potentially hazardous condition.

Advanced warning flashers and their effect on red-light-running violations was studied in Bloomington, Minnesota. The intersection of U.S. Highway 169 and Pioneer Trail was chosen as a case study intersection based on its recent accident history, perceived and observed occurrences of red light running, traffic speeds, traffic mixture, and ease of equipment installation. The advanced warning flashers were used for approximately three months. Red light running violations data was collected before, during, and after the use of warning flashers. It was determined that the installation of the advanced yellow flashing lights reduced red light running violations at the intersection by 29 percent overall and, for trucks, by an impressive 63 percent.

6.3.3 In Pavement Warning Lights

The City of Anaheim recently completed an evaluation of the use of in-pavement warning lights at a signalized intersection used by the rubber-tired tram vehicles that transport visitors to Disneyland between the parking areas and the park facilities. The evaluation was done under the oversight of the California Traffic Control Devices Committee. For the evaluation project, in-pavement warning lights were installed in advance of the stop line on both approaches to the intersection where the tram vehicles crossed. Before and after data was collected regarding red light running violations and a significant reduction in the number of red light running violations was recorded.

The Millennium MUTCD limits the application of in-pavement warning lights to pedestrian crosswalks at intersections that are not controlled by traffic signals or other traffic control devices. Their use as a possible deterrent to red light running at signalized intersections is not approved except under experimental conditions as done in the City of Anaheim.

6.3.4 Cross Street Green Delay Time

Photo enforcement systems deployed in the cities of Irvine and Culver City provide for a one-second delay or hold on the intersecting street green time when a red light running violation is detected. While this feature does not serve to reduce the number of red light running violations, it does provide an effective means to reducing the likelihood that the red light running violation will result in a collision.

6.3.5 Coordinated Traffic Signal Operations

A coordinated traffic signal operation where motorists are able to move smoothly in platoons from intersection to intersection reduces the risk of a red light running violations and collisions resulting from red light running violations. The traffic signals at 18 of the City's photo-enforced intersections are coordinated with the traffic signals at adjacent intersections.

Longer signal cycle times may also be a contributing factor to red light running as motorists become impatient or elect to not wait for the next cycle to enter an intersection. However, longer cycle times are necessary to provide the necessary capacity to accommodate the traffic volumes that use the City's arterial street network, especially during the peak periods.

6.3.6 Recap

Table 6-2 below summarizes the red light running countermeasures and the manner in which they can be expected to promote traffic safety by influencing different types of behavior. As can be seen, unintentional red light running is more susceptible to traffic engineering and operation measures while photo enforcement is considered to be the most effective mechanism for reducing red light running violations by intentional violators.

Table 6-4
SUMMARY OF SELECTED ENGINEERING COUNTERMEASURES

Countermeasure	Reduce Intentional Violations	Reduce Unintentional Violations	Reduce Right-Angle Collisions
Longer Yellow Change Interval	Less Effective	Most Effective	Effective
Red Clearance Interval	No Difference	No Difference	Effective
Enhanced Advance Warning Signs	Less Effective	Probably Effective	Probably Effective
Advance Warning Flashing Lights	Less Effective	Probably Effective	Probably Effective
In-Pavement Warning Lights	Less Effective	May Be Effective	May Be Effective
Cross Street Green Delay Time	No Difference	No Difference	No Difference
Coordinated Traffic Signal Operation	Effective	Effective	Effective
Red Light Camera Enforcement	Most Effective	Most Effective	Most Effective

6.4 TOP PRIORITY INTERSECTIONS FOR TRAFFIC SAFETY IMPROVEMENTS

The City Traffic Engineering Department reviews accident data for the City's 1,500 signalized intersections and, on an annual basis, prepares a list that identifies the City's "top priority" locations where traffic safety improvements are needed. The locations are selected on the basis of accident data and community inputs regarding potentially hazardous locations. A diagnostic review is conducted for each of these "top priority" locations and appropriate improvements are recommended.

The types of improvements may include changes in traffic signal timing, the installation of additional traffic control devices including traffic signals at intersections that are not signalized, signing and striping improvements, pedestrian-oriented treatments, and street modifications or widening.

6.5 FINDINGS AND RECOMMENDATIONS

- The actual yellow change intervals at 17 of the photo-enforced intersections are equal to or higher than yellow times calculated using the City's guidelines. The intersections where the yellow times were lower than the City's guideline were at Harbor Drive and

32nd Street (4.5 seconds actual versus 4.7 seconds per City's guideline) and Black Mountain Road and Gemini Avenue (3.7 seconds actual versus 4.2 seconds per City's guideline).

Speed surveys should be done for the approaches at the two intersections where the yellow times did not meet the City's guidelines in order to re-calculate the yellow times for these intersections. The yellow times should be adjusted accordingly when the yellow times have been re-calculated.

- SB 667 requires that the yellow change intervals be based on the Caltrans Traffic Manual. The yellow change intervals at 10 of the 19 photo-enforced intersections are shorter than the yellow times specified by the Caltrans Traffic Manual. Eight of the yellow change intervals that are not in compliance are for left turns where the Caltrans Traffic Manual specifies a minimum yellow time of 3.1 seconds, as opposed to 3.0 seconds per the City guidelines.

  Before the photo enforcement systems is re-started, it will be necessary to adjust the yellow change intervals to be in compliance with the Caltrans Traffic Manual, including any changes being implemented or considered for the Caltrans Traffic Manual that may be required for compliance with the Millennium MUTCD.

- It is a key recommendation of this review that the City's Police Department work more closely with the City's Traffic Engineering Department to develop a comprehensive methodology for the deployment of photo enforcement cameras in the City, building upon the Traffic Engineering Department's on-going traffic safety improvement program and resulting in the future deployment of photo enforcement cameras within the context of an overall traffic safety improvement program; to ensure that the yellow change intervals at photo-enforced intersections are adjusted in accordance with the City's guidelines; to coordinate photo enforcement system installations so that vehicle detection is provided for both photo enforcement and traffic signal control applications without one adversely impacting the other; and to reinforce the mutual interests and capabilities of the City's law enforcement and traffic engineering professionals to develop an overall traffic safety improvement program for the City that is a model for other cities and agencies throughout California.

7.0 SYSTEM POLICIES AND MANAGEMENT

Policies and procedures employed by the City Police Department and by LM/ACS governing the management of the program were reviewed and considered from the point of view of the many stakeholders involved in the deployment and operation of the City's photo enforcement system.

7.1 METHODOLOGY

LM/ACS personnel involved in the management and administration of the photo enforcement system were interviewed at the beginning of the project. At that time, the full procedures for administering the system were explained and demonstrated. The initial interviews were followed up with subsequent visits to the LM/ACS facility to collect data, conduct audits of photographic and equipment maintenance records, and to examine the procedures that are in place for the photo enforcement program.

Additionally, selected individuals at the San Diego Police Department Traffic Division were interviewed to determine the full scope of the procedures, review the history of the program and its development, and to examine the City's program management procedures. City Traffic Engineering Department officials were also interviewed for insights into their involvement with the photo enforcement equipment installations, loop installations, traffic signal timing adjustments made at certain photo-enforced intersections, and on-going traffic safety improvement activities.

Lastly, a representative of the San Diego Superior Court was also interviewed to review selected aspects of the Court's experience with the program.

Data from photo enforcement programs underway in other cities in California and elsewhere in the United States were obtained and used in this review. A review of these photo enforcement programs was undertaken to determine if methods used to deploy systems in San Diego are similar or different to those used in other parts of California and elsewhere and the extent to which their experience could be incorporated into an expanded program for the City of San Diego.

7.2 PHOTO ENFORCEMENT SYSTEM OPERATIONS

LM/ACS is responsible for the day-to-day operations and maintenance of the photo enforcement system, under the overall direction of the City Police Department. In this capacity, LM/ACS is responsible for the following functions:

- Collect camera film and data for 19 photo-enforced intersections
- Inspect camera and vehicle detection system operations
- Perform preventative maintenance and cleaning
- Identify defective equipment and make repairs or replace
- Process film and memory card data
- Identify violations
- Identify vehicle registered owner
- Prepare citations for Police Department review and approval
- Mail citations
- Answer telephone inquiries
- Schedule violator appointments

- Process Section D citations
- Provide court-requested information and support court hearings
- Prepare monthly progress reports

In conducting this review, PBF examined the procedures used by LM/ACS in connection with the City's photo enforcement program and, additionally, audited a sample of violations from the LM/ACS violations database as well as selected camera unit service and equipment repair records.

From the project team observations and audit results, the procedures and methods applied by LM/ACS are generally proper and being applied in a timely manner consistent with the requirements of the California Vehicle Code. The procedures and methods are designed to ensure the chain of evidence for each recorded violation so that backup data and documentation can be easily retrieved when needed. Internal quality control is maintained by a double blind internal review of each violation. Additionally, all citations prepared by LM/ACS are reviewed and approved by the Police Department before they are issued. It is noted that LM/ACS provides similar system operation and citation processing services to a number of other cities in California and elsewhere using, for the most part, the same internal procedures and methods.

The major deficiency identified in the system operating procedures relates to the difficulties experienced as a result of the vehicle detection loops being moved at three intersections without corresponding adjustments in the pitch calculations and citation preparation guidelines. These difficulties were the result of a significant breakdown in the communications between LM/ACS and the City Police Department. However, it should be pointed out that the re-location of these loops and the implications of their re-location was of much greater importance for the City, because of the unique loop configuration used at the City's photo-enforced intersections, than would be the case for other installations where the vehicle detection loops are configured in accordance with the manufacturer's recommendations and established photo enforcement practice.

In addition to the internal procedures and methods used by LM/ACS, it is perhaps more important that the Police Department procedures be comprehensive, clearly documented in writing, and followed without exception to the maximum extent possible. In particular, the procedures should address in detail the following items:

- Guidelines to be applied for issuing a citation, in other words, a very specific definition of what constitutes a red light running violation;
- Citation review and approval requirements, including provisions for the procedure to be used when the time to review is shortened, traffic officers are not available to conduct the reviews, or the number of citations is larger than usual; and
- Quality assurance audits, to be conducted by trained traffic officers for randomly selected sample of recorded violations on a periodic basis.

It is also possible that the City could take on added responsibilities for certain system operations and citation processing functions. These functions can be done internally or by outsourcing as is currently done by the City.

7.3 PHOTO ENFORCMENT SYSTEM MAINTENANCE

When operating, each camera unit is serviced every 2-3 days depending on the number of photographs taken. The date and time of service, the location code and camera unit number, and the total number of exposures are recorded in the service log. The film and memory card are removed from the camera unit and replaced. The camera unit and cabinet interior are cleaned and the condition of the pole, cabinet, loops, camera unit, and warning signs are inspected and noted in the service log. At the end of the servicing, the camera unit is activated in its “test” mode and, if operating correctly, it is noted that the camera unit was observed to be functioning correctly.

LM/ACS has carried out the required equipment servicing and inspection functions since the system startup. LM/ACS has maintained service and inspection logs for the photo enforcement equipment installed at the 19 intersections from the period of their installation to the time at which the cameras were turned off in June 2001. The equipment service logs were reviewed for the three months of operation before the system was turned off for selected intersections. From the service logs, there was no indication of any unusual equipment malfunctions or problem areas during this period. The service logs also confirmed that LM/ACS was carrying out its equipment service and inspection functions as required.

7.4 PUBLIC AWARENESS AND INFORMATION

One of the most important aspects of a successful photo enforcement program is effective public awareness and information campaign. Research has indicated that public information campaigns may “make or break” automated red light enforcement programs and that some programs, in the past, have discontinued operations due to a lack of public support.

According to a study recently completed by the Federal Highway Administration, a public awareness and information campaign is needed to accomplish three objectives in connection with the implementation of photo enforcement programs. First, public awareness and information will make citizens more aware of their driving patterns and may help stimulate a voluntary change in behavior at signalized intersections. Second, open communications through a variety of media with the public and with elected officials in explaining program objectives as well as program results will be critical to gain public support for program expansion. Lastly, public awareness and information will provide motorists with advance warning that there is increased enforcement on the street. This, by itself, may cause a shift in driving patterns but should also serve to limit the amount of hostility and bad feelings towards these systems. Photo enforcement programs will not succeed if they become associated with the outdated image of a small town police officer parked behind a billboard at the edge of town, waiting for unsuspecting motorists. Without an appropriate educational campaign, motorists may be surprised or confused when they receive a citation. If questions or concerns can be effectively answered through written, telephone, or web-based information, motorists receiving citations will be more supportive of the program and less likely to become hostile and question the program’s overall objectives.

A review of literature found that public awareness and information campaigns are frequently used prior to and during the development of a photo enforcement program. The campaigns often employ a variety of methods in an effort to reach as many citizens as possible. The extent of the campaigns, however, varies among the jurisdictions where photo enforcement systems have been deployed. Table 7-1 identifies some of the more commonly used methods to increase public awareness and provide information.

Table 7-1
PUBLIC AWARENESS AND EDUCATION CAMPAIGN ELEMENTS USED BY SELECTED PHOTO ENFORCEMENT PROGRAMS

Jurisdiction	Posters	Mailings	Hand outs	Media	Warning Notices	Billboards	Warning Sings	Press Releases	Slogans	Bumper Stickers
Charlotte	X	X	X	X	X	X	X	X	X	X
Fairfax		X		X	X		X	X		
Howard County	X		X	X	X		X			
Lincoln				X		X				
New York				X	X		X			
Oxnard	X		X	X					X	X
Polk County					X		X			
San Francisco				X	X	X	X	X		X
San Diego		*X*		*X*			*X*	*X*		

According to the Federal Highway Administration, a recent poll conducted for Advocates For Highway And Auto Safety found that “65 percent of Americans favored adoption of legislation to allow use of red light cameras”. Support for the use of photo enforcement cameras is above 80 percent in larger cities and communities with established photo enforcement programs.

The City of San Francisco has a continuing public outreach and information campaign in connection with the City’s photo enforcement program and monitors progress in terms of public awareness and acceptance through regular surveys. Fairness through uniform geographical coverage as well as an overall approach to enhancing traffic safety that includes intersection improvements, traffic signal timing adjustments, and the use of photo enforcement cameras are elements of the philosophy that is being developed in San Francisco.

San Diego’s efforts to increase public awareness and information appear to have been limited. An informational mailer that described the program was included in utility bills at the startup of the program. Some information about the program is included in the citation package. Two surveys of public opinion have been conducted. In 1998 as the program was starting, 45 percent of those responding to the survey were strongly in favor of the City’s photo enforcement program. However, by February 2000 when the second survey was conducted, the approval rating had slipped to 41 percent. The adverse media coverage for the program has been extensive while the benefits from reduced red light running and fewer collisions attributable to red light running have received little publicity.

An important aspect of the public awareness and information campaign relates to the telephone information procedures used by LM/ACS for providing information to individuals receiving citations in the mail and for scheduling appointments so that any of these individuals, if desired, can meet with traffic officers to review their citation and view the photographic evidence. Since the San Diego system was not functioning at the time of the review, there was no opportunity to listen and comment on the actual handling of these requests by LM/ACS personnel. For public relations purposes, the City should give consideration to handling all information and appointment requests internally, offering both telephone and web-based opportunities to the public.

It is also important for the success of the photo enforcement program that traffic court officials, including traffic judges, commissioners, and administrative support personnel, be fully informed about the program. Pro-tem officials often conduct traffic court hearings and, as such, these officials may not be fully versed in the operation of the photo enforcement equipment. For court hearings, data packages for citations that are being contested need to be prepared in a thorough and timely manner so that these citations are upheld. The increased use of methods that allow for electronic data transfers and viewing may be appropriate to ensure the court packages are readily available when needed.

The City's photo enforcement program should not be re-started without a comprehensive public awareness and information campaign in connection with the on-going operation and development of its photo enforcement program. This recommendation is of equal importance to the earlier recommendation regarding re-location of the vehicle detection loops before the program is re-started.

Outreach efforts to schools, driver education, and local community groups and the media are needed. Reports of results of the program, emphasizing safety benefits achieved, should be posted on a program web site. The campaign should employ various communications media designed to reach as many community residents as possible, include regular surveys to gauge public support and awareness, and be focused on a central message of improving traffic safety, for which photo enforcement can be applied as an effective tool to reduce collisions resulting from red light running.

7.5 PROGRAM DEVELOPMENT

Analysis of the red light running violations and accident data for the City's photo-enforced intersections, together with the lessons learned from other cities with similar programs, confirm that red light camera enforcement is effective in reducing red light running and improving traffic safety. However, photo enforcement should not be viewed in isolation. There is no one remedy for the traffic safety improvements or the reduction in collisions at signalized intersections but rather a toolbox of measures all of which have a role to play.

The following elements are recommended as the basis for program development.

7.5.1 Re-Engineered Photo Enforcement Equipment Installations

At a minimum and before the program is re-started, it is necessary that the vehicle detection loops used to trigger the photo enforcement cameras at 18 of the 19 photo-enforced intersections be re-located. At the same time, the City should consider the installation of enhanced advanced warning signs and investigate camera equipment upgrades, such as nearside cameras and auxiliary flashes, for selected locations.

7.5.2 Public Awareness and Information Campaign

As discussed above, the photo enforcement program should not be re-started without a comprehensive public awareness and information campaign in connection with the on-going operation and development of its photo enforcement program.

The public awareness and information campaign should encompass the following elements.

- Provide a clear description of the operation of the photo enforcement equipment in non-technical terms;
- Clearly state the program objectives;
- Describe the advantages of automated enforcement over manual enforcement;
- Explain other measures being taken to improve safety at intersections;
- Discuss the use of the photo enforcement program revenues;
- Re-launch the project with as much media and community support as possible;
- Outreach efforts to schools, driver education, local community groups, and all area media;
- Telephone and web-based information centers that include a hot-line for calls about intersection problems and traffic safety concerns in addition to handling inquires regarding the operation of the photo enforcement program; and
- Ability to respond to telephone and e-mail inquiries and correspondence within not longer than one working day.

7.5.3 City Design and Construction Review

The red light camera improvements were not processed and installed within the normal procedures used by the City for construction improvements in the public rights of way. Instead, the process used for the installation work did not require the contractor to have improvement plans prepared and signed by a licensed California Civil or Electrical Engineer and then have the plans go through the City's normal plan check and construction inspection processes. With these processes in place, as-built drawings for the photo enforcement system installations reflecting the later changes in the location of the vehicle detection loops at three photo-enforced intersections would have been prepared and readily available for reference.

For any future modifications, changes, or expansion to the photo enforcement installations, the City's normal design review and construction inspection procedures should be in place and carried out. This will insure that up to date knowledge of the installations, is maintained by the City at all times.

7.5.4 Program Objectives

The program objectives need to be defined as clearly as possible as an early step for moving forward. It is clear that the primary objective of any red light running photo enforcement program, including the City's program, is the reduction of collisions at signalized intersections resulting from red light running. Furthermore, the accident data analysis results presented in Section 2 of this report indicate that the program has been highly effective at reducing the number of collisions attributable to red light running.

Importantly, program objectives should address specific operational objectives as well as objectives related to financial performance. The latter is especially important and questions such as whether or not each location where photo enforcement equipment is installed needs to be self-sustaining need to be addressed and incorporated into the statement of operational objectives. Additionally, the program objectives should support the development of a formula for the use of the revenues generated by the photo enforcement program, such as by the allocation of “x” percent of the program revenue for on-going accident data analysis and reporting; “y” percent for the development and maintenance of a public awareness and information campaign; and “z” percent for the funding or partial funding of other traffic safety improvements, not related to accidents caused by red light running violations.

7.5.5 On-Going Problem Identification and Analysis

The on-going analysis of the violations and citations issued data provided by the photo enforcement program as well as on-going analysis of intersection accident rates by type of accident together with community inputs are the basis for a comprehensive traffic safety improvement program.

A portion of the revenues derived from the photo enforcement program should be directed towards the necessary data analysis, problem identification, and problem diagnostic review work tasks.

In particular, it is recommended that the City review the violations data and accident data analysis presented in this report and, using that data, evaluate the measured effectiveness of the photo enforcement cameras at each of the 19 photo-enforced intersections. Before the program is re-started, the City could elect to not re-start at selected locations where the use of the cameras is not warranted by the accident rates or by the number of recorded violations.

7.5.6 Traffic Safety Partnership

The City’s photo enforcement program is complex one that requires a very high level of quality control and the on-going coordination of activities related to operation and maintenance of systems that are owned and maintained by a third-party contractor with those of the City’s Police Department, Traffic Engineering Department, and Traffic Courts. Clearly, the program also has significant visibility with the community at large and with their elected officials that require coordination primarily related to effectively communicating the program’s objectives.

In the past, it appears that there has not been adequate coordination between all the necessary project participants. As the program moves forward, it is recommended that the Police Department establish a more broadly-based partnership with all the necessary project participants including the following:

- Police Department
- Traffic Engineering Department
- Public Works Department
- City Attorney’s Office
- City Public Relations Office
- Photo Enforcement Services Contractor
- Selected Community Representatives
- Selected Outside Agency Representatives, such as Caltrans and Auto Club

A Coordinating Committee consisting of representatives from each project participant should be established and meet on a regular basis, monthly to start with but not less often than quarterly. Regular agenda items should be the review of the violations and citations issued data with a discussion of any changes or trends noted. Inputs from the City's Traffic Engineering Department and Street Maintenance Department should include regular updates on planned traffic signal modifications or street improvements construction that could impact the operation of the system. Discussion should be encouraged on whether program objectives are being met through the deployment of photo enforcement cameras or whether alternative measures should be applied. The group should have input to the regular prioritization of intersections targeted for safety-related improvements.

A monitoring program for the improved and timely collection and reporting of accident data is needed as a top priority item. Currently, both the Police and Traffic Engineering Departments have responsibilities for the collection and reporting of accident data. Traffic safety professionals from both Departments need to review intersection safety issues and conduct diagnostic reviews of intersections identified from the accident data tabulations as warranting safety-related improvements. A portion of the revenues from the photo enforcement program should be directed to enhancements in the accident data collection and reporting systems so that accident data trends can be more easily monitored.

Regular reports on the public awareness and information campaign should be tabled. Public use of the web site and telephone information systems should be monitored. Revenue collection should also be monitored so that the impact of changed policies can be evaluated.

7.5.7 Program Expansion

Typically, photo enforcement cameras are located at intersections based on one or more of three criteria:

- At "high risk" or historically dangerous intersections, based on the number of accidents or, where available, on an analysis of the number of accidents attributable to red light running;
- At intersections where a video pre-survey has counted a high number of red light running violations and where engineering observations suggest that a high percentage of the recorded violations should be able to be cited; and
- At geographically-dispersed intersections in order to distribute the presence of the photo enforcement cameras and warning signs, for fairness and to take advantage of the "spillover" effect of photo enforcement cameras in reducing accident rates at intersections in the vicinity of photo-enforced intersections.

Most agencies report that they use accident data as the primary means to locate red light cameras. Data regarding the total number of accidents may be used although intersections with high numbers of collisions may not have a high number of collisions related to red light running violations.

Agencies may also deploy photo enforcement cameras at locations where it is known that there are high numbers of red light running violations but not necessarily corresponding high numbers of collisions related to the red light running. Heavily traveled intersections where there are heavy left turn movements operated on protected left turn phases are often intersections of this type.

Vendors providing photo enforcement equipment and services typically conduct video pre-surveys to evaluate a short list of candidate intersections and make recommendations to agencies regarding the preferred locations based on the anticipated number of violations. Since the vendors are typically reimbursed from the fine revenues or any shortfall from fine revenues needs to be made up by the agency, it is advantageous to select locations where the potential number of citations issued is high. A published report for one established red light running program estimates that photo enforcement cameras must be located at intersections that experience at least 30 violations per day in order to be financially viable. At the same time, enforcement at the locations with a high number of potential violations serves to maximize the number of motorists who are directly affected by the program and who may alter their driving behavior as a result of the program.

Other criteria for the location of photo enforcement cameras includes suggestions from law enforcement and traffic safety professionals, inputs from community groups including complaints regarding red light running, traffic volumes, and political and historical factors. These criteria may be applied in conjunction with accident and violations or citations data.

Undesirable characteristics such as driveways that restrict camera pole or auxiliary flash placement such as driveways, approaches that are more than three lanes wide and double left turn lanes where views are more frequently obstructed, wide crossing streets where second photographs may not be taken at the pre-determined location due to motorists speeding up and slowing down as they traverse the intersection, and similar factors will also affect decisions regarding the installation of photo enforcement cameras.

For the City of San Diego, it is recommended that the photo enforcement program be expanded on the following basis:

- To provide uniform coverage throughout the City according to a pre-determined minimum coverage standard; or

- For intersection approaches where the accident rate for accidents caused by red light running exceeds a pre-determined minimum threshold standard; and

- For intersection approaches meeting one of the above standards where installation of the photo enforcement equipment is feasible and can be expected to meet or exceed the pre-determined minimum percent cited standard; or

- For intersection approaches where a diagnostic team review has determined that photo enforcement should be effective to mitigate a particular traffic safety hazard, even through the intersection approach may not be in compliance with one or both of the above standards.

Program expansion should also consider new photo enforcement technologies. The GATSO equipment being used by the City utilizes a proven and widely used film-based technology based on the ROBOT camera, the first version of which was deployed over 60 years ago for aerial surveillance purposes. Other photo enforcement technologies have become available over the past five years, most notably technologies that employ digital camera equipment where photographic data, including streamed video clips, may be immediately downloaded for processing using T-1 telephone line or microwave communications. Additionally, photo enforcement systems that use video-based and radar vehicle detection methods as well as systems that employ overhead camera placements and floodlighting equipment as an alternative to the curb-based placements used for the San Diego program are being tested by cities throughout California and elsewhere. Figures 7-1 and 7-2 show field installations for photo enforcement systems using the new photo enforcement technologies.

Figure 7-1
CURB MOUNTED DIGITAL PHOTO ENFORCEMENT CAMERA SYSTEM

Figure 7-2
OVERHEAD DIGITAL PHOTO ENFORCEMENT CAMERA SYSTEM

It is important that the City Police Department stay in touch with other agencies and with the suppliers offering new photo enforcement technologies. These technologies may offer cost advantages since film does not need to be changed in the camera units and then processed, shorter turnaround times for mailing citations, and improved photographic data to be used as evidence of the recorded violations.

Where technologies appear to offer advantages that may be especially beneficial to the City, the technologies should be installed and tested. Unfortunately, testing of different equipment types is more difficult than for many other products due to the approach under which photo enforcement systems are currently marketed and deployed in California, that is, where the equipment suppliers are generally responsible for equipment installation, maintenance, and citation processing services. Ultimately, it is expected that the contractors offering hardware-independent photo enforcement support services will be available and serve to expand the possibilities for system testing and deployment by cities interested in enhancing public safety through the application of photo enforcement systems.

APPENDIX A
RED LIGHT CAMERA SITE INSPECTION DATA

Red Light Camera Equipment Data (Aero Drive at Murphy Canyon Road)

Red Light Running Evaluation Field Data

Intersection: Aero Drive at Murphy Canyon Road **Inspection Date:** September 25th, 2001

CAMERA POLE AND CABINET

Camera Pole Type: Hinged **Camera Pole Model:** 200 **Camera Cabinet Type:** Bolted/ Steel/ Vandalism Proof

Camera Pole Condition: Rust

CAMERA UNIT

Camera Unit Type: GATSO **Model:** 36mST-MC **Property/USPT Tag:** 957 / E 0025 **Focal Length:** N/A

Filters Present: Yes **Filter Type:** Polarizing Filter **Year:** Year listed on product data sheet only **Lens Type:** 75mm

CAMERA UNIT SETTINGS

Camera Location Code: 1422 **Date:** 9/25/01 **Time:** 10:29 AM **Delay:** 0.4 Sec **Detection Location:** Front

Flash On: No **Flash Intensity:** High **Sleep/Active Days and Times:** None

Minimum Detection Speed (in miles per hour): 15 mph **Interval (meters):** 22m **Camera Test:** OK **Pitch:** 198cm

REMOTE FLASH

Flash Model: EL 500 **Flash Power/Intensity:** 500 W **Serial/Tag Number:** Not Available

DETECTORS

Detector Types Present: Loops

	Frequency	Sensitivity	Mode	Detection Working	Mega Test
Loop 1	High	Low	Pulse	Yes	N/A
Loop 2	High	Low	Pulse	Yes	N/A
Loop 3	High	Low	Pulse	Yes	N/A
Loop 4	High	Low	Pulse	Yes	N/A
Loop 5					
Loop 6					

Red Light Camera Equipment Data (Carmel Mountain Road at Rancho Carmel Drive)

Red Light Running Evaluation Field Data

Intersection: Carmel Mountian Road at Rancho Carmel Drive **Inspection Date:** September 25th, 2001

CAMERA POLE AND CABINET

Camera Pole Type: Elevator **Camera Pole Model:** 300 **Camera Cabinet Type:** Steel / Side Bolt

Camera Pole Condition: Very little rust

CAMERA UNIT

Camera Unit Type: GATSO **Model:** RLC 36 **Property/USPT Tag:** 1100 / E 0488 **Focal Length:** NA

Filters Present: No **Filter Type:** NA **Year:** Year listed on product data sheet only **Lens Type:** 45mm

CAMERA UNIT SETTINGS

Camera Location Code: 1543 **Date:** 9/25/01 **Time:** 11:28 AM **Delay:** 0.4sec **Detection Location:** Front

Flash On: No **Flash Intensity:** High **Sleep/Active Days and Times:** None

Minimum Detection Speed (in miles per hour): 12mph **Interval (meters):** 28m **Camera Test:** Failed **Pitch:** 203cm

REMOTE FLASH

Flash Model: EL 250 **Flash Power/Intensity:** 250W **Serial/Tag Number:** NA

DETECTORS

Detector Types Present: Loops

Loop 1	Frequency: NA	Sensitivity: NA	Mode: NA	Detection Working: No	Mega Test: Pass
Loop 2	Frequency: NA	Sensitivity: NA	Mode: NA	Detection Working: No	Mega Test: Pass
Loop 3	Frequency: NA	Sensitivity: NA	Mode: NA	Detection Working: No	Mega Test: Pass
Loop 4	Frequency: NA	Sensitivity: NA	Mode: NA	Detection Working: No	Mega Test: Pass
Loop 5	Frequency:	Sensitivity:	Mode:	Detection Working:	Mega Test:
Loop 6	Frequency:	Sensitivity:	Mode:	Detection Working:	Mega Test:

Red Light Camera Equipment Data (Bernardo Center Drive at Rancho Bernardo Road)

Red Light Running Evaluation Field Data

Intersection: Bernardo Center Crive at Rancho Bernardo Road **Inspection Date:** September 25th, 2001

CAMERA POLE AND CABINET

Camera Pole Type: Hinged **Camera Pole Model:** 200 **Camera Cabinet Type:** Bolted / Steel / Vandalism Proof

Camera Pole Condition: Good but dirty

CAMERA UNIT

Camera Unit Type: GATSO **Model:** 36mST-MC **Property/USPT Tag:** 856 / 00609 **Focal Length:** 20m

Filters Present: No **Filter Type:** NA **Year:** Year listed on product data sheet only **Lens Type:** 75mm

CAMERA UNIT SETTINGS

Camera Location Code: 1414 **Date:** 9/25/01 **Time:** 12:34 PM **Delay:** 0.4sec **Detection Location:** Front

Flash On: No **Flash Intensity:** Medium **Sleep/Active Days and Times:** None

Minimum Detection Speed (in miles per hour): 15mph **Interval (meters):** 20m **Camera Test:** Pass **Pitch:** 198cm

REMOTE FLASH

Flash Model: None **Flash Power/Intensity:** NA **Serial/Tag Number:** NA

DETECTORS

Detector Types Present: Loops

	Frequency:	Sensitivity:	Mode:	Detection Working:	Mega Test:
Loop 1	High	Low	Presence	Yes	NA
Loop 2	High	Low	Presence	Yes	NA
Loop 3	High	Low	Presence	Yes	NA
Loop 4	High	Low	Presence	Yes	NA
Loop 5					
Loop 6					

Red Light Camera Equipment Data (Mira Mesa Boulevard at Black Mountain Road)

Red Light Running Evaluation Field Data

Intersection: Mira Mesa Boulevard at Black Mountain Road **Inspection Date:** September 25th, 2001

CAMERA POLE AND CABINET

Camera Pole Type: Hinged **Camera Pole Model:** 200 **Camera Cabinet Type:** Bolted / Steel / Vandalism Proof

Camera Pole Condition: Little rust and dirty

CAMERA UNIT

Camera Unit Type: GATSO **Model:** RLC 36 **Property/USPT Tag:** 1188 / ??? **Focal Length:** NA

Filters Present: No **Filter Type:** NA **Year:** Year listed on product data sheet only **Lens Type:** 90mm

CAMERA UNIT SETTINGS

Camera Location Code: 1492 **Date:** 9/25/01 **Time:** 1:33 PM **Delay:** 0.4sec **Detection Location:** Front

Flash On: No **Flash Intensity:** Medium **Sleep/Active Days and Times:** None

Minimum Detection Speed (in miles per hour): 15mph **Interval (meters):** 27m **Camera Test:** Pass **Pitch:** 203cm

REMOTE FLASH

Flash Model: None **Flash Power/Intensity:** NA **Serial/Tag Number:** NA

DETECTORS

Detector Types Present: Loops

	Frequency	Sensitivity	Mode	Detection Working	Mega Test
Loop 1	NA	NA	NA	Yes	Pass
Loop 2	NA	NA	NA	Yes	Pass
Loop 3	NA	NA	NA	Yes	Pass
Loop 4	NA	NA	NA	Yes	Pass
Loop 5					
Loop 6					

Red Light Camera Equipment Data (Miramar Road at Camino Ruiz)

Red Light Running Evaluation Field Data

Intersection: Miramar Road at Camino Ruiz **Inspection Date:** September 25th, 2001

CAMERA POLE AND CABINET

Camera Pole Type: Elevator **Camera Pole Model:** 300 **Camera Cabinet Type:** Bolted / Steel / Vandalism Proof

Camera Pole Condition: Needs paint touch up and has rust

CAMERA UNIT

Camera Unit Type: GATSO **Model:** RLC 36 **Property/USPT Tag:** 1356 / A 1123 **Focal Length:** NA

Filters Present: No **Filter Type:** NA **Year:** Year listed on product data sheet only **Lens Type:** 75mm

CAMERA UNIT SETTINGS

Camera Location Code: 1534 **Date:** 9/25/01 **Time:** 2:31 PM **Delay:** 0.4sec **Detection Location:** Front

Flash On: No **Flash Intensity:** High **Sleep/Active Days and Times:** None

Minimum Detection Speed (in miles per hour): 15mph **Interval (meters):** 21m **Camera Test:** Pass **Pitch:** 202cm

REMOTE FLASH

Flash Model: EL 250 **Flash Power/Intensity:** 250W **Serial/Tag Number:** NA

DETECTORS

Detector Types Present: Loops

Loop 1	Frequency: NA	Sensitivity: NA	Mode: NA	Detection Working: Yes	Mega Test: NA
Loop 2	Frequency: NA	Sensitivity: NA	Mode: NA	Detection Working: Yes	Mega Test: NA
Loop 3	Frequency: NA	Sensitivity: NA	Mode: NA	Detection Working: Yes	Mega Test: NA
Loop 4	Frequency: NA	Sensitivity: NA	Mode: NA	Detection Working: Yes	Mega Test: NA
Loop 5	Frequency: NA	Sensitivity: NA	Mode: NA	Detection Working: Yes	Mega Test: NA
Loop 6	Frequency: NA	Sensitivity: NA	Mode: NA	Detection Working: Yes	Mega Test: NA

Red Light Camera Equipment Data (Towne Center Drive at La Jolla Village Drive)

Red Light Running Evaluation Field Data

Intersection: Towne Center Drive at La Jolla Village Drive **Inspection Date:** September 25th, 2001

CAMERA POLE AND CABINET

Camera Pole Type: Hinged **Camera Pole Model:** 200 **Camera Cabinet Type:** Bolted / Steel / Vandalism Proof

Camera Pole Condition: Good but dirty

CAMERA UNIT

Camera Unit Type: GATSO **Model:** RLC 36 **Property/USPT Tag:** 1186 / E 0990 **Focal Length:** NA

Filters Present: No **Filter Type:** NA **Year:** Year listed on product data sheet only **Lens Type:** 90mm

CAMERA UNIT SETTINGS

Camera Location Code: 1474 **Date:** 9/25/01 **Time:** 3:42 PM **Delay:** 0.4sec **Detection Location:** Front

Flash On: No **Flash Intensity:** Medium **Sleep/Active Days and Times:** None

Minimum Detection Speed (in miles per hour): 15mph **Interval (meters):** 18m **Camera Test:** Failed **Pitch:** 231cm

REMOTE FLASH

Flash Model: None **Flash Power/Intensity:** NA **Serial/Tag Number:** NA

DETECTORS

Detector Types Present: Loops

Loop 1	Frequency: NA	Sensitivity: NA	Mode: NA	Detection Working: Yes	Mega Test: Pass
Loop 2	Frequency: NA	Sensitivity: NA	Mode: NA	Detection Working: Yes	Mega Test: Weak
Loop 3	Frequency: NA	Sensitivity: NA	Mode: NA	Detection Working: Yes	Mega Test: Pass
Loop 4	Frequency: NA	Sensitivity: NA	Mode: NA	Detection Working: Yes	Mega Test: Pass
Loop 5	Frequency:	Sensitivity:	Mode:	Detection Working:	Mega Test:
Loop 6	Frequency:	Sensitivity:	Mode:	Detection Working:	Mega Test:

Red Light Camera Equipment Data (Mission Bay Drive at Garnet Avenue)

Red Light Running Evaluation Field Data

Intersection: Mission Bay Drive at Garnet Avenue **Inspection Date:** September 25th, 2001

CAMERA POLE AND CABINET

Camera Pole Type: Hinged **Camera Pole Model:** 200 **Camera Cabinet Type:** Bolted / Steel / Vandalism Proof

Camera Pole Condition: Marked up, needs paint touch up, and dirty

CAMERA UNIT

Camera Unit Type: GATSO **Model:** RLC 36 **Property/USPT Tag:** 1066 / E 0454 **Focal Length:** 20m

Filters Present: No **Filter Type:** NA **Year:** Year listed on product data sheet only **Lens Type:** 75mm

CAMERA UNIT SETTINGS

Camera Location Code: 1513 **Date:** 9/25/01 **Time:** 4:17 PM **Delay:** 0.4sec **Detection Location:** Front

Flash On: No **Flash Intensity:** High **Sleep/Active Days and Times:** None

Minimum Detection Speed (in miles per hour): 15mph **Interval (meters):** 16m **Camera Test:** Pass **Pitch:** 228cm

REMOTE FLASH

Flash Model: None **Flash Power/Intensity:** NA **Serial/Tag Number:** NA

DETECTORS

Detector Types Present: Loops

	Frequency:	Sensitivity:	Mode:	Detection Working:	Mega Test:
Loop 1	NA	NA	NA	Yes	NA
Loop 2	NA	NA	NA	Yes	NA
Loop 3	NA	NA	NA	Yes	NA
Loop 4	NA	NA	NA	Yes	NA
Loop 5					
Loop 6					

Red Light Camera Equipment Data (Garnet Avenue at Ingraham Street)

Red Light Running Evaluation Field Data

Intersection: Garnet Avenue and Ingram Street **Inspection Date:** September 25th, 2001

CAMERA POLE AND CABINET

Camera Pole Type: Hinged **Camera Pole Model:** 200 **Camera Cabinet Type:** Bolted / Steel / Vandalism Proof

Camera Pole Condition: Graffiti and dirty

CAMERA UNIT

Camera Unit Type: GATSO **Model:** 36mST-MC **Property/USPT Tag:** 847 / 00889 **Focal Length:** 20m

Filters Present: Yes **Filter Type:** Polarizing **Year:** Year listed on product data sheet only **Lens Type:** 90mm

CAMERA UNIT SETTINGS

Camera Location Code: 1454 **Date:** 9/25/01 **Time:** 4:57 PM **Delay:** 0.4sec **Detection Location:** Front

Flash On: No **Flash Intensity:** High **Sleep/Active Days and Times:** None

Minimum Detection Speed (in miles per hour): 15mph **Interval (meters):** 17m **Camera Test:** Pass **Pitch:** 204cm

REMOTE FLASH

Flash Model: None **Flash Power/Intensity:** NA **Serial/Tag Number:** NA

DETECTORS

Detector Types Present: Loops

Loop 1	Frequency: High	Sensitivity: Low	Mode: Presence	Detection Working: Yes	Mega Test: NA
Loop 2	Frequency: High	Sensitivity: Low	Mode: Presence	Detection Working: Yes	Mega Test: NA
Loop 3	Frequency:	Sensitivity:	Mode:	Detection Working:	Mega Test:
Loop 4	Frequency:	Sensitivity:	Mode:	Detection Working:	Mega Test:
Loop 5	Frequency:	Sensitivity:	Mode:	Detection Working:	Mega Test:
Loop 6	Frequency:	Sensitivity:	Mode:	Detection Working:	Mega Test:

Red Light Camera Equipment Data (Black Mountain Road at Gemini Avenue)

Red Light Running Evaluation Field Data

Intersection: Black Mountain Road and Gemini Avenue **Inspection Date:** September 26th, 2001

CAMERA POLE AND CABINET

Camera Pole Type: Elevator **Camera Pole Model:** 400 **Camera Cabinet Type:** Bolted / Steel / Vandalism Proof

Camera Pole Condition: Good but dirty

CAMERA UNIT

Camera Unit Type: GATSO **Model:** RLC 36 **Property/USPT Tag:** 1064 / E 0442 **Focal Length:** 20m

Filters Present: No **Filter Type:** NA **Year:** Year listed on product data sheet only **Lens Type:** 75mm

CAMERA UNIT SETTINGS

Camera Location Code: 1551 **Date:** 9/26/01 **Time:** 10:00 AM **Delay:** 0.4sec **Detection Location:** Front

Flash On: No **Flash Intensity:** High **Sleep/Active Days and Times:** None

Minimum Detection Speed (in miles per hour): 12mph **Interval (meters):** 8m **Camera Test:** Failed **Pitch:** 202cm

REMOTE FLASH

Flash Model: EL 250 **Flash Power/Intensity:** 250W **Serial/Tag Number:** NA

DETECTORS

Detector Types Present: Loops

Loop 1	Frequency: NA	Sensitivity: NA	Mode: NA	Detection Working: No	Mega Test: Pass
Loop 2	Frequency: NA	Sensitivity: NA	Mode: NA	Detection Working: No	Mega Test: Pass
Loop 3	Frequency: NA	Sensitivity: NA	Mode: NA	Detection Working: No	Mega Test: Fail
Loop 4	Frequency: NA	Sensitivity: NA	Mode: NA	Detection Working: No	Mega Test: Pass
Loop 5	Frequency:	Sensitivity:	Mode:	Detection Working:	Mega Test:
Loop 6	Frequency:	Sensitivity:	Mode:	Detection Working:	Mega Test:

Red Light Camera Equipment Data ("F" Street at 16th Street)

Red Light Running Evaluation Field Data

Intersection: F Street and 16th Street **Inspection Date:** September 26th, 2001

CAMERA POLE AND CABINET

Camera Pole Type: Hinged **Camera Pole Model:** 200 **Camera Cabinet Type:** Bolted / Steel / Vandalism Proof

Camera Pole Condition: Needs paint touch up, has rust and is dirty

CAMERA UNIT

Camera Unit Type: GATSO **Model:** 36 MST MC3P **Property/USPT Tag:** 899 / 00912 **Focal Length:** NA

Filters Present: NA **Filter Type:** NA **Year:** Year listed on product data sheet only **Lens Type:** NA

CAMERA UNIT SETTINGS

Camera Location Code: 1504 **Date:** 9/26/01 **Time:** 12:20 PM **Delay:** 0.4sec **Detection Location:** Front

Flash On: No **Flash Intensity:** Medium **Sleep/Active Days and Times:** None

Minimum Detection Speed (in miles per hour): 15mph **Interval (meters):** 14m **Camera Test:** NA **Pitch:** 203cm

REMOTE FLASH

Flash Model: None **Flash Power/Intensity:** NA **Serial/Tag Number:** NA

DETECTORS

Detector Types Present: Loops

Loop 1	Frequency:	High	Sensitivity:	Low	Mode:	Presence	Detection Working:	Yes	Mega Test:	Pass
Loop 2	Frequency:	High	Sensitivity:	Low	Mode:	Presence	Detection Working:	Yes	Mega Test:	Fail
Loop 3	Frequency:	High	Sensitivity:	Low	Mode:	Presence	Detection Working:	Yes	Mega Test:	Pass
Loop 4	Frequency:	High	Sensitivity:	Low	Mode:	Presence	Detection Working:	Yes	Mega Test:	Pass
Loop 5	Frequency:	High	Sensitivity:	Low	Mode:	Presence	Detection Working:	Yes	Mega Test:	Fail
Loop 6	Frequency:	High	Sensitivity:	Low	Mode:	Presence	Detection Working:	Yes	Mega Test:	Pass

Red Light Camera Equipment Data (10th Avenue at "A" Street)

Red Light Running Evaluation Field Data

Intersection: 10th Avenue at A Street **Inspection Date:** September 26th, 2001

CAMERA POLE AND CABINET

Camera Pole Type: Elevator **Camera Pole Model:** 300 **Camera Cabinet Type:** Bolted / Steel / Vanalism Proof

Camera Pole Condition: Good

CAMERA UNIT

Camera Unit Type: GATSO **Model:** RLC 36 **Property/USPT Tag:** 1094 / E 0509 **Focal Length:** Slightly over 20m

Filters Present: Yes **Filter Type:** Polarizing **Year:** Year listed on product data sheet only **Lens Type:** 90mm

CAMERA UNIT SETTINGS

Camera Location Code: 1523 **Date:** 9/26/01 **Time:** 12:54 PM **Delay:** 0.1sec **Detection Location:** Front

Flash On: No **Flash Intensity:** High **Sleep/Active Days and Times:** None

Minimum Detection Speed (in miles per hour): 12mph **Interval (meters):** 17m **Camera Test:** Pass **Pitch:** 205cm

REMOTE FLASH

Flash Model: El 250 **Flash Power/Intensity:** 250W **Serial/Tag Number:** NA

DETECTORS

Detector Types Present: Loops

Loop 1	Frequency: NA	Sensitivity: NA	Mode: NA	Detection Working: Yes	Mega Test: NA
Loop 2	Frequency: NA	Sensitivity: NA	Mode: NA	Detection Working: Yes	Mega Test: NA
Loop 3	Frequency: NA	Sensitivity: NA	Mode: NA	Detection Working: Yes	Mega Test: NA
Loop 4	Frequency: NA	Sensitivity: NA	Mode: NA	Detection Working: Yes	Mega Test: NA
Loop 5	Frequency: NA	Sensitivity: NA	Mode: NA	Detection Working: Yes	Mega Test: NA
Loop 6	Frequency: NA	Sensitivity: NA	Mode: NA	Detection Working: Yes	Mega Test: NA

Red Light Camera Equipment Data (Garnet Avenue at Mission Boulevard)

Red Light Running Evaluation Field Data

Intersection: Garnett Avenue and Mission Boulevard **Inspection Date:** September 26th, 2001

CAMERA POLE AND CABINET

Camera Pole Type: El;evator **Camera Pole Model:** 400 **Camera Cabinet Type:** Bolted / Steel / Vandalism Proof

Camera Pole Condition: Marked up, graffiti, and dirty

CAMERA UNIT

Camera Unit Type: GATSO **Model:** RLC 36 **Property/USPT Tag:** 1101 / E 0527 **Focal Length:** 22m

Filters Present: Yes **Filter Type:** Polarizing **Year:** Year listed on product data sheet only **Lens Type:** 75mm

CAMERA UNIT SETTINGS

Camera Location Code: 1542 **Date:** 9/26/01 **Time:** 2:54 PM **Delay:** 0.4sec **Detection Location:** Front

Flash On: No **Flash Intensity:** Medium **Sleep/Active Days and Times:** None

Minimum Detection Speed (in miles per hour): 12mph **Interval (meters):** 13m **Camera Test:** Pass **Pitch:** 203cm

REMOTE FLASH

Flash Model: None **Flash Power/Intensity:** NA **Serial/Tag Number:** NA

DETECTORS

Detector Types Present: Loops

	Frequency:	Sensitivity:	Mode:	Detection Working:	Mega Test:
Loop 1	NA	NA	NA	Yes	NA
Loop 2	NA	NA	NA	Yes	NA
Loop 3	NA	NA	NA	Yes	NA
Loop 4	NA	NA	NA	Yes	NA
Loop 5					
Loop 6					

Red Light Camera Equipment Data (Mission Bay Drive at Grand Avenue)

Red Light Running Evaluation Field Data

Intersection: Mission Bay Drive and Grand Avenue **Inspection Date:** September 26th, 2001

CAMERA POLE AND CABINET

Camera Pole Type: Elevator **Camera Pole Model:** 400 **Camera Cabinet Type:** Bolted / Steel / Vandalism Proof

Camera Pole Condition: Good

CAMERA UNIT

Camera Unit Type: GATSO **Model:** RLC 36 **Property/USPT Tag:** 1357 / A 1129 **Focal Length:** 21m

Filters Present: Yes **Filter Type:** Polarizing **Year:** Year listed on product data sheet only **Lens Type:** 75mm

CAMERA UNIT SETTINGS

Camera Location Code: 1541 **Date:** 9/26/01 **Time:** 3:24 PM **Delay:** 0.4sec **Detection Location:** Front

Flash On: No **Flash Intensity:** High **Sleep/Active Days and Times:** None

Minimum Detection Speed (in miles per hour): 15mph **Interval (meters):** 33m **Camera Test:** Pass **Pitch:** 202cm

REMOTE FLASH

Flash Model: EL 250 **Flash Power/Intensity:** 250W **Serial/Tag Number:** NA

DETECTORS

Detector Types Present: Loops

	Frequency:	Sensitivity:	Mode:	Detection Working:	Mega Test:
Loop 1	NA	NA	NA	Yes	NA
Loop 2	NA	NA	NA	Yes	NA
Loop 3	NA	NA	NA	Yes	NA
Loop 4	NA	NA	NA	Yes	NA
Loop 5					
Loop 6					

Red Light Camera Equipment Data (Grape Street at Harbor Drive)

Red Light Running Evaluation Field Data

Intersection: Grape Street and Harbor Street **Inspection Date:** September 26th, 2001

CAMERA POLE AND CABINET

Camera Pole Type: Elevator **Camera Pole Model:** 300 **Camera Cabinet Type:** Bolted / Steel / Vandalism Proof

Camera Pole Condition: Extremely dirty

CAMERA UNIT

Camera Unit Type: GATSO **Model:** RLC 36 **Property/USPT Tag:** 1105 / E 0628 **Focal Length:** 20m

Filters Present: No **Filter Type:** NA **Year:** Year listed on product data sheet only **Lens Type:** 75mm

CAMERA UNIT SETTINGS

Camera Location Code: 1533 **Date:** 9/26/01 **Time:** 3:30 PM **Delay:** 0.5sec **Detection Location:** 203cm

Flash On: No **Flash Intensity:** High **Sleep/Active Days and Times:** None

Minimum Detection Speed (in miles per hour): 12mph **Interval (meters):** 18m **Camera Test:** Pass **Pitch:** 203cm

REMOTE FLASH

Flash Model: EL 250 **Flash Power/Intensity:** 250W **Serial/Tag Number:** NA

DETECTORS

Detector Types Present: Loops

Loop 1	Frequency: NA	Sensitivity: NA	Mode: NA	Detection Working: Yes	Mega Test: NA
Loop 2	Frequency: NA	Sensitivity: NA	Mode: NA	Detection Working: Yes	Mega Test: NA
Loop 3	Frequency: NA	Sensitivity: NA	Mode: NA	Detection Working: Yes	Mega Test: NA
Loop 4	Frequency: NA	Sensitivity: NA	Mode: NA	Detection Working: Yes	Mega Test: NA
Loop 5	Frequency:	Sensitivity:	Mode:	Detection Working:	Mega Test:
Loop 6	Frequency:	Sensitivity:	Mode:	Detection Working:	Mega Test:

Red Light Camera Equipment Data (32nd Street at Harbor Drive)

Red Light Running Evaluation Field Data

Intersection: Harbor Drive at 32nd Street **Inspection Date:** September 26th, 2001

CAMERA POLE AND CABINET

Camera Pole Type: Hinged **Camera Pole Model:** 200 **Camera Cabinet Type:** Bolted / Steel / Vandalism Proof

Camera Pole Condition: Needs paint touch up and is dirty

CAMERA UNIT

Camera Unit Type: GATSO **Model:** RLC 36 **Property/USPT Tag:** 1058 / E 0448 **Focal Length:** 20m

Filters Present: Yes **Filter Type:** Polarizing **Year:** Year listed on product data sheet only **Lens Type:** 90mm

CAMERA UNIT SETTINGS

Camera Location Code: 1444 **Date:** 9/26/01 **Time:** 4:23 PM **Delay:** 0.4sec **Detection Location:** Front

Flash On: No **Flash Intensity:** High **Sleep/Active Days and Times:** None

Minimum Detection Speed (in miles per hour): 15mph **Interval (meters):** 16m **Camera Test:** Pass **Pitch:** 227cm

REMOTE FLASH

Flash Model: None **Flash Power/Intensity:** NA **Serial/Tag Number:** NA

DETECTORS

Detector Types Present: Loops

Loop 1	Frequency: NA	Sensitivity: NA	Mode: NA	Detection Working: Yes	Mega Test: NA
Loop 2	Frequency: NA	Sensitivity: NA	Mode: NA	Detection Working: Yes	Mega Test: NA
Loop 3	Frequency: NA	Sensitivity: NA	Mode: NA	Detection Working: Yes	Mega Test: NA
Loop 4	Frequency: NA	Sensitivity: NA	Mode: NA	Detection Working: Yes	Mega Test: NA
Loop 5	Frequency:	Sensitivity:	Mode:	Detection Working:	Mega Test:
Loop 6	Frequency:	Sensitivity:	Mode:	Detection Working:	Mega Test:

Red Light Camera Equipment Data (Imperial Avenue at Euclid Avenue)

Red Light Running Evaluation Field Data

Intersection: Imperial Avenue and Euclid Avenue **Inspection Date:** September 26th, 2001

CAMERA POLE AND CABINET

Camera Pole Type: Hinged **Camera Pole Model:** 200 **Camera Cabinet Type:** Bolted / Steel / Vandalism Proof

Camera Pole Condition: Dirty

CAMERA UNIT

Camera Unit Type: GATSO **Model:** RLC 36 **Property/USPT Tag:** 1102 / E 0533 **Focal Length:** 20m

Filters Present: No **Filter Type:** NA **Year:** Year listed on product data sheet only **Lens Type:** 90mm

CAMERA UNIT SETTINGS

Camera Location Code: 1484 **Date:** 9/26/01 **Time:** 5:07 PM **Delay:** 0.4sec **Detection Location:** Front

Flash On: No **Flash Intensity:** Medium **Sleep/Active Days and Times:** None

Minimum Detection Speed (in miles per hour): 15 mph **Interval (meters):** 13m **Camera Test:** Pass **Pitch:** 228cm

REMOTE FLASH

Flash Model: None **Flash Power/Intensity:** NA **Serial/Tag Number:** NA

DETECTORS

Detector Types Present: Loops

	Frequency:	Sensitivity:	Mode:	Detection Working:	Mega Test:
Loop 1	NA	NA	NA	Yes	NA
Loop 2	NA	NA	NA	Yes	NA
Loop 3	NA	NA	NA	Yes	NA
Loop 4	NA	NA	NA	Yes	NA
Loop 5					
Loop 6					

Red Light Camera Equipment Data (El Cajun Boulevard at 43rd Street)

Red Light Running Evaluation Field Data

Intersection: El Cajun Boulevard and 43rd Street **Inspection Date:** September 26th, 2001

CAMERA POLE AND CABINET

Camera Pole Type: Hinged **Camera Pole Model:** 200 **Camera Cabinet Type:** Bolted / Steel / Vandalism Proof

Camera Pole Condition: Graffiti, a little rust, and dirty

CAMERA UNIT

Camera Unit Type: GATSO **Model:** RLC 36 **Property/USPT Tag:** 1057 / E 0459 **Focal Length:** 20m

Filters Present: No **Filter Type:** NA **Year:** Year listed on product data sheet only **Lens Type:** 75mm

CAMERA UNIT SETTINGS

Camera Location Code: 1404 **Date:** 9/26/01 **Time:** 5:34 PM **Delay:** 0.4sec **Detection Location:** Front

Flash On: No **Flash Intensity:** Medium **Sleep/Active Days and Times:** None

Minimum Detection Speed (in miles per hour): 15mph **Interval (meters):** 11m **Camera Test:** Pass **Pitch:** 202cm

REMOTE FLASH

Flash Model: None **Flash Power/Intensity:** NA **Serial/Tag Number:** NA

DETECTORS

Detector Types Present: Loops

	Frequency:	Sensitivity:	Mode:	Detection Working:	Mega Test:
Loop 1	NA	NA	NA	Yes	NA
Loop 2	NA	NA	NA	Yes	NA
Loop 3	NA	NA	NA	Yes	NA
Loop 4	NA	NA	NA	Yes	NA
Loop 5					NA
Loop 6					

Red Light Camera Equipment Data (College Avenue at Montezuma Road)

Red Light Running Evaluation Field Data

Intersection: College Avenue at Montezuma Road **Inspection Date:** September 27th, 2001

CAMERA POLE AND CABINET

Camera Pole Type: Hinged **Camera Pole Model:** 200 **Camera Cabinet Type:** Bolted / Steel / Vandalism Proof

Camera Pole Condition: Graffiti and dirty

CAMERA UNIT

Camera Unit Type: GATSO **Model:** RLC 36 **Property/USPT Tag:** 1055 / E 0436 **Focal Length:** 20m

Filters Present: No **Filter Type:** NA **Year:** Year listed on product data sheet only **Lens Type:** 75mm

CAMERA UNIT SETTINGS

Camera Location Code: 1462 **Date:** 9/27/01 **Time:** 8:09 AM **Delay:** 0.4sec **Detection Location:** Front

Flash On: No **Flash Intensity:** Medium **Sleep/Active Days and Times:** None

Minimum Detection Speed (in miles per hour): 15mph **Interval (meters):** 21m **Camera Test:** Pass **Pitch:** 234cm

REMOTE FLASH

Flash Model: None **Flash Power/Intensity:** NA **Serial/Tag Number:** NA

DETECTORS

Detector Types Present: Loops

Loop 1	Frequency: NA	Sensitivity: NA	Mode: NA	Detection Working: Yes	Mega Test: NA
Loop 2	Frequency: NA	Sensitivity: NA	Mode: NA	Detection Working: Yes	Mega Test: NA
Loop 3	Frequency:	Sensitivity:	Mode:	Detection Working:	Mega Test:
Loop 4	Frequency:	Sensitivity:	Mode:	Detection Working:	Mega Test:
Loop 5	Frequency:	Sensitivity:	Mode:	Detection Working:	Mega Test:
Loop 6	Frequency:	Sensitivity:	Mode:	Detection Working:	Mega Test:

Red Light Camera Equipment Data (Mira Mesa Boulevard at Scranton Road)

Red Light Running Evaluation Field Data

Intersection: Mira Mesa Boulevard at Scranton Road **Inspection Date:** September 27th, 2001

CAMERA POLE AND CABINET

Camera Pole Type: Elevator **Camera Pole Model:** 400 **Camera Cabinet Type:** Bolted /Steel / Vandalism Proof

Camera Pole Condition: Dirty

CAMERA UNIT

Camera Unit Type: GATSO **Model:** RLR 36 **Property/USPT Tag:** 1359 / A 1141 **Focal Length:** 20m

Filters Present: No **Filter Type:** NA **Year:** Year listed on product data sheet only **Lens Type:** 75mm

CAMERA UNIT SETTINGS

Camera Location Code: 1553 **Date:** 9/27/01 **Time:** 10:14 AM **Delay:** 0.4sec **Detection Location:** Front

Flash On: No **Flash Intensity:** High **Sleep/Active Days and Times:** None

Minimum Detection Speed (in miles per hour): 15mph **Interval (meters):** 14m **Camera Test:** Pass **Pitch:** 203cm

REMOTE FLASH

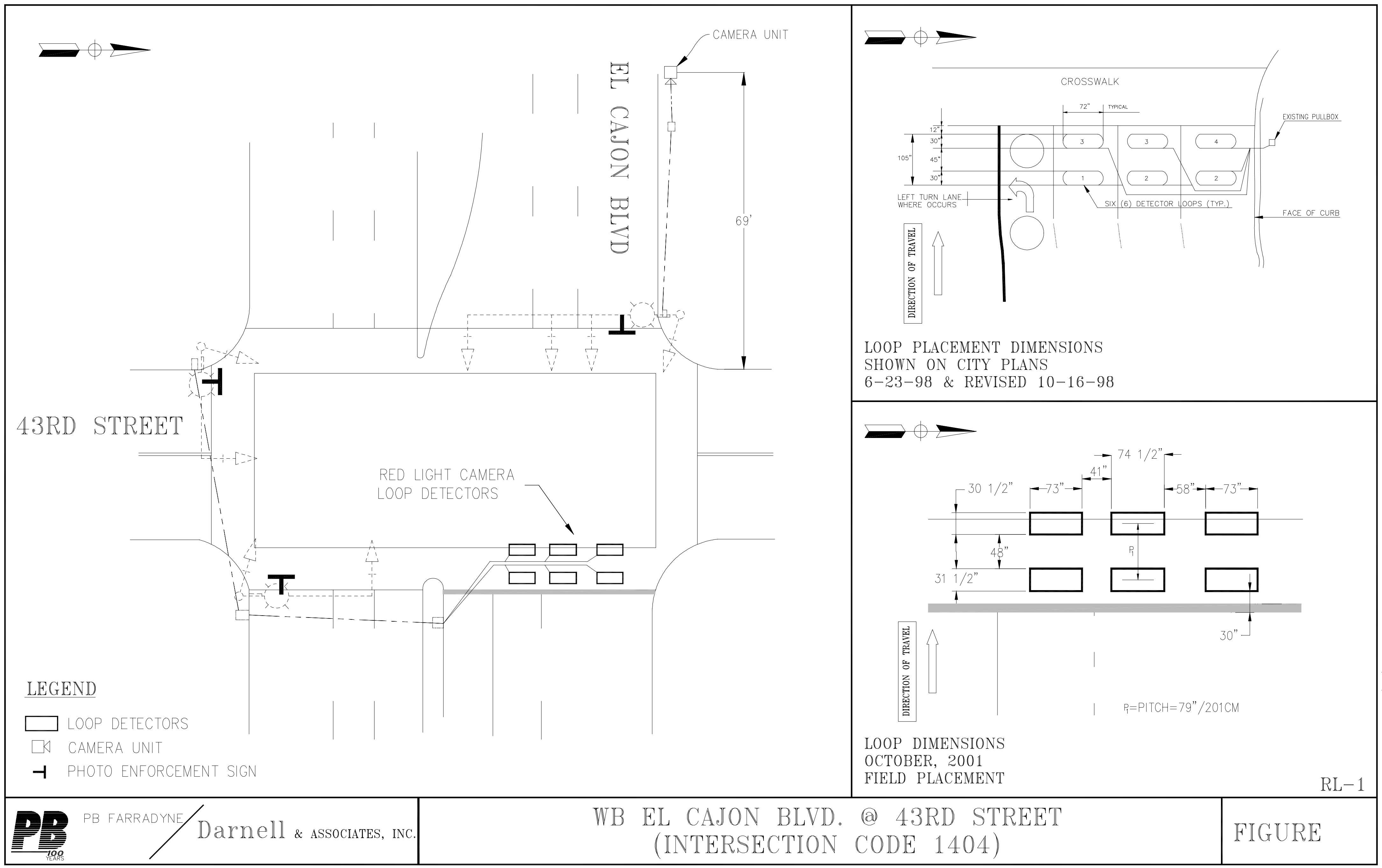
Flash Model: EL 250 **Flash Power/Intensity:** 250W **Serial/Tag Number:** NA

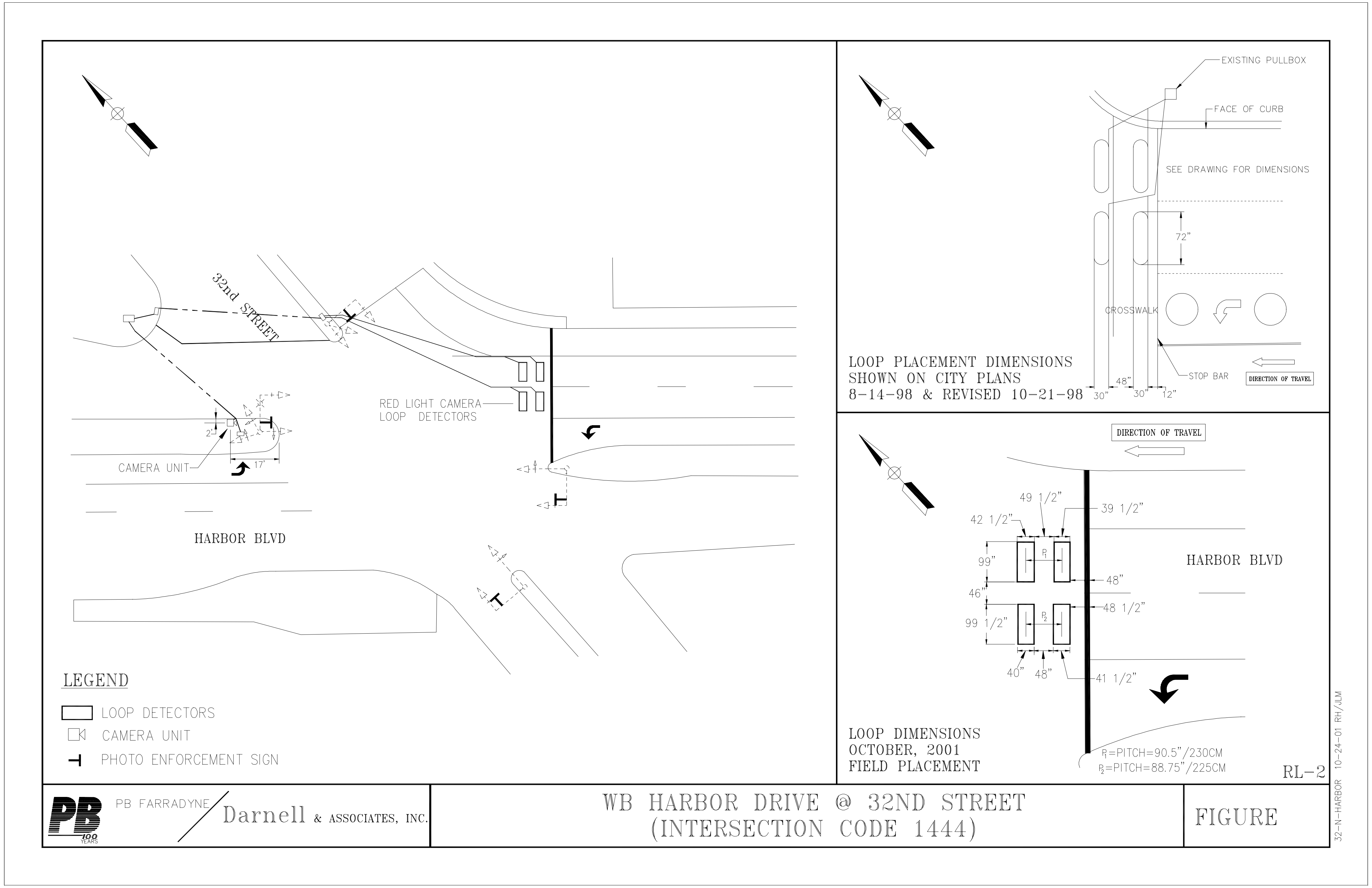
DETECTORS

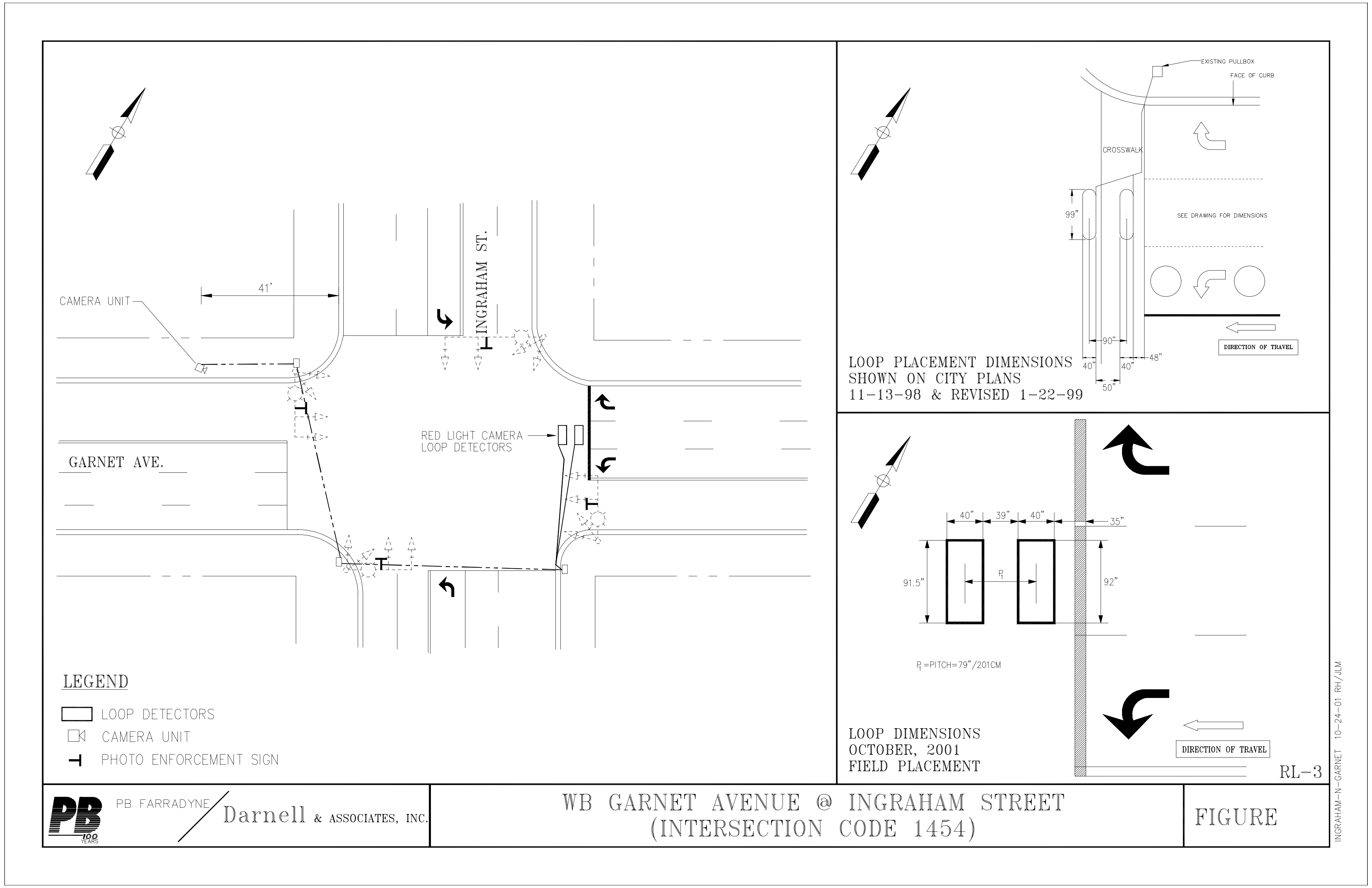
Detector Types Present: Loops

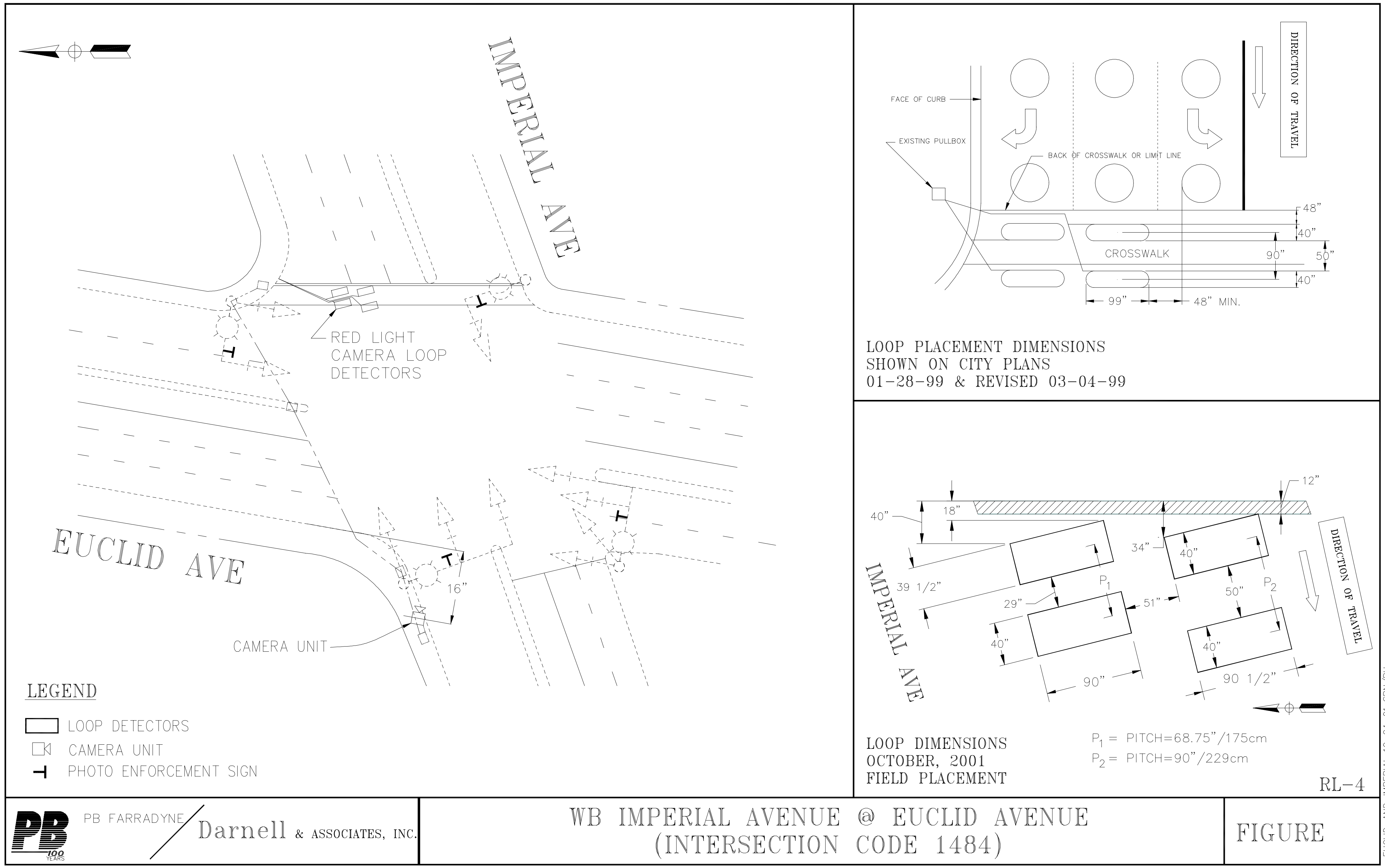
Loop 1	Frequency:	NA	Sensitivity:	NA	Mode:	NA	Detection Working:	Yes	Mega Test:	NA
Loop 2	Frequency:	NA	Sensitivity:	NA	Mode:	NA	Detection Working:	Yes	Mega Test:	NA
Loop 3	Frequency:	NA	Sensitivity:	NA	Mode:	NA	Detection Working:	Yes	Mega Test:	NA
Loop 4	Frequency:	NA	Sensitivity:	NA	Mode:	NA	Detection Working:	Yes	Mega Test:	NA
Loop 5	Frequency:	NA	Sensitivity:	NA	Mode:	NA	Detection Working:	Yes	Mega Test:	NA
Loop 6	Frequency:	NA	Sensitivity:	NA	Mode:	NA	Detection Working:	Yes	Mega Test:	NA

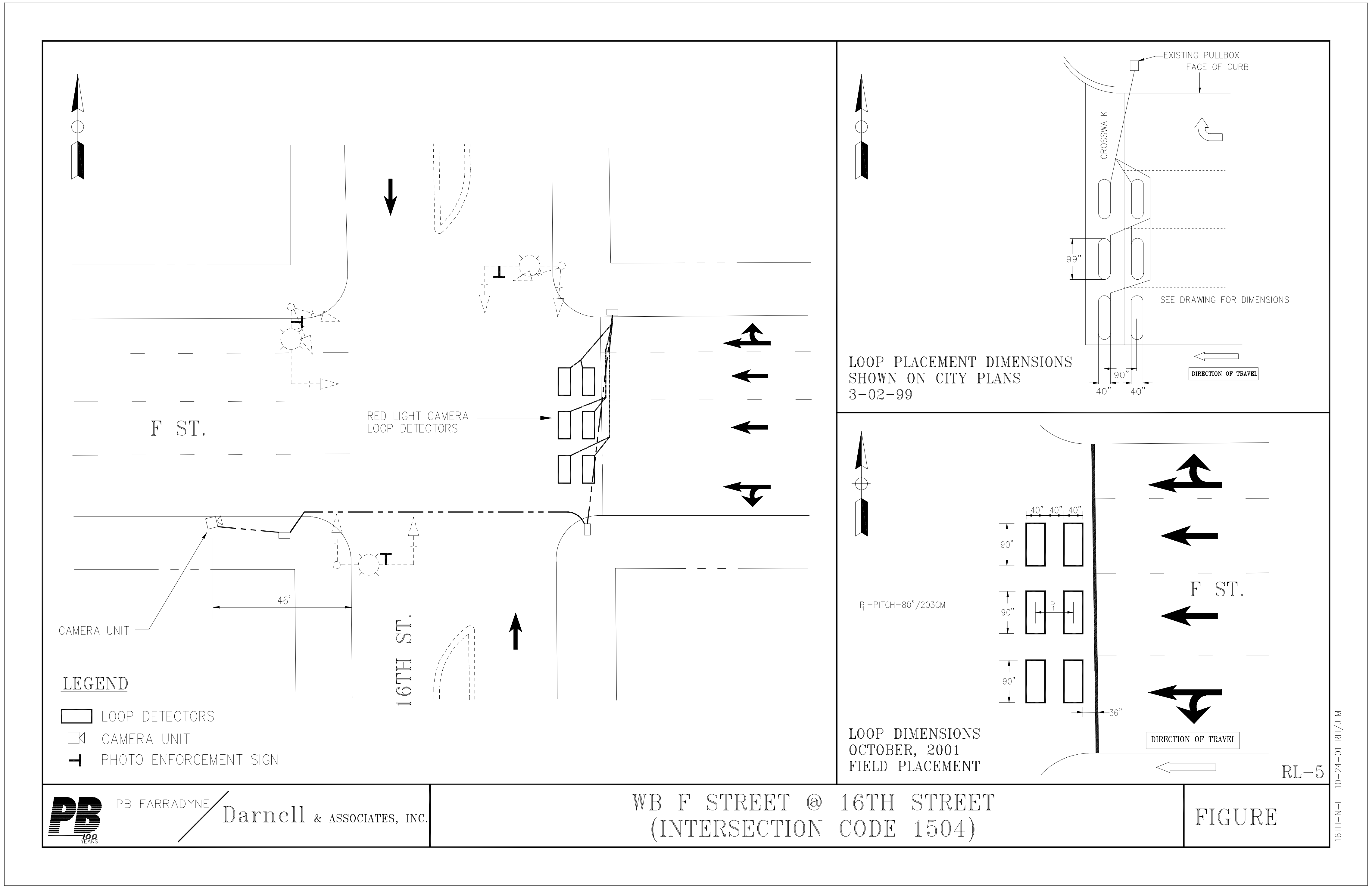
APPENDIX B
PHOTO-ENFORCED INTERSECTION DRAWINGS

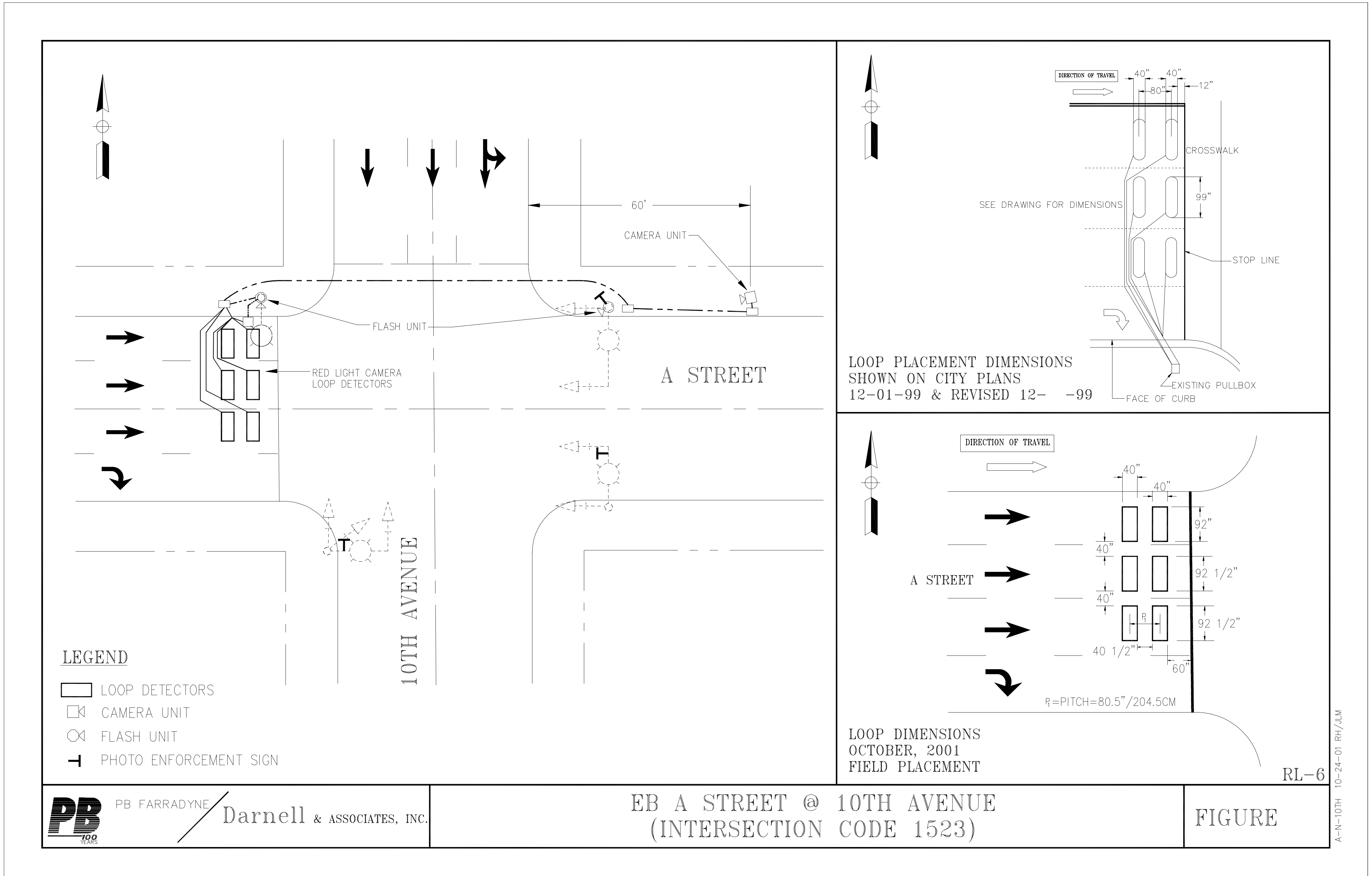

CAMERA UNIT
EL CAJON BLVD
69'
43RD STREET
RED LIGHT CAMERA
LOOP DETECTORS
LEGEND
LOOP DETECTORS
CAMERA UNIT
PHOTO ENFORCEMENT SIGN
CROSSWALK
72" TYPICAL
EXISTING PULLBOX
12"
30"
105"
45"
30"
LEFT TURN LANE
WHERE OCCURS
SIX (6) DETECTOR LOOPS (TYP.)
FACE OF CURB
DIRECTION OF TRAVEL
LOOP PLACEMENT DIMENSIONS
SHOWN ON CITY PLANS
6-23-98 & REVISED 10-16-98
74 1/2"
41"
30 1/2"
73"
58"
73"
48"
31 1/2"
30"
DIRECTION OF TRAVEL
℞=PITCH=79"/201CM
LOOP DIMENSIONS
OCTOBER, 2001
FIELD PLACEMENT
RL-1
43RD_AND_ELCAJON 10-24-01 JLM/RH/JLM
PB FARRADYNE
Darnell & ASSOCIATES, INC.
WB EL CAJON BLVD. @ 43RD STREET
(INTERSECTION CODE 1404)
FIGURE

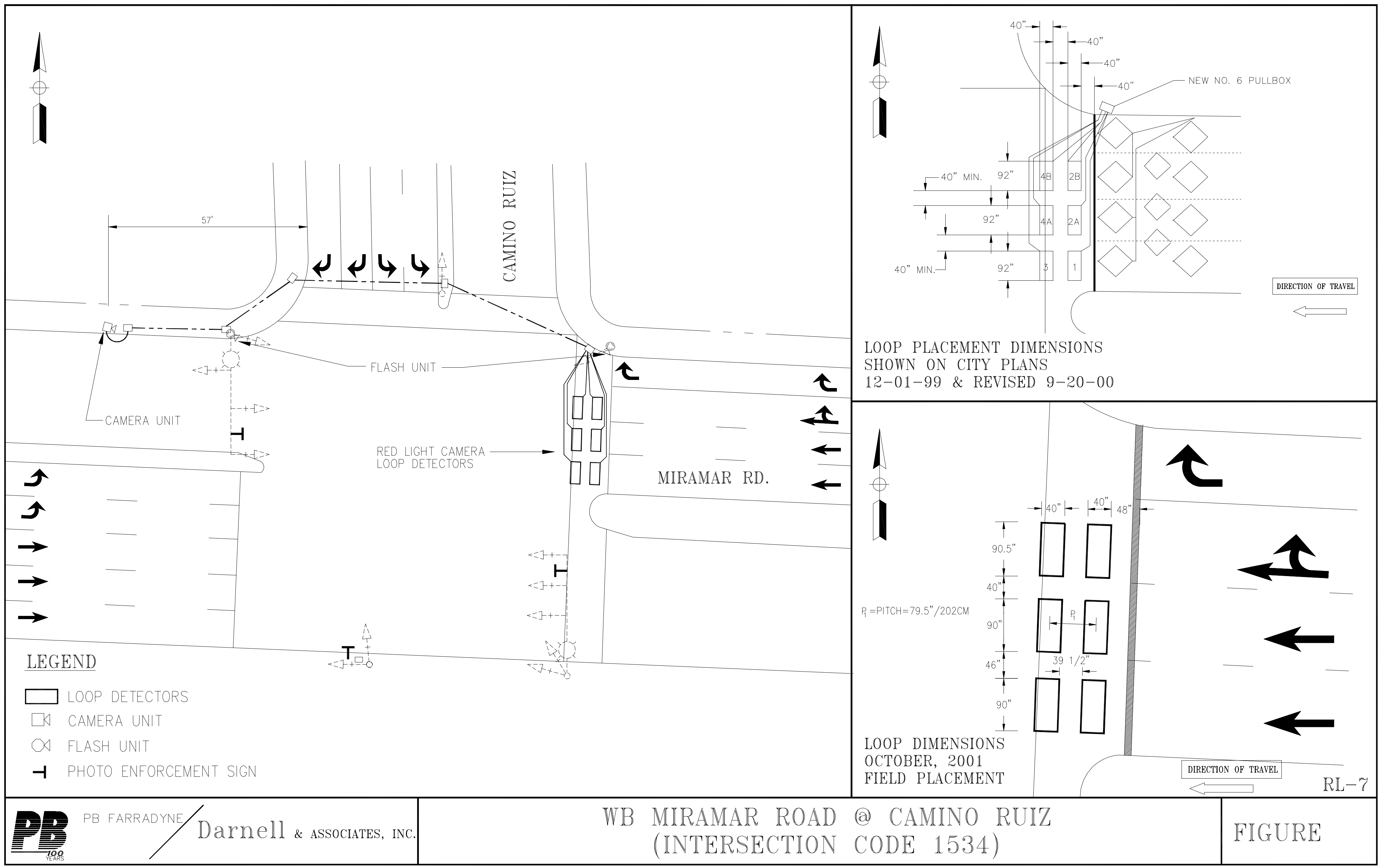

32nd STREET
RED LIGHT CAMERA LOOP DETECTORS
CAMERA UNIT
17'
HARBOR BLVD
LEGEND
LOOP DETECTORS
CAMERA UNIT
PHOTO ENFORCEMENT SIGN
EXISTING PULLBOX
FACE OF CURB
SEE DRAWING FOR DIMENSIONS
72"
CROSSWALK
STOP BAR
DIRECTION OF TRAVEL
LOOP PLACEMENT DIMENSIONS SHOWN ON CITY PLANS 8-14-98 & REVISED 10-21-98
30" 48" 30" 12"
49 1/2"
42 1/2"
39 1/2"
99"
48"
46"
48 1/2"
99 1/2"
40" 48"
41 1/2"
HARBOR BLVD
LOOP DIMENSIONS OCTOBER, 2001 FIELD PLACEMENT
P1=PITCH=90.5"/230CM
P2=PITCH=88.75"/225CM
RL-2
32-N-HARBOR 10-24-01 RH/JLM
PB FARRADYNE
Darnell & ASSOCIATES, INC.
WB HARBOR DRIVE @ 32ND STREET
(INTERSECTION CODE 1444)
FIGURE

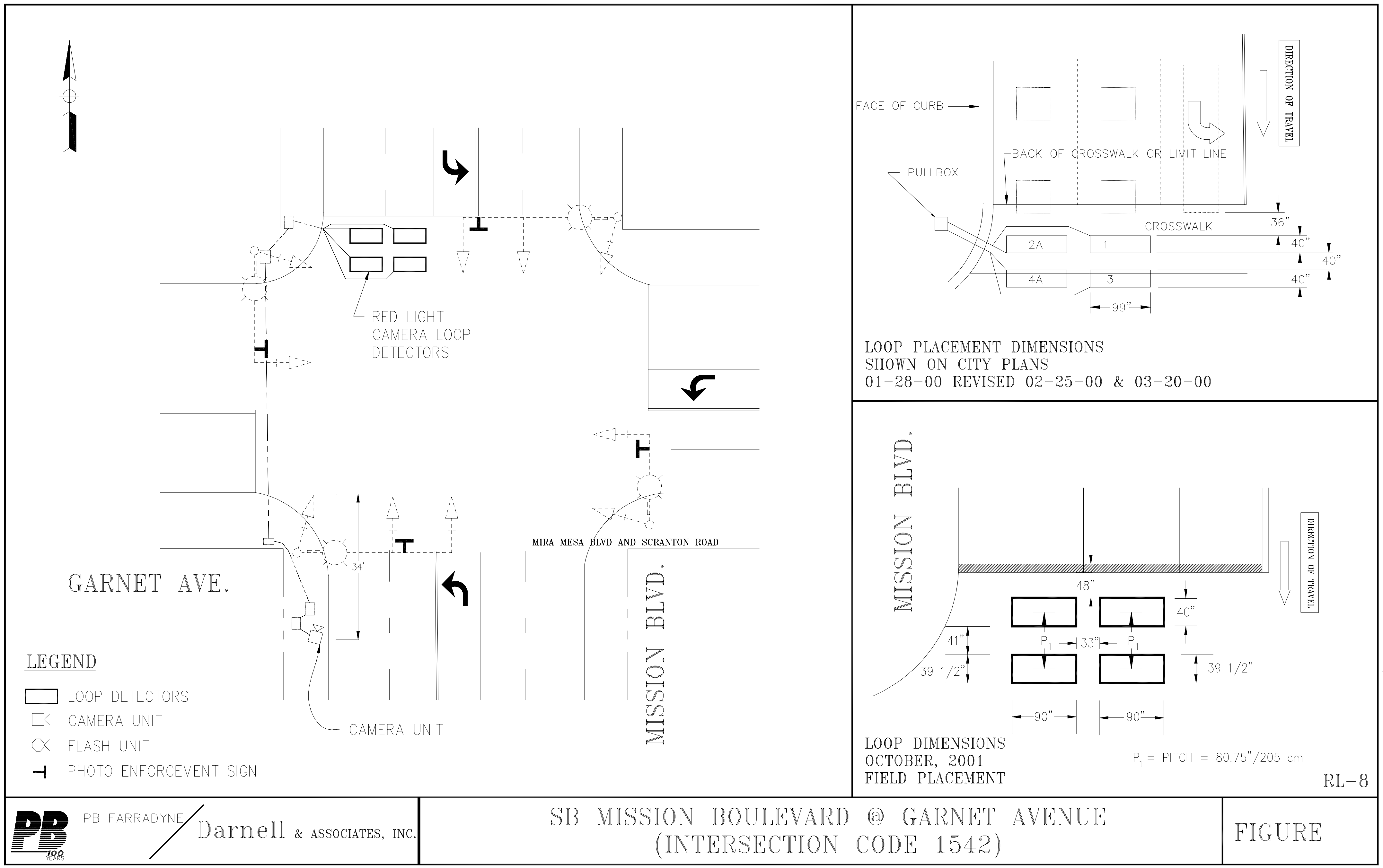

CAMERA UNIT
41'
INGRAHAM ST.
GARNET AVE.
RED LIGHT CAMERA
LOOP DETECTORS
LEGEND
LOOP DETECTORS
CAMERA UNIT
PHOTO ENFORCEMENT SIGN
EXISTING PULLBOX
FACE OF CURB
CROSSWALK
SEE DRAWING FOR DIMENSIONS
99"
90"
40"
40"
48"
50"
DIRECTION OF TRAVEL
LOOP PLACEMENT DIMENSIONS
SHOWN ON CITY PLANS
11-13-98 & REVISED 1-22-99
40"
39"
40"
35"
91.5"
92"
=PITCH=79"/201CM
LOOP DIMENSIONS
OCTOBER, 2001
FIELD PLACEMENT
DIRECTION OF TRAVEL
RL-3
INGRAHAM-N-GARNET 10-24-01 RH/JLM
PB FARRADYNE
Darnell & ASSOCIATES, INC.
WB GARNET AVENUE @ INGRAHAM STREET
(INTERSECTION CODE 1454)
FIGURE

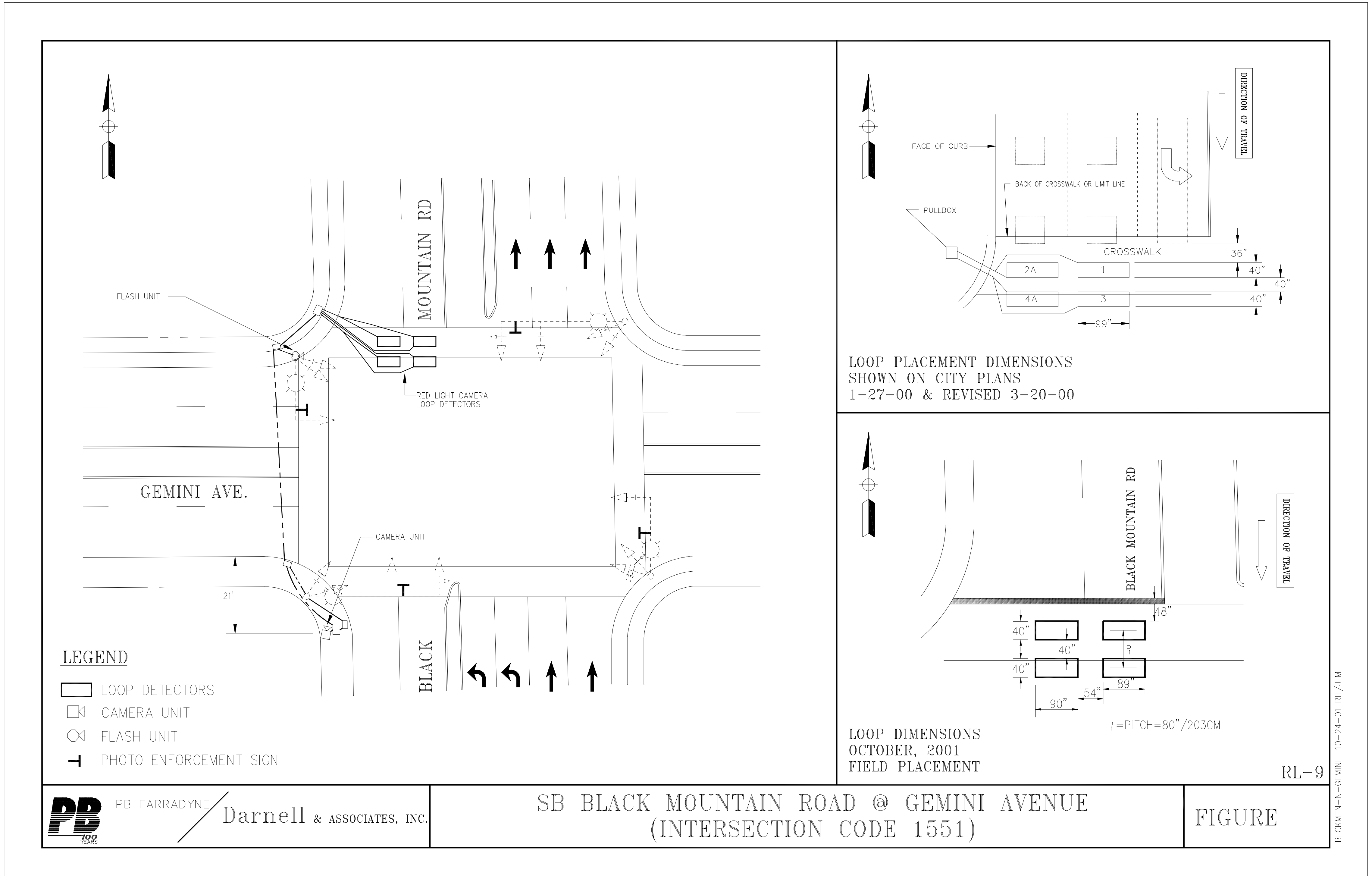

IMPERIAL AVE
EUCLID AVE
RED LIGHT CAMERA LOOP DETECTORS
CAMERA UNIT
16"
LEGEND
LOOP DETECTORS
CAMERA UNIT
PHOTO ENFORCEMENT SIGN
FACE OF CURB
EXISTING PULLBOX
BACK OF CROSSWALK OR LIMIT LINE
DIRECTION OF TRAVEL
CROSSWALK
48"
40"
90"
50"
40"
99"
48" MIN.
LOOP PLACEMENT DIMENSIONS
SHOWN ON CITY PLANS
01-28-99 & REVISED 03-04-99
12"
40"
18"
34"
40"
39 1/2"
29"
51"
50"
40"
40"
90"
90 1/2"
IMPERIAL AVE
DIRECTION OF TRAVEL
LOOP DIMENSIONS
OCTOBER, 2001
FIELD PLACEMENT
P1 = PITCH=68.75"/175cm
P2 = PITCH=90"/229cm
RL-4
PB FARRADYNE
Darnell & ASSOCIATES, INC.
WB IMPERIAL AVENUE @ EUCLID AVENUE
(INTERSECTION CODE 1484)
FIGURE
EUCLID_AND_IMPERIAL 10-24-01 SRN/RH

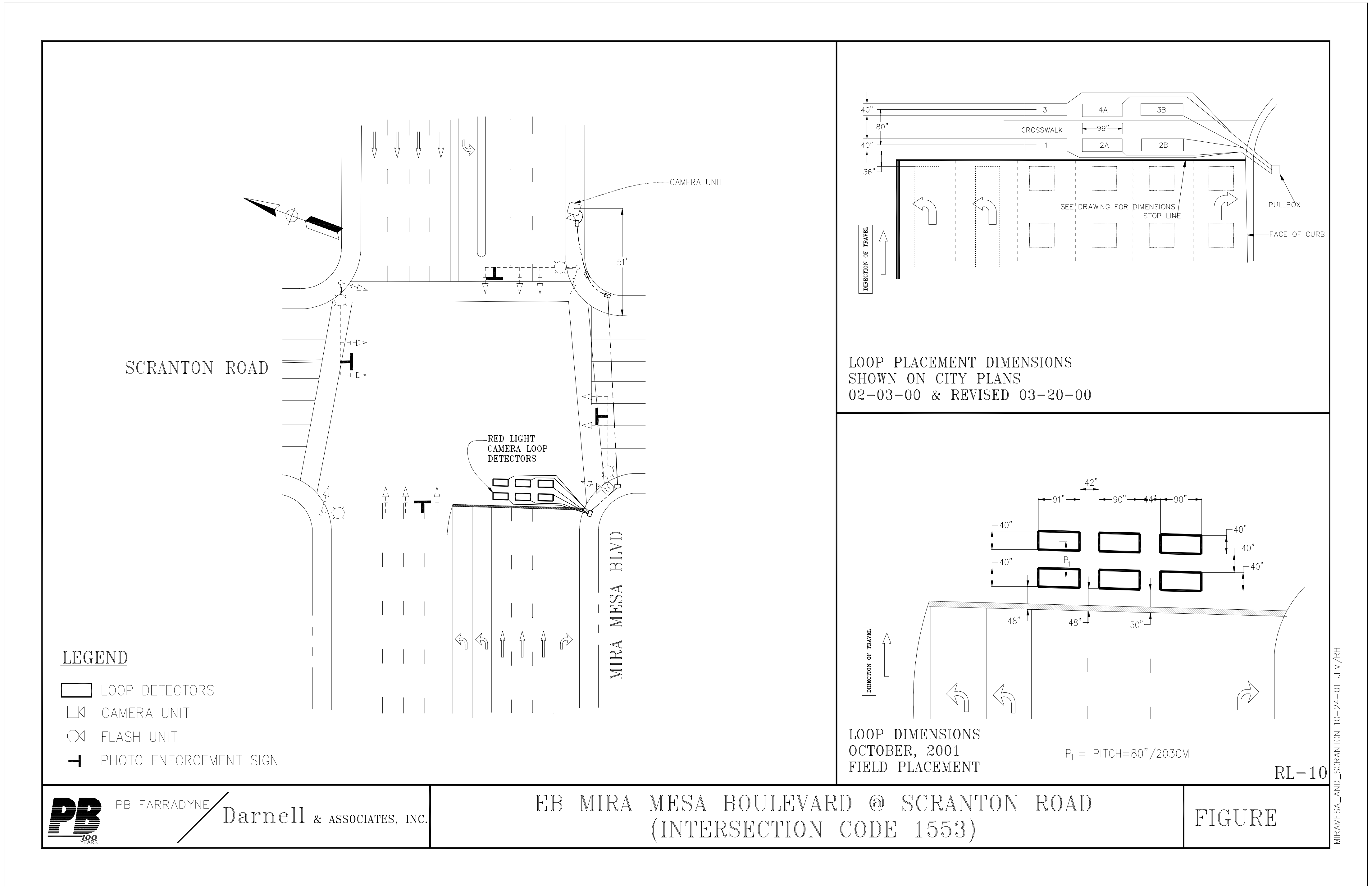

F ST.
RED LIGHT CAMERA
LOOP DETECTORS
46'
CAMERA UNIT
16TH ST.
LEGEND
LOOP DETECTORS
CAMERA UNIT
PHOTO ENFORCEMENT SIGN
EXISTING PULLBOX
FACE OF CURB
CROSSWALK
99"
SEE DRAWING FOR DIMENSIONS
LOOP PLACEMENT DIMENSIONS
SHOWN ON CITY PLANS
3-02-99
90"
40"
40"
DIRECTION OF TRAVEL
40" 40" 40"
90"
P1 =PITCH=80"/203CM
90"
90"
36"
F ST.
LOOP DIMENSIONS
OCTOBER, 2001
FIELD PLACEMENT
DIRECTION OF TRAVEL
RL-5
16TH-N-F 10-24-01 RH/JLM
PB FARRADYNE
Darnell & ASSOCIATES, INC.
WB F STREET @ 16TH STREET
(INTERSECTION CODE 1504)
FIGURE

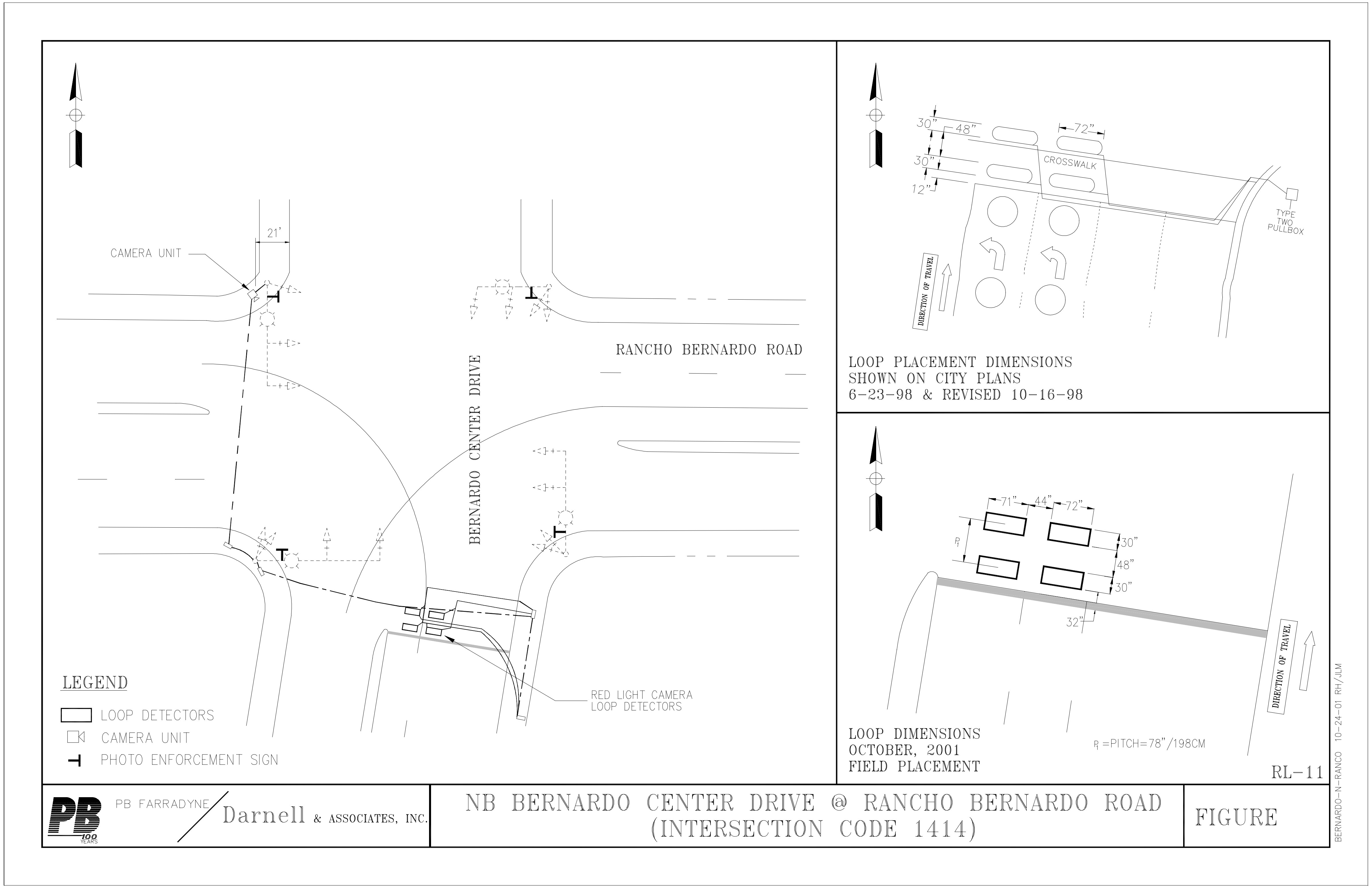

60'
CAMERA UNIT
FLASH UNIT
RED LIGHT CAMERA
LOOP DETECTORS
A STREET
10TH AVENUE
LEGEND
LOOP DETECTORS
CAMERA UNIT
FLASH UNIT
PHOTO ENFORCEMENT SIGN
DIRECTION OF TRAVEL
40"
80"
12"
CROSSWALK
99"
SEE DRAWING FOR DIMENSIONS
STOP LINE
LOOP PLACEMENT DIMENSIONS
SHOWN ON CITY PLANS
12-01-99 & REVISED 12- -99
EXISTING PULLBOX
FACE OF CURB
92"
92 1/2"
40 1/2"
60"
R=PITCH=80.5"/204.5CM
LOOP DIMENSIONS
OCTOBER, 2001
FIELD PLACEMENT
RL-6
A-N-10TH 10-24-01 RH/JLM
PB FARRADYNE
Darnell & ASSOCIATES, INC.
EB A STREET @ 10TH AVENUE
(INTERSECTION CODE 1523)
FIGURE

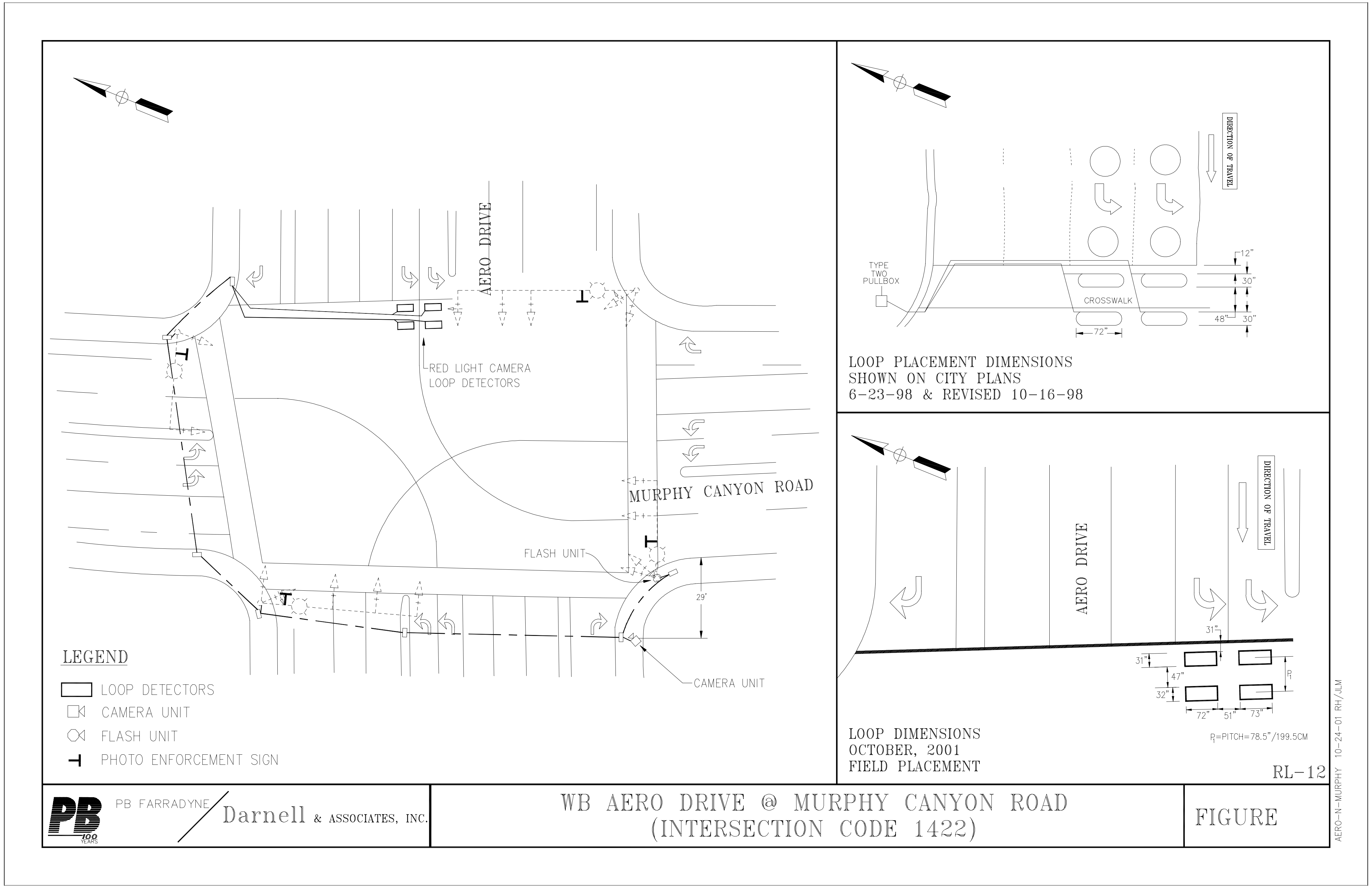

57'
CAMINO RUIZ
FLASH UNIT
CAMERA UNIT
RED LIGHT CAMERA
LOOP DETECTORS
MIRAMAR RD.
LEGEND
LOOP DETECTORS
CAMERA UNIT
FLASH UNIT
PHOTO ENFORCEMENT SIGN
NEW NO. 6 PULLBOX
40" MIN.
92"
DIRECTION OF TRAVEL
LOOP PLACEMENT DIMENSIONS
SHOWN ON CITY PLANS
12-01-99 & REVISED 9-20-00
P =PITCH=79.5"/202CM
LOOP DIMENSIONS
OCTOBER, 2001
FIELD PLACEMENT
RL-7
PB FARRADYNE
Darnell & ASSOCIATES, INC.
WB MIRAMAR ROAD @ CAMINO RUIZ
(INTERSECTION CODE 1534)
FIGURE
MIRAMAR-N-CAMINO 10-24-01 JLM

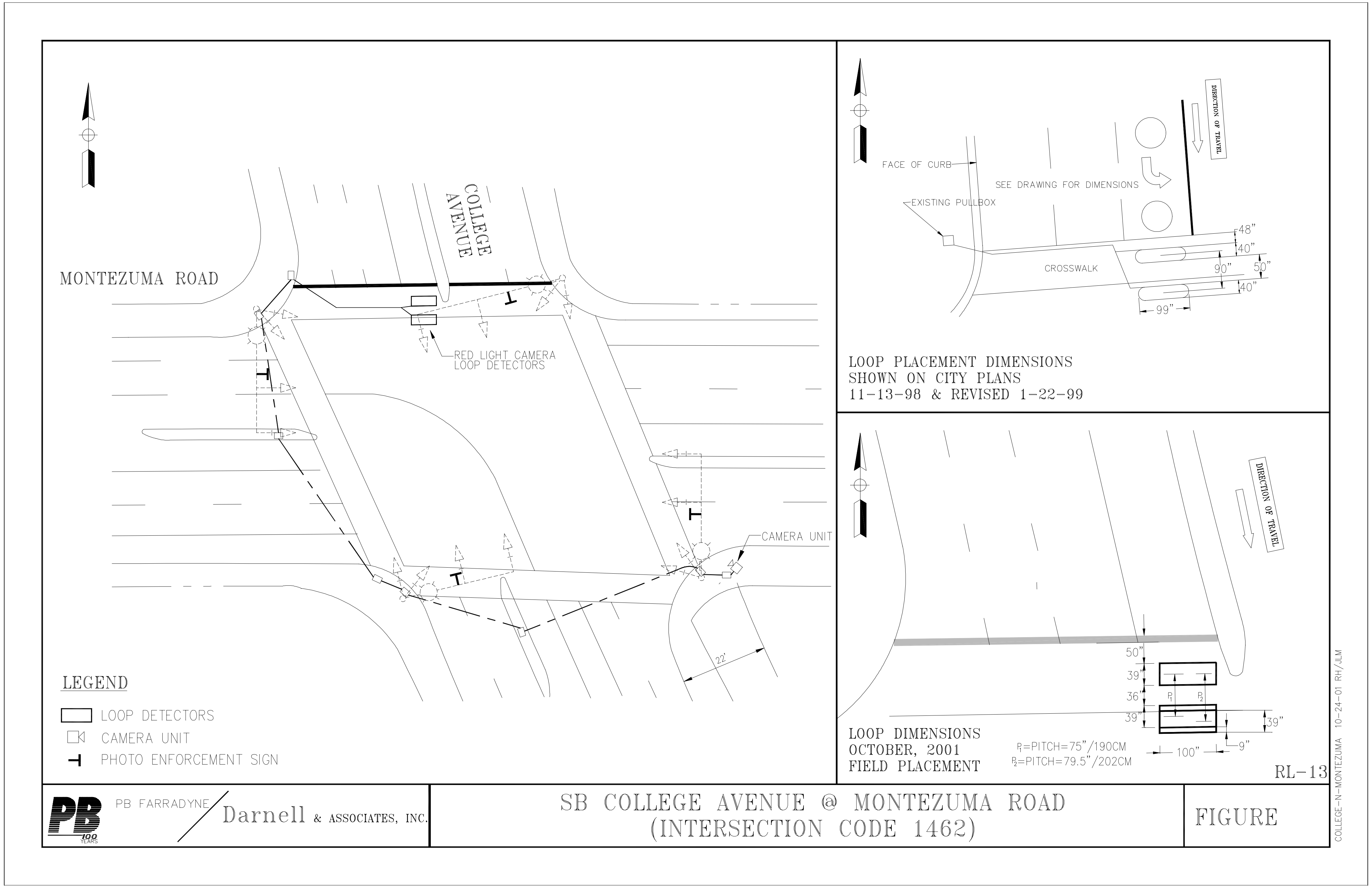

RED LIGHT CAMERA LOOP DETECTORS
MIRA MESA BLVD AND SCRANTON ROAD
GARNET AVE.
MISSION BLVD.
CAMERA UNIT
34'
LEGEND
LOOP DETECTORS
CAMERA UNIT
FLASH UNIT
PHOTO ENFORCEMENT SIGN
FACE OF CURB
PULLBOX
BACK OF CROSSWALK OR LIMIT LINE
DIRECTION OF TRAVEL
CROSSWALK
36"
40"
40"
40"
2A
1
4A
3
99"
LOOP PLACEMENT DIMENSIONS
SHOWN ON CITY PLANS
01-28-00 REVISED 02-25-00 & 03-20-00
MISSION BLVD.
DIRECTION OF TRAVEL
48"
40"
41"
39 1/2"
33"
39 1/2"
90"
90"
LOOP DIMENSIONS
OCTOBER, 2001
FIELD PLACEMENT
P1 = PITCH = 80.75"/205 cm
RL-8
MISSIONBLVD-N-GARNET 10-24-01 JLM/RH
PB FARRADYNE
Darnell & ASSOCIATES, INC.
SB MISSION BOULEVARD @ GARNET AVENUE
(INTERSECTION CODE 1542)
FIGURE

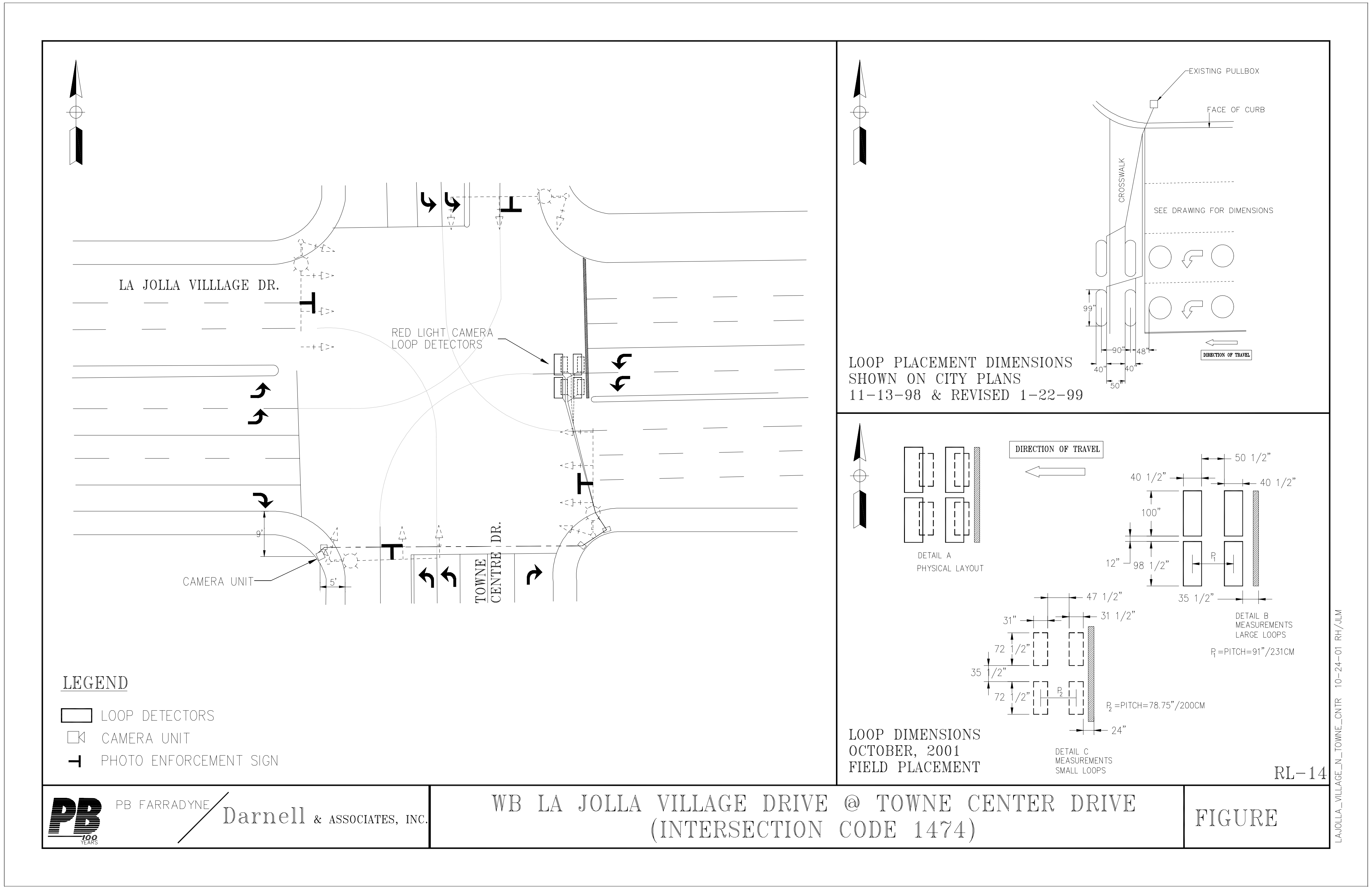

FLASH UNIT
MOUNTAIN RD
RED LIGHT CAMERA LOOP DETECTORS
GEMINI AVE.
CAMERA UNIT
21'
BLACK
LEGEND
LOOP DETECTORS
CAMERA UNIT
FLASH UNIT
PHOTO ENFORCEMENT SIGN
FACE OF CURB
BACK OF CROSSWALK OR LIMIT LINE
PULLBOX
DIRECTION OF TRAVEL
CROSSWALK
36"
40"
40"
40"
2A
1
4A
3
99"
LOOP PLACEMENT DIMENSIONS
SHOWN ON CITY PLANS
1-27-00 & REVISED 3-20-00
BLACK MOUNTAIN RD
DIRECTION OF TRAVEL
48"
40"
40"
40"
54"
89"
90"
℞ =PITCH=80"/203CM
LOOP DIMENSIONS
OCTOBER, 2001
FIELD PLACEMENT
RL-9
BLCKMTN-N-GEMINI 10-24-01 RH/JLM
PB FARRADYNE
Darnell & ASSOCIATES, INC.
SB BLACK MOUNTAIN ROAD @ GEMINI AVENUE
(INTERSECTION CODE 1551)
FIGURE

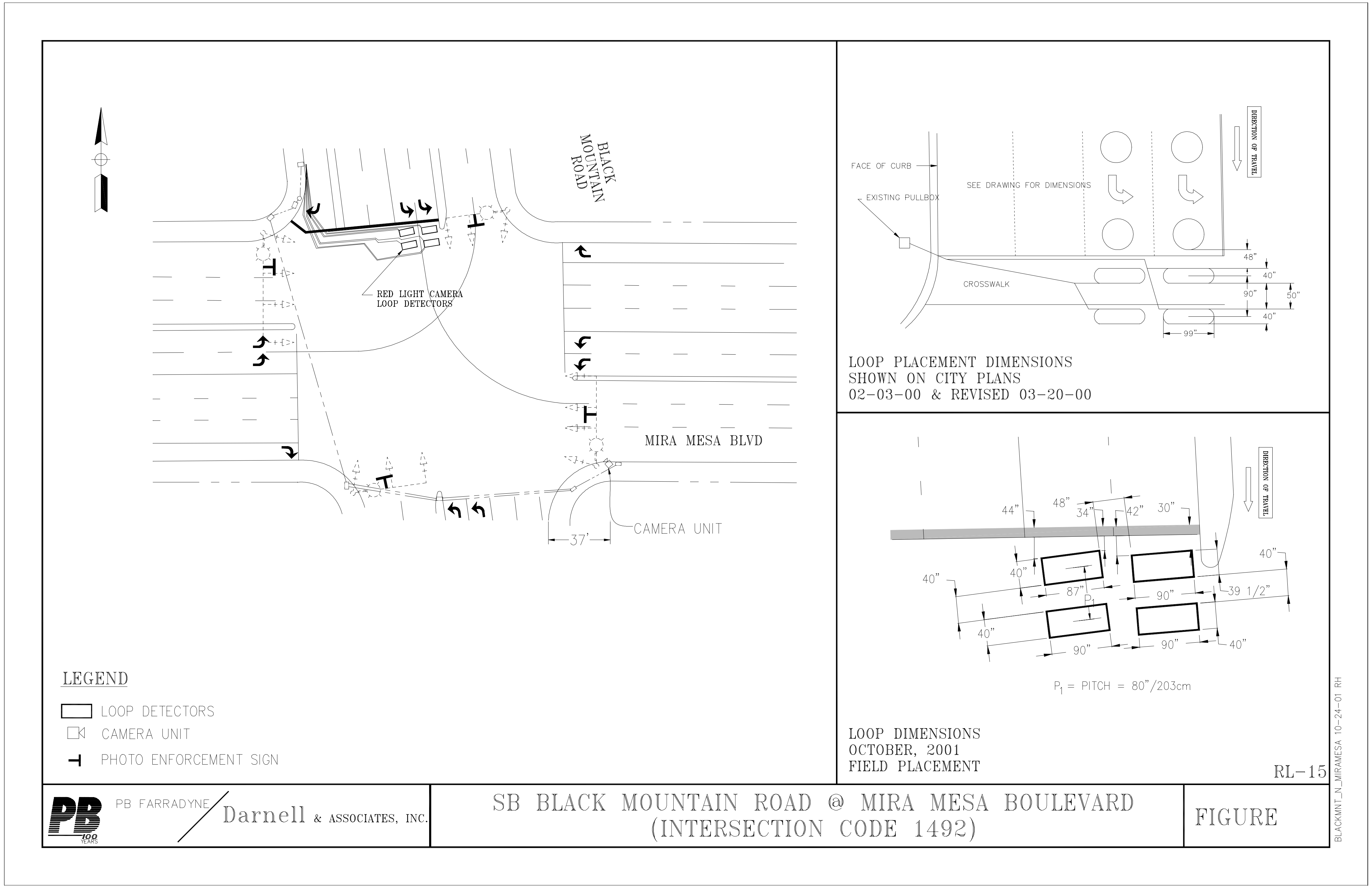

CAMERA UNIT
51'
SCRANTON ROAD
RED LIGHT CAMERA LOOP DETECTORS
MIRA MESA BLVD
LEGEND
LOOP DETECTORS
CAMERA UNIT
FLASH UNIT
PHOTO ENFORCEMENT SIGN
CROSSWALK
SEE DRAWING FOR DIMENSIONS
STOP LINE
PULLBOX
FACE OF CURB
DIRECTION OF TRAVEL
LOOP PLACEMENT DIMENSIONS SHOWN ON CITY PLANS 02-03-00 & REVISED 03-20-00
LOOP DIMENSIONS OCTOBER, 2001 FIELD PLACEMENT
P1 = PITCH=80"/203CM
RL-10
PB FARRADYNE
Darnell & ASSOCIATES, INC.
EB MIRA MESA BOULEVARD @ SCRANTON ROAD (INTERSECTION CODE 1553)
FIGURE
MIRAMESA_AND_SCRANTON 10-24-01 JLM/RH

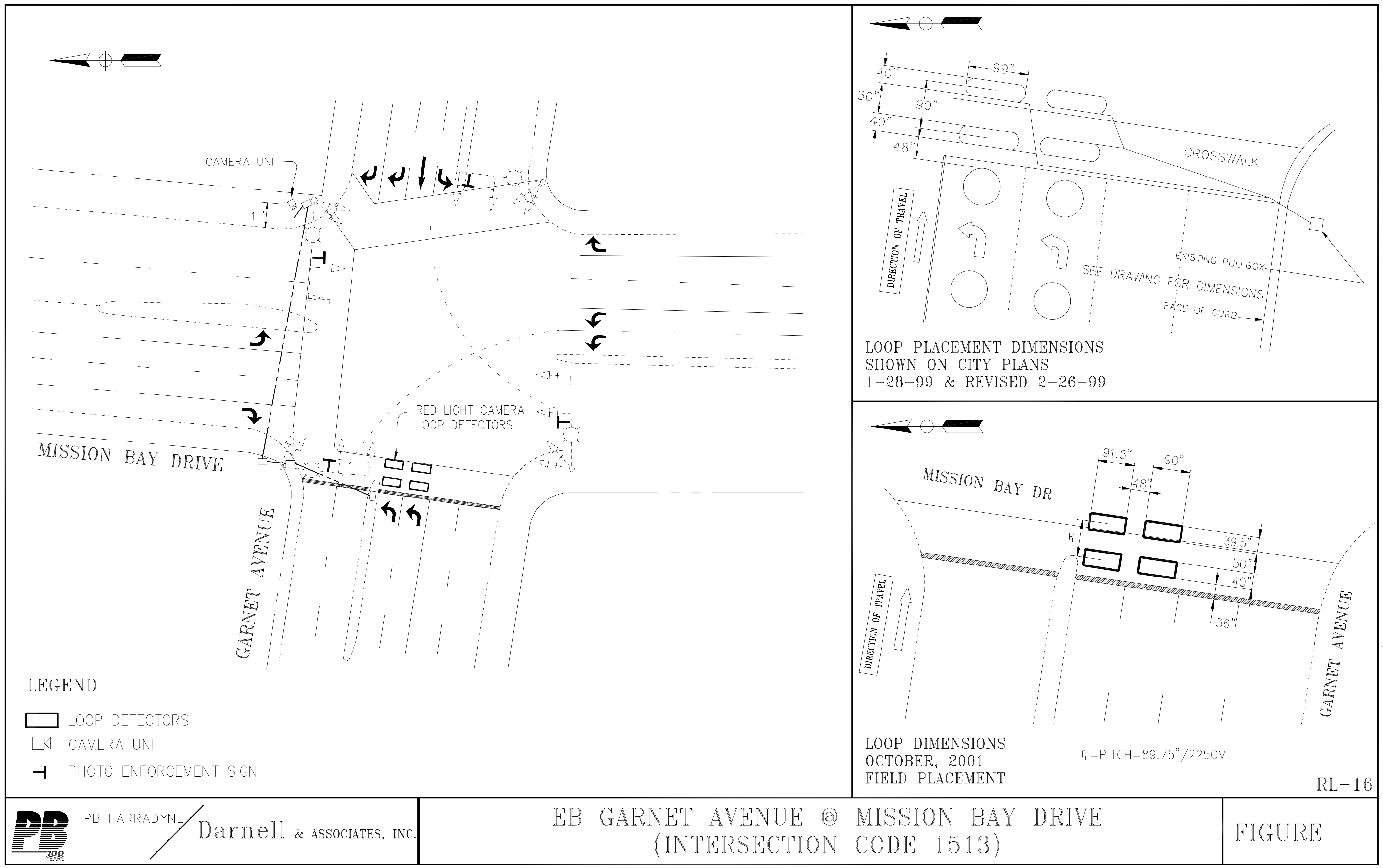

CAMERA UNIT
21'
RANCHO BERNARDO ROAD
BERNARDO CENTER DRIVE
RED LIGHT CAMERA LOOP DETECTORS
LEGEND
LOOP DETECTORS
CAMERA UNIT
PHOTO ENFORCEMENT SIGN
CROSSWALK
TYPE TWO PULLBOX
DIRECTION OF TRAVEL
LOOP PLACEMENT DIMENSIONS
SHOWN ON CITY PLANS
6-23-98 & REVISED 10-16-98
LOOP DIMENSIONS
OCTOBER, 2001
FIELD PLACEMENT
℞ =PITCH=78"/198CM
RL-11
PB FARRADYNE
Darnell & ASSOCIATES, INC.
NB BERNARDO CENTER DRIVE @ RANCHO BERNARDO ROAD
(INTERSECTION CODE 1414)
FIGURE
BERNARDO-N-RANCO 10-24-01 RH/JLM

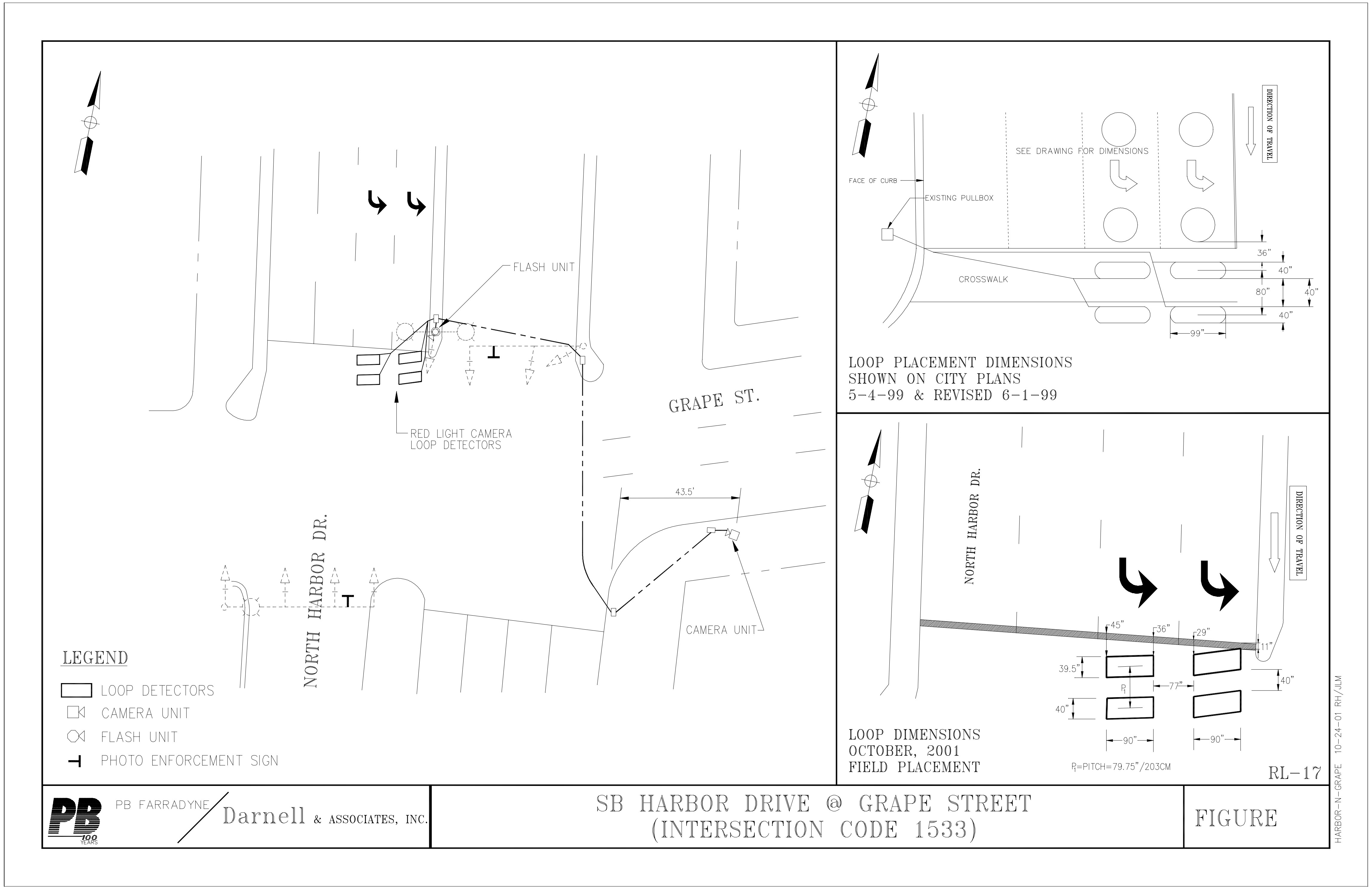

AERO DRIVE
MURPHY CANYON ROAD
RED LIGHT CAMERA LOOP DETECTORS
FLASH UNIT
CAMERA UNIT
29'
LEGEND
LOOP DETECTORS
CAMERA UNIT
FLASH UNIT
PHOTO ENFORCEMENT SIGN
TYPE TWO PULLBOX
CROSSWALK
DIRECTION OF TRAVEL
LOOP PLACEMENT DIMENSIONS
SHOWN ON CITY PLANS
6-23-98 & REVISED 10-16-98
LOOP DIMENSIONS
OCTOBER, 2001
FIELD PLACEMENT
R=PITCH=78.5"/199.5CM
RL-12
PB FARRADYNE
Darnell & ASSOCIATES, INC.
WB AERO DRIVE @ MURPHY CANYON ROAD
(INTERSECTION CODE 1422)
FIGURE
AERO-N-MURPHY 10-24-01 RH/JLM

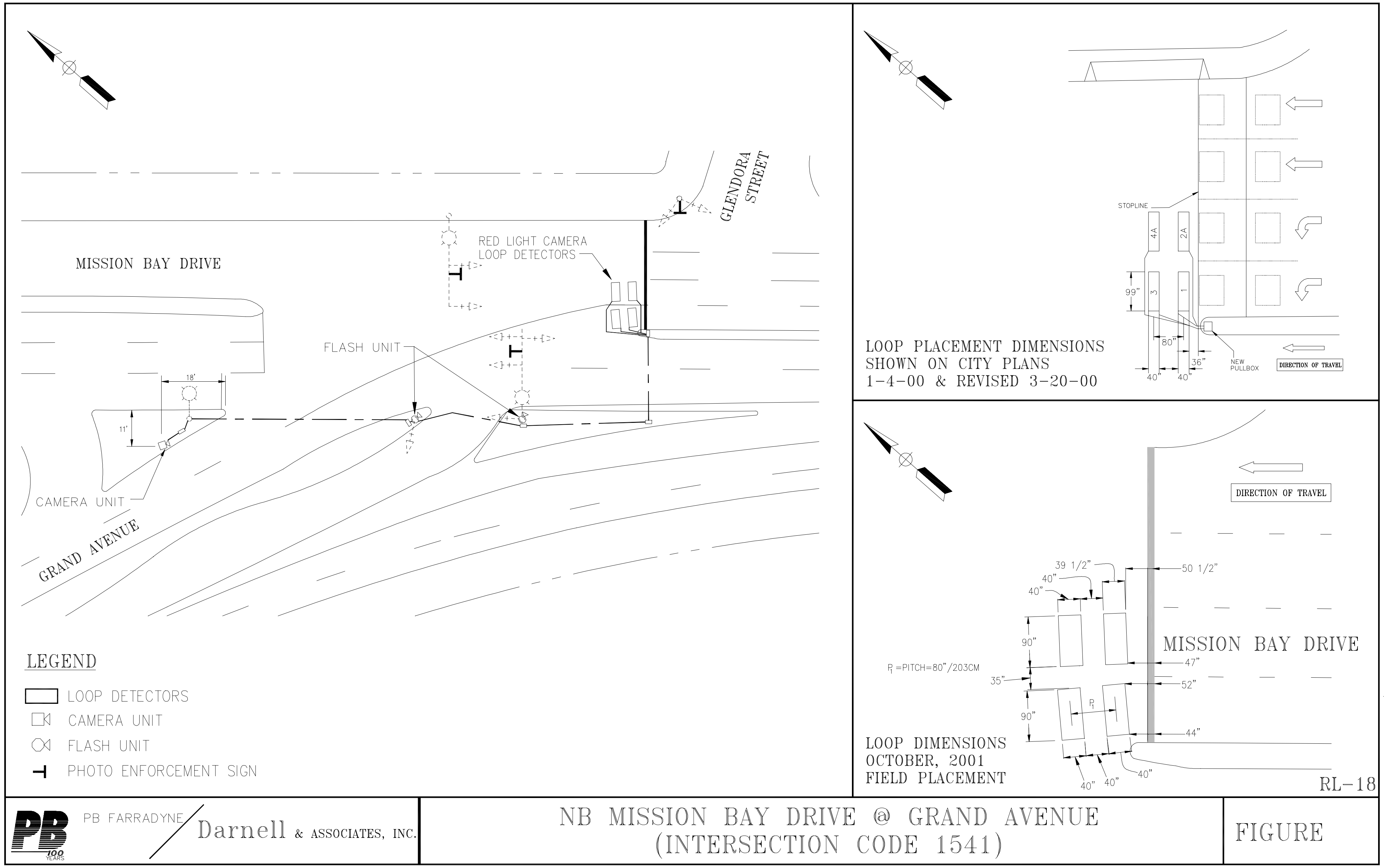

MONTEZUMA ROAD
COLLEGE AVENUE
RED LIGHT CAMERA LOOP DETECTORS
CAMERA UNIT
22'
LEGEND
LOOP DETECTORS
CAMERA UNIT
PHOTO ENFORCEMENT SIGN
FACE OF CURB
EXISTING PULLBOX
SEE DRAWING FOR DIMENSIONS
DIRECTION OF TRAVEL
CROSSWALK
48"
40"
90"
50"
40"
99"
LOOP PLACEMENT DIMENSIONS
SHOWN ON CITY PLANS
11-13-98 & REVISED 1-22-99
DIRECTION OF TRAVEL
50"
39"
36"
39"
39"
100"
9"
LOOP DIMENSIONS
OCTOBER, 2001
FIELD PLACEMENT
P1=PITCH=75"/190CM
P2=PITCH=79.5"/202CM
RL-13
PB FARRADYNE
Darnell & ASSOCIATES, INC.
SB COLLEGE AVENUE @ MONTEZUMA ROAD
(INTERSECTION CODE 1462)
FIGURE
COLLEGE-N-MONTEZUMA 10-24-01 RH/JLM


LA JOLLA VILLLAGE DR.
RED LIGHT CAMERA LOOP DETECTORS
CAMERA UNIT
TOWNE CENTRE DR.
LEGEND
LOOP DETECTORS
CAMERA UNIT
PHOTO ENFORCEMENT SIGN
EXISTING PULLBOX
FACE OF CURB
CROSSWALK
SEE DRAWING FOR DIMENSIONS
DIRECTION OF TRAVEL
LOOP PLACEMENT DIMENSIONS SHOWN ON CITY PLANS 11-13-98 & REVISED 1-22-99
DETAIL A PHYSICAL LAYOUT
DETAIL B MEASUREMENTS LARGE LOOPS
P1 =PITCH=91"/231CM
DETAIL C MEASUREMENTS SMALL LOOPS
P2 =PITCH=78.75"/200CM
LOOP DIMENSIONS OCTOBER, 2001 FIELD PLACEMENT
RL-14
PB FARRADYNE
Darnell & ASSOCIATES, INC.
WB LA JOLLA VILLAGE DRIVE @ TOWNE CENTER DRIVE (INTERSECTION CODE 1474)
FIGURE
LAJOLLA_VILLAGE_N_TOWNE_CNTR 10-24-01 RH/JLM


BLACK MOUNTAIN ROAD
RED LIGHT CAMERA LOOP DETECTORS
MIRA MESA BLVD
37'
CAMERA UNIT
LEGEND
LOOP DETECTORS
CAMERA UNIT
PHOTO ENFORCEMENT SIGN
FACE OF CURB
EXISTING PULLBOX
SEE DRAWING FOR DIMENSIONS
CROSSWALK
DIRECTION OF TRAVEL
48"
40"
90"
50"
40"
99"
LOOP PLACEMENT DIMENSIONS
SHOWN ON CITY PLANS
02-03-00 & REVISED 03-20-00
44"
48"
34"
42"
30"
40"
40"
87"
90"
39 1/2"
40"
90"
90"
40"
P1 = PITCH = 80"/203cm
LOOP DIMENSIONS
OCTOBER, 2001
FIELD PLACEMENT
RL-15
BLACKMNT_N_MIRAMESA 10-24-01 RH
PB FARRADYNE
Darnell & ASSOCIATES, INC.
SB BLACK MOUNTAIN ROAD @ MIRA MESA BOULEVARD
(INTERSECTION CODE 1492)
FIGURE

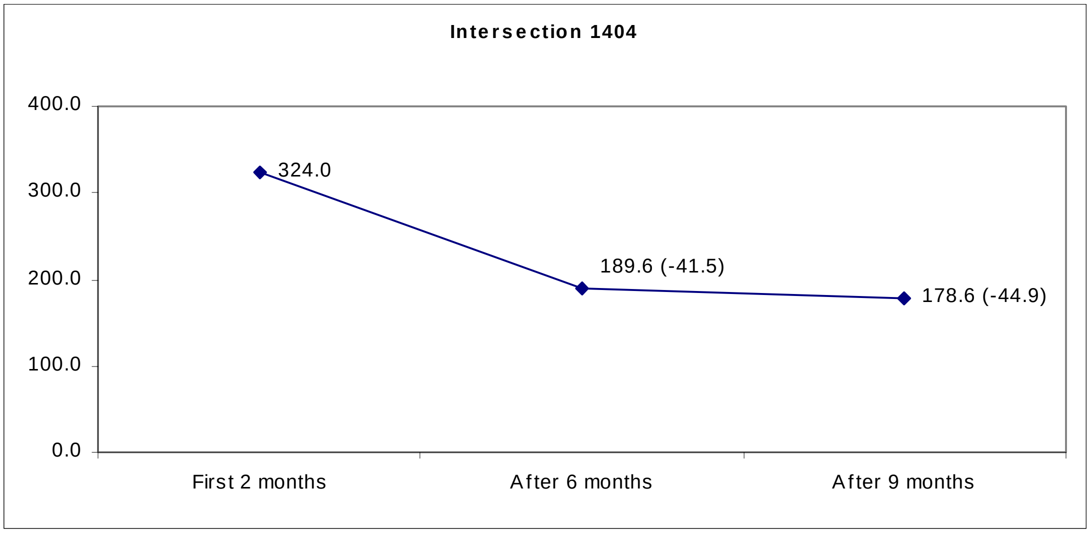

CAMERA UNIT
11'
RED LIGHT CAMERA
LOOP DETECTORS
MISSION BAY DRIVE
GARNET AVENUE
LEGEND
LOOP DETECTORS
CAMERA UNIT
PHOTO ENFORCEMENT SIGN
99"
40"
50"
90"
40"
48"
CROSSWALK
DIRECTION OF TRAVEL
EXISTING PULLBOX
SEE DRAWING FOR DIMENSIONS
FACE OF CURB
LOOP PLACEMENT DIMENSIONS
SHOWN ON CITY PLANS
1-28-99 & REVISED 2-26-99
MISSION BAY DR
91.5"
90"
48"
39.5"
50"
40"
36"
GARNET AVENUE
DIRECTION OF TRAVEL
LOOP DIMENSIONS
OCTOBER, 2001
FIELD PLACEMENT
℄=PITCH=89.75"/225CM
RL-16
PB FARRADYNE
Darnell & ASSOCIATES, INC.
EB GARNET AVENUE @ MISSION BAY DRIVE
(INTERSECTION CODE 1513)
FIGURE
GARNET AV-MISSION_BAY_DR 10-24-01 SRN/JLM

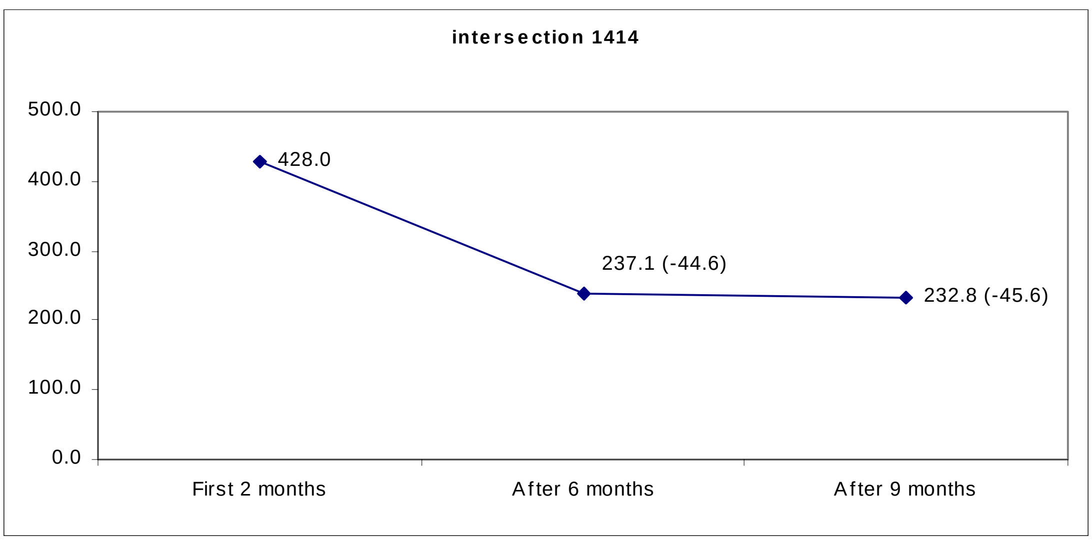

FLASH UNIT
GRAPE ST.
RED LIGHT CAMERA
LOOP DETECTORS
43.5'
NORTH HARBOR DR.
CAMERA UNIT
LEGEND
LOOP DETECTORS
CAMERA UNIT
FLASH UNIT
PHOTO ENFORCEMENT SIGN
SEE DRAWING FOR DIMENSIONS
FACE OF CURB
EXISTING PULLBOX
CROSSWALK
DIRECTION OF TRAVEL
LOOP PLACEMENT DIMENSIONS
SHOWN ON CITY PLANS
5-4-99 & REVISED 6-1-99
NORTH HARBOR DR.
LOOP DIMENSIONS
OCTOBER, 2001
FIELD PLACEMENT
P=PITCH=79.75"/203CM
RL-17
PB FARRADYNE
Darnell & ASSOCIATES, INC.
SB HARBOR DRIVE @ GRAPE STREET
(INTERSECTION CODE 1533)
FIGURE
HARBOR-N-GRAPE 10-24-01 RH/JLM

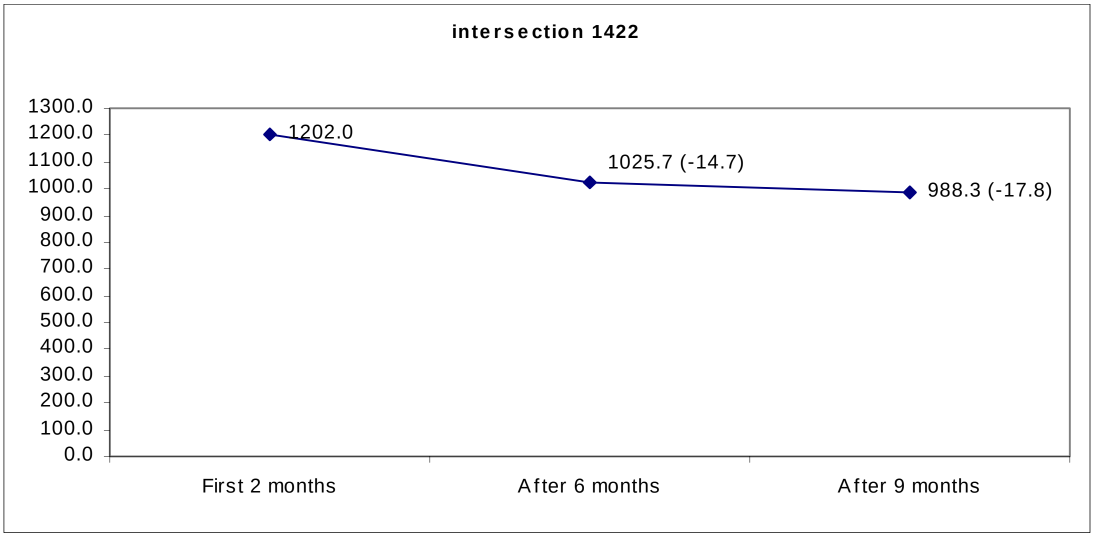


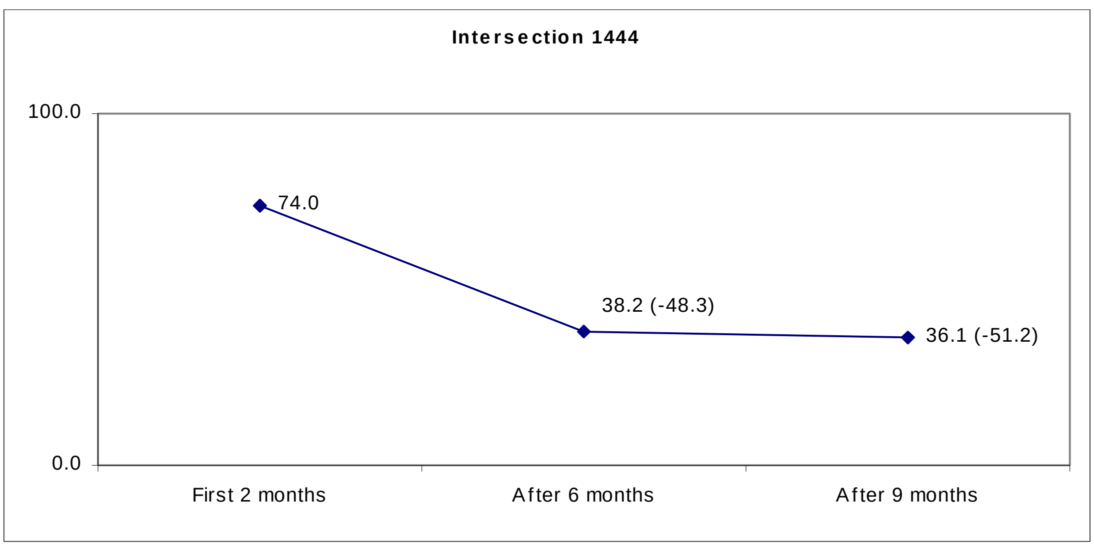
MISSION BAY DRIVE
GLENDORA STREET
RED LIGHT CAMERA LOOP DETECTORS
FLASH UNIT
CAMERA UNIT
GRAND AVENUE
18'
11'
LEGEND
LOOP DETECTORS
CAMERA UNIT
FLASH UNIT
PHOTO ENFORCEMENT SIGN
STOPLINE
4A
2A
3
1
99"
80"
36"
40"
40"
NEW PULLBOX
DIRECTION OF TRAVEL
LOOP PLACEMENT DIMENSIONS SHOWN ON CITY PLANS 1-4-00 & REVISED 3-20-00
DIRECTION OF TRAVEL
39 1/2"
40"
40"
50 1/2"
90"
35"
90"
47"
52"
44"
MISSION BAY DRIVE
P1 =PITCH=80"/203CM
LOOP DIMENSIONS OCTOBER, 2001 FIELD PLACEMENT
40"
40"
40"
RL-18
PB FARRADYNE
Darnell & ASSOCIATES, INC.
NB MISSION BAY DRIVE @ GRAND AVENUE (INTERSECTION CODE 1541)
FIGURE
MISSION-N-GRAND 10-24-01 RH/JLM

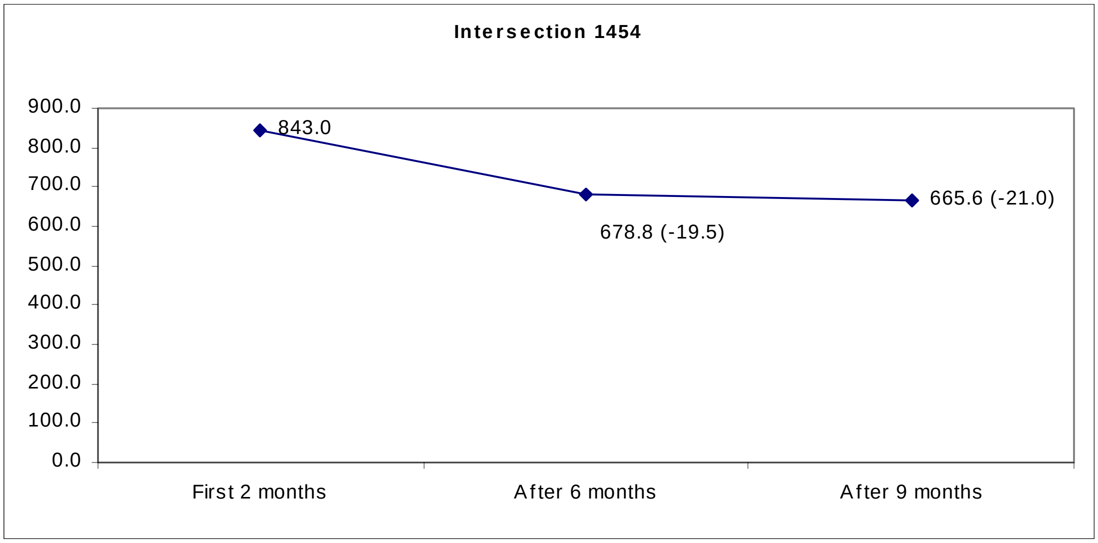
APPENDIX C
VIOLATION TREND AT PHOTO ENFORCED INTERSECTIONS

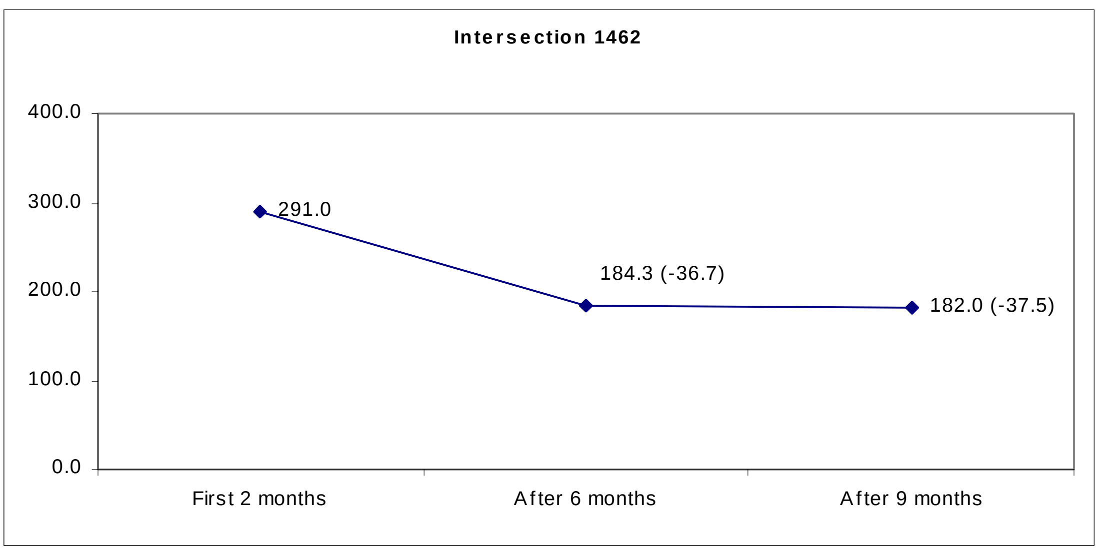

Intersection 1404
400.0
300.0
200.0
100.0
0.0
324.0
189.6 (-41.5)
178.6 (-44.9)
First 2 months
After 6 months
After 9 months

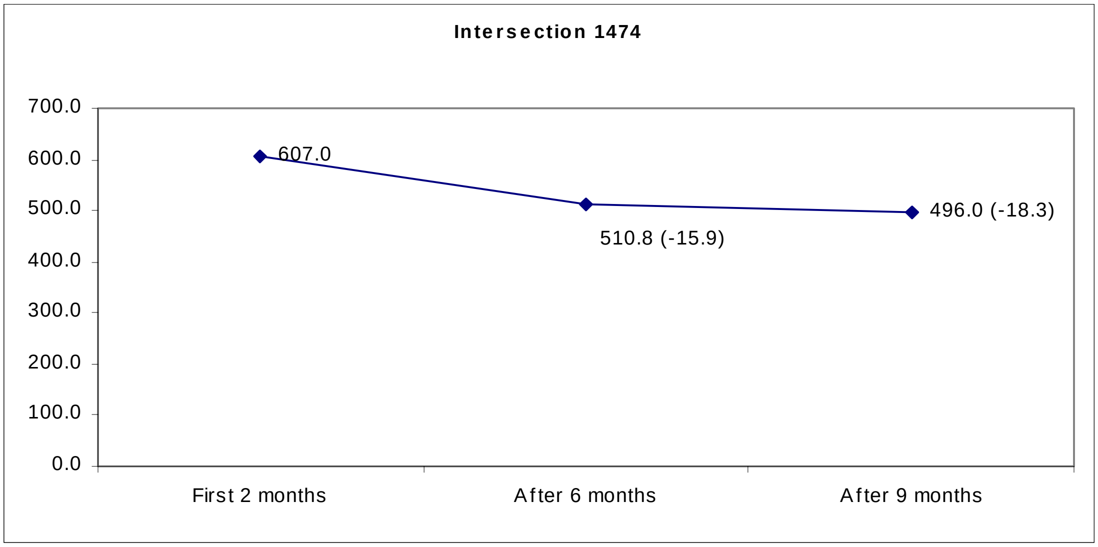

intersection 1414
500.0
400.0
300.0
200.0
100.0
0.0
428.0
237.1 (-44.6)
232.8 (-45.6)
First 2 months
After 6 months
After 9 months

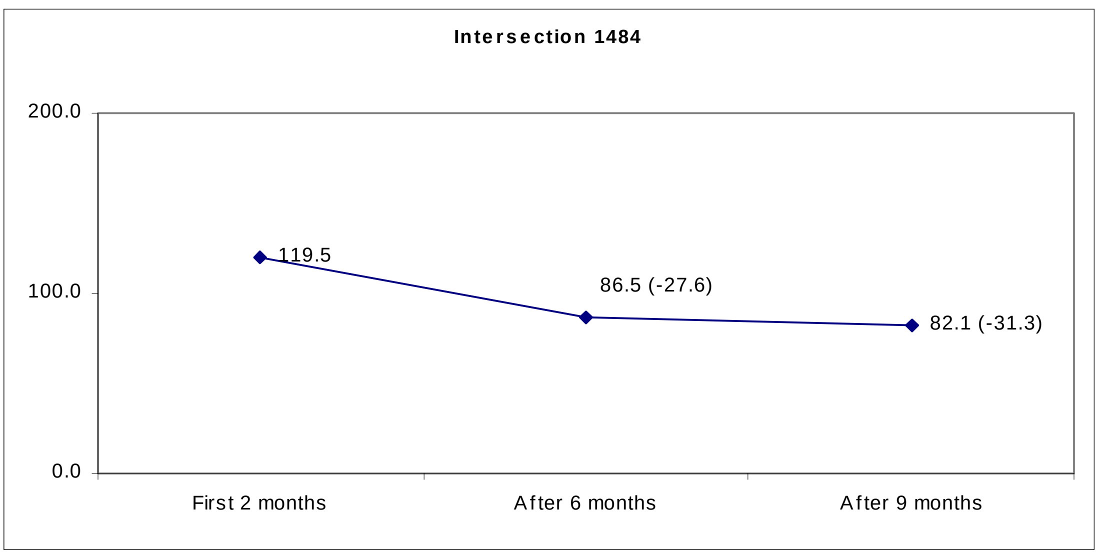

intersection 1422
1300.0
1200.0
1100.0
1000.0
900.0
800.0
700.0
600.0
500.0
400.0
300.0
200.0
100.0
0.0
1202.0
1025.7 (-14.7)
988.3 (-17.8)
First 2 months
After 6 months
After 9 months

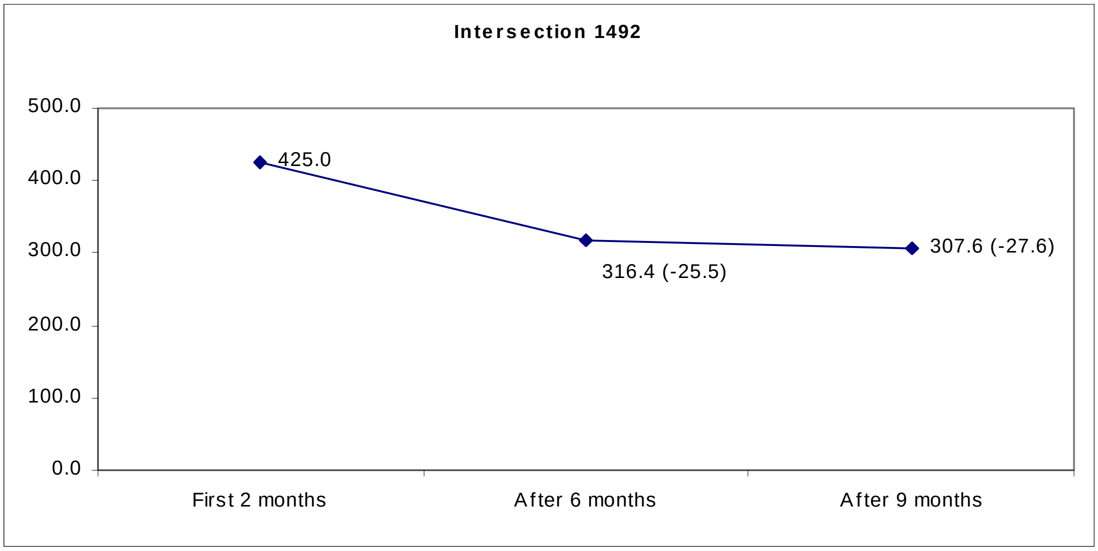

Intersection 1444
100.0
0.0
74.0
38.2 (-48.3)
36.1 (-51.2)
First 2 months
After 6 months
After 9 months

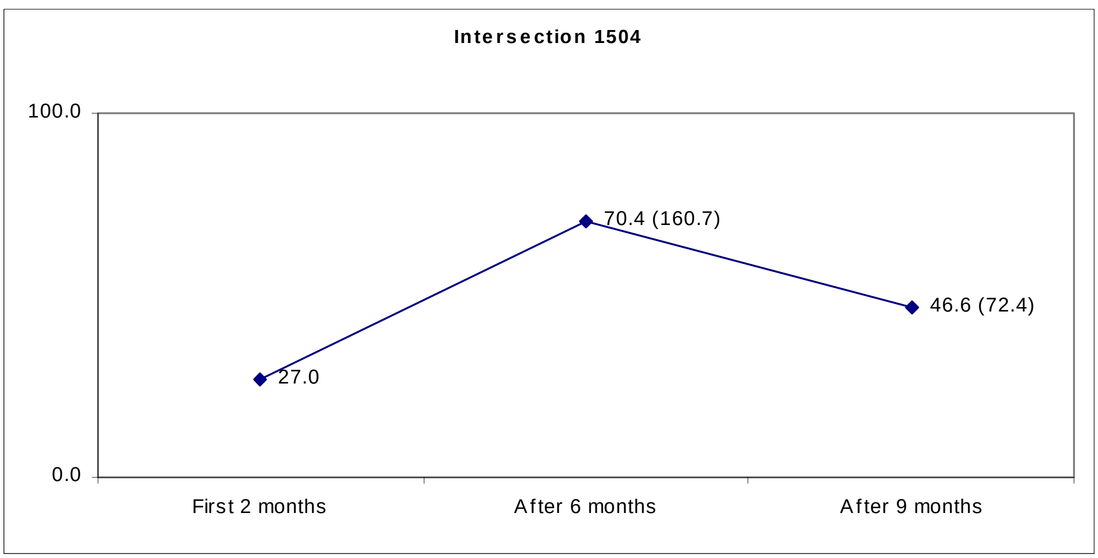

Intersection 1454
900.0
800.0
700.0
600.0
500.0
400.0
300.0
200.0
100.0
0.0
843.0
678.8 (-19.5)
665.6 (-21.0)
First 2 months
After 6 months
After 9 months

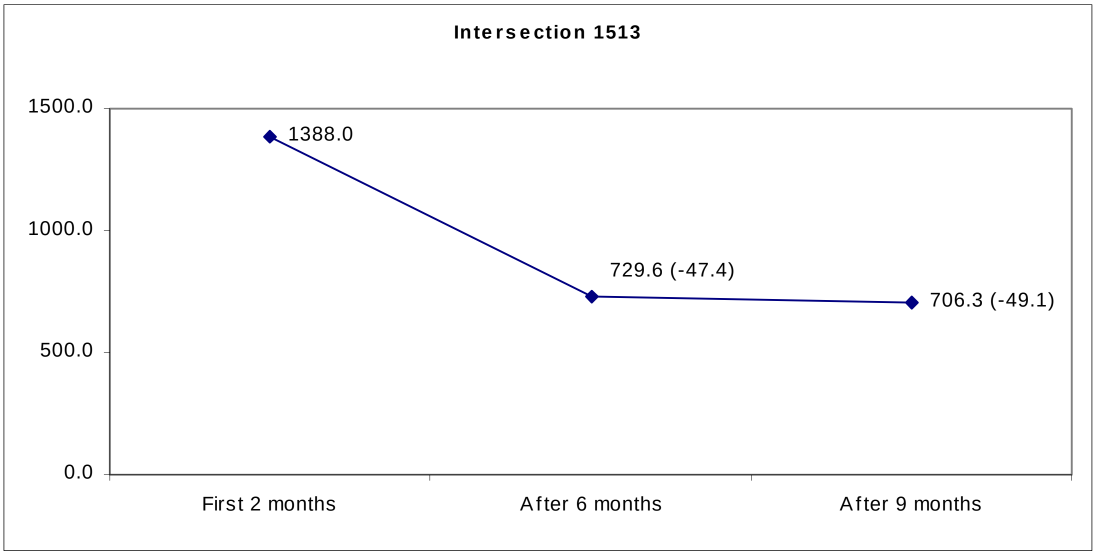

Intersection 1462
400.0
300.0
200.0
100.0
0.0
291.0
184.3 (-36.7)
182.0 (-37.5)
First 2 months
After 6 months
After 9 months


Intersection 1474
700.0
600.0
500.0
400.0
300.0
200.0
100.0
0.0
607.0
510.8 (-15.9)
496.0 (-18.3)
First 2 months
After 6 months
After 9 months

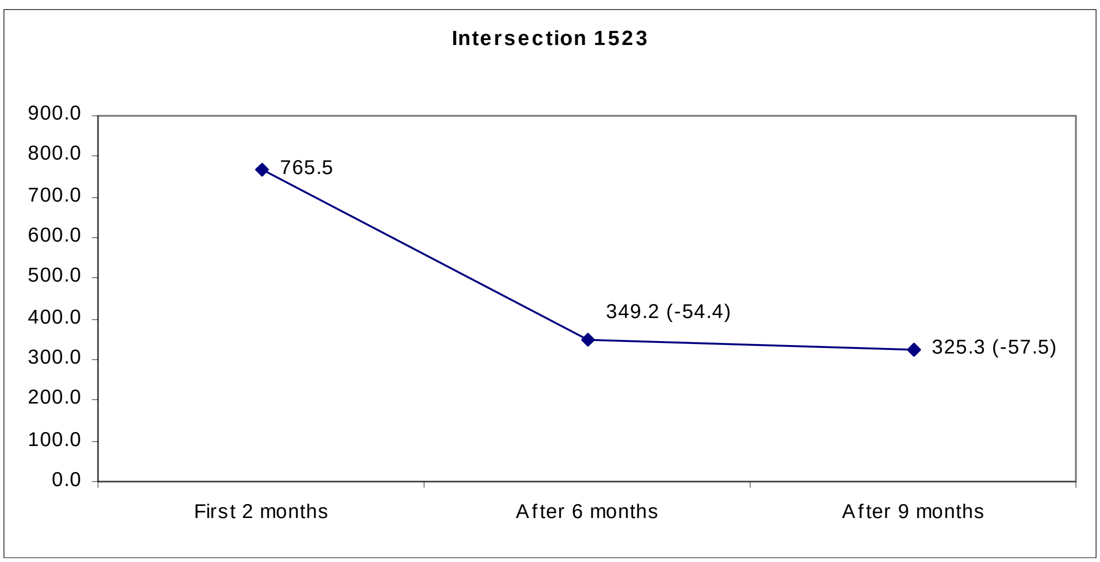

Intersection 1484
200.0
100.0
0.0
119.5
86.5 (-27.6)
82.1 (-31.3)
First 2 months
After 6 months
After 9 months


Intersection 1492
500.0
400.0
300.0
200.0
100.0
0.0
425.0
316.4 (-25.5)
307.6 (-27.6)
First 2 months
After 6 months
After 9 months

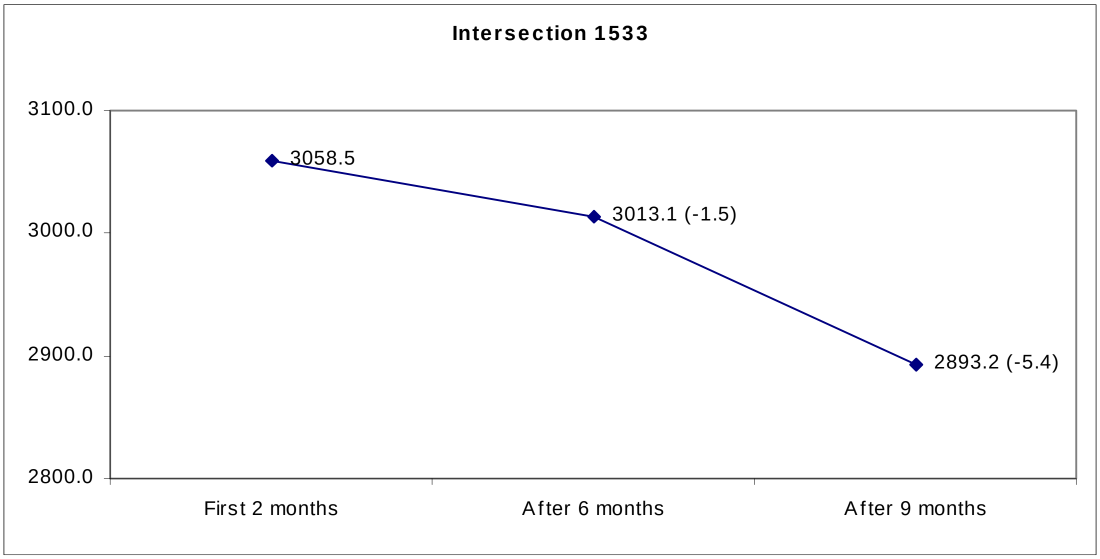

Intersection 1504
100.0
0.0
70.4 (160.7)
46.6 (72.4)
27.0
First 2 months
After 6 months
After 9 months

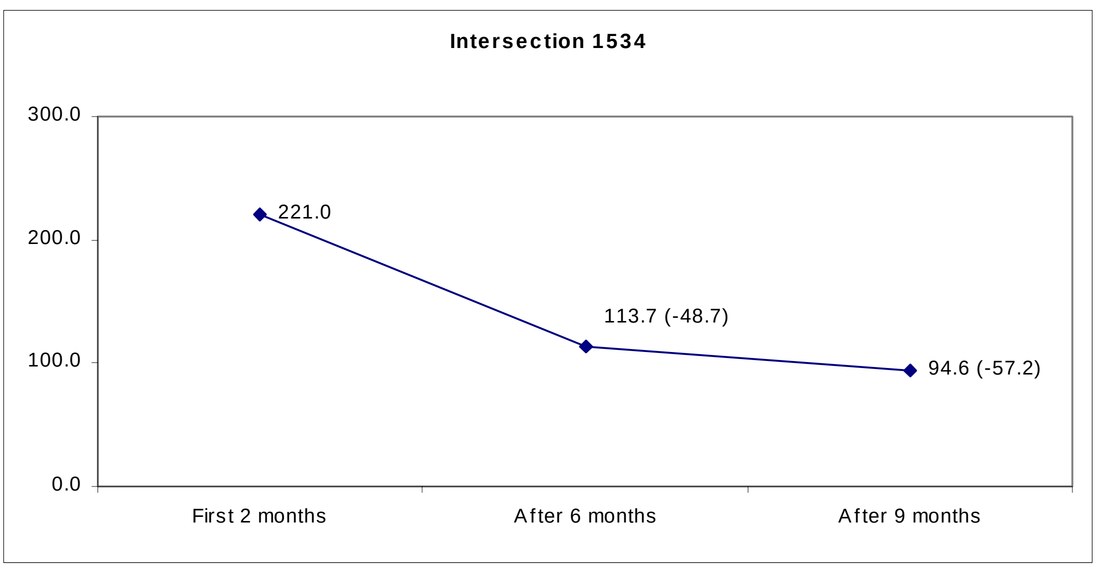


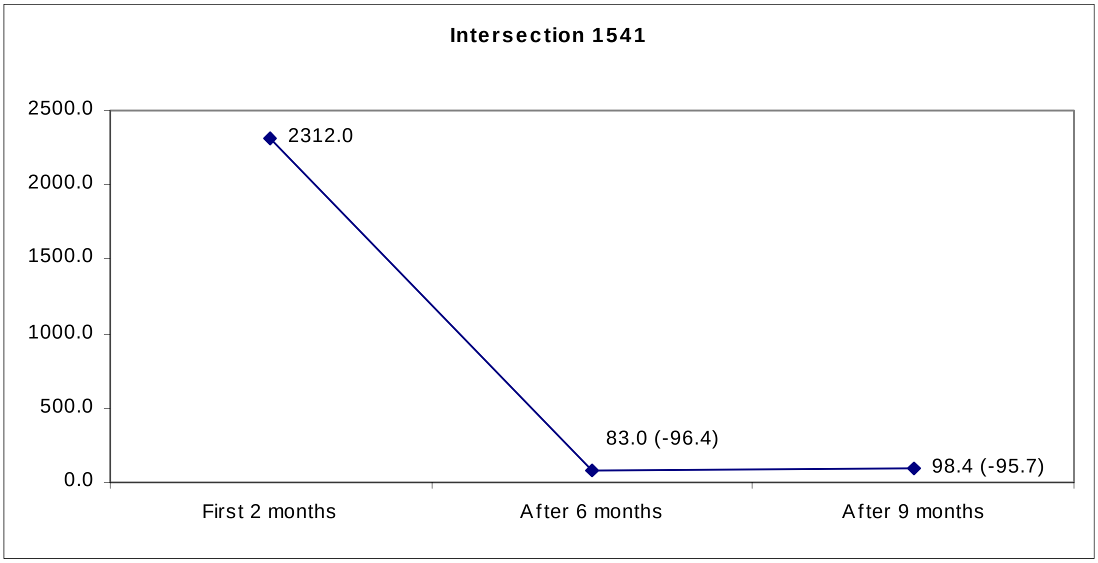
Intersection 1513
1500.0
1000.0
500.0
0.0
1388.0
729.6 (-47.4)
706.3 (-49.1)
First 2 months
After 6 months
After 9 months

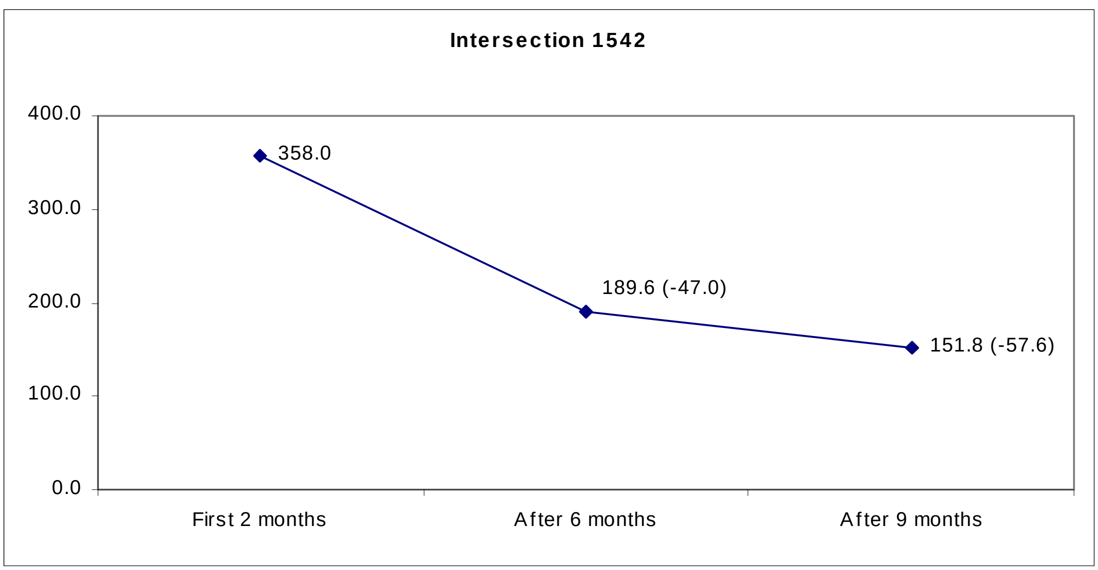


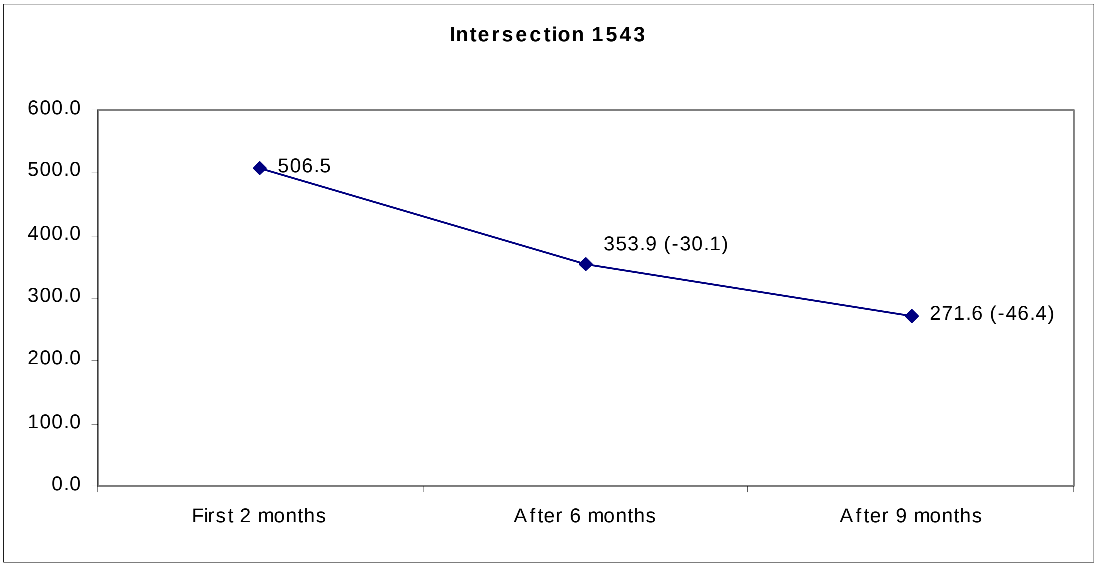
Intersection 1523
900.0
800.0
700.0
600.0
500.0
400.0
300.0
200.0
100.0
0.0
765.5
349.2 (-54.4)
325.3 (-57.5)
First 2 months
After 6 months
After 9 months

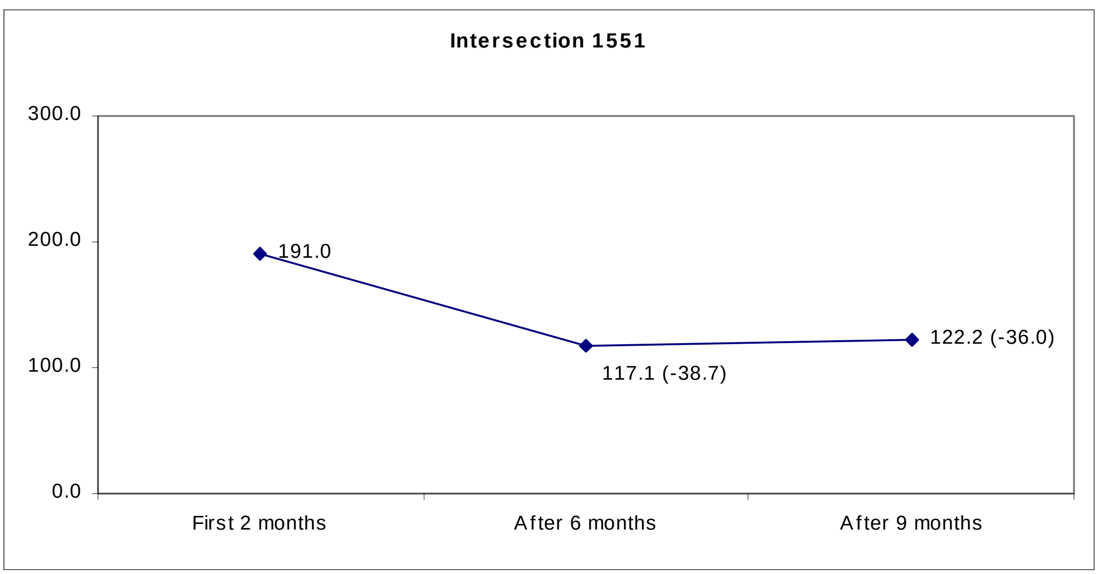

Intersection 1533
3100.0
3000.0
2900.0
2800.0
3058.5
3013.1 (-1.5)
2893.2 (-5.4)
First 2 months
After 6 months
After 9 months

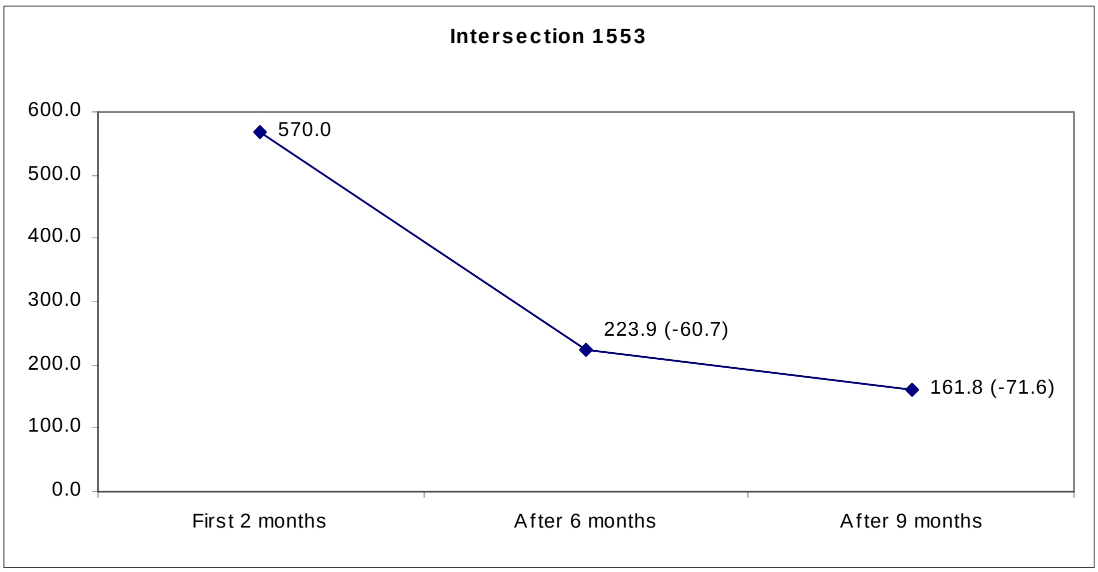

Intersection 1534
300.0
200.0
100.0
0.0
221.0
113.7 (-48.7)
94.6 (-57.2)
First 2 months
After 6 months
After 9 months


Intersection 1541
2500.0
2000.0
1500.0
1000.0
500.0
0.0
2312.0
83.0 (-96.4)
98.4 (-95.7)
First 2 months
After 6 months
After 9 months


Intersection 1542
400.0
300.0
200.0
100.0
0.0
358.0
189.6 (-47.0)
151.8 (-57.6)
First 2 months
After 6 months
After 9 months


Intersection 1543
600.0
500.0
400.0
300.0
200.0
100.0
0.0
506.5
353.9 (-30.1)
271.6 (-46.4)
First 2 months
After 6 months
After 9 months


Intersection 1551
300.0
200.0
100.0
0.0
191.0
117.1 (-38.7)
122.2 (-36.0)
First 2 months
After 6 months
After 9 months


Intersection 1553
600.0
500.0
400.0
300.0
200.0
100.0
0.0
570.0
223.9 (-60.7)
161.8 (-71.6)
First 2 months
After 6 months
After 9 months

APPENDIX D
PHOTO ENFORCEMENT GRACE PERIOD COMPUTATIONS

Location	L [1](ft)	Speed (MPH)	Red Time[2] (Second)	Distance from stop bar (ft)		Delay at stop bar (Second)	
				Before[3]	After[4]	Before	After
1404	9.2	21	0.5	15.4	**6.2**	0.5	**0.30**
	9.2	17	0.6	15.0	**5.8**	0.6	**0.37**
	9.2	15	0.7	15.4	**6.2**	0.7	**0.42**
1414	9.2	21	0.5	15.4	**6.2**	0.5	**0.30**
	9.2	17	0.6	15.0	**5.8**	0.6	**0.37**
	9.2	15	0.7	15.4	**6.2**	0.7	**0.42**
1422	9.2	21	0.5	15.4	**6.2**	0.5	**0.30**
	9.2	17	0.6	15.0	**5.8**	0.6	**0.37**
	9.2	15	0.7	15.4	**6.2**	0.7	**0.42**
1444	11.45	25	0.5	18.4	**6.9**	0.5	**0.31**
	11.45	21	0.6	18.5	**7.1**	0.6	**0.37**
	11.45	18	0.7	18.5	**7.1**	0.7	**0.43**
	11.45	16	0.8	18.8	**7.4**	0.8	**0.49**
	11.45	15	0.9	19.8	**8.4**	0.9	**0.52**
1484	9.75	23	0.5	16.9	**7.2**	0.5	**0.29**
	9.75	19	0.6	16.8	**7.0**	0.6	**0.35**
	9.75	16	0.7	16.5	**6.7**	0.7	**0.41**
	9.75	15	0.8	17.6	**7.9**	0.8	**0.44**
1492	9.75	23	0.5	16.9	**7.2**	0.5	**0.29**
	9.75	19	0.6	16.8	**7.0**	0.6	**0.35**
	9.75	16	0.7	16.5	**6.7**	0.7	**0.41**
	9.75	15	0.8	17.6	**7.9**	0.8	**0.44**
1541	10.7	24	0.5	17.6	**6.9**	0.5	**0.30**
	10.7	20	0.6	17.6	**6.9**	0.6	**0.36**
	10.7	17	0.7	17.5	**6.8**	0.7	**0.43**
	10.7	15	0.8	17.6	**6.9**	0.8	**0.49**
1553	10.9	24	0.5	17.6	**6.7**	0.5	**0.31**
	10.9	20	0.6	17.6	**6.7**	0.6	**0.37**
	10.9	17	0.7	17.5	**6.6**	0.7	**0.44**
	10.9	15	0.8	17.6	**6.7**	0.8	**0.49**
1462	12.1	26	0.5	19.1	**7.0**	0.5	**0.32**
	12.1	22	0.6	19.4	**7.3**	0.6	**0.37**
	12.1	19	0.7	19.6	**7.5**	0.7	**0.43**
	12.1	16	0.8	18.8	**6.7**	0.8	**0.51**
	12.1	15	0.9	19.8	**7.7**	0.9	**0.55**
1533	8.5	23	0.5	16.9	**8.4**	0.5	**0.25**
	8.5	19	0.6	16.8	**8.3**	0.6	**0.30**
	8.5	16	0.7	16.5	**8.0**	0.7	**0.36**
	8.5	14	0.8	16.5	**8.0**	0.8	**0.41**
	8.5	13	0.9	17.2	**8.7**	0.9	**0.44**
	8.5	12	1	17.6	**9.1**	1	**0.48**
	10.1	23	0.5	16.9	**6.8**	0.5	**0.30**
	10.1	19	0.6	16.8	**6.7**	0.6	**0.36**
	10.1	16	0.7	16.5	**6.4**	0.7	**0.43**
	10.1	14	0.8	16.5	**6.4**	0.8	**0.49**
	10.1	13	0.9	17.2	**7.1**	0.9	**0.53**
	10.1	12	1	17.6	**7.5**	1	**0.57**

Location	L [1](ft)	Speed (MPH)	Red Time[2] (Second)	Distance from stop bar (ft)		Delay at stop bar (Second)	
				Before[3]	After[4]	Before	After
1454	9.6	22	0.5	16.2	**6.6**	0.5	**0.30**
	9.6	19	0.6	16.8	**7.2**	0.6	**0.34**
	9.6	16	0.7	16.5	**6.9**	0.7	**0.41**
	9.6	15	0.8	17.6	**8.0**	0.8	**0.44**
1504	9.7	22	0.5	16.2	**6.5**	0.5	**0.30**
	9.7	19	0.6	16.8	**7.1**	0.6	**0.35**
	9.7	16	0.7	16.5	**6.8**	0.7	**0.41**
	9.7	15	0.8	17.6	**7.9**	0.8	**0.44**
1474	10.45	24	0.5	17.6	**7.2**	0.5	**0.30**
	10.45	20	0.6	17.6	**7.2**	0.6	**0.36**
	10.45	17	0.7	17.5	**7.0**	0.7	**0.42**
	10.45	15	0.8	17.6	**7.2**	0.8	**0.47**
1513	10.6	24	0.5	17.6	**7.0**	0.5	**0.30**
	10.6	20	0.6	17.6	**7.0**	0.6	**0.36**
	10.6	17	0.7	17.5	**6.9**	0.7	**0.42**
	10.6	15	0.8	17.6	**7.0**	0.8	**0.48**
1534	10.7	24	0.5	17.6	**6.9**	0.5	**0.30**
	10.7	20	0.6	17.6	**6.9**	0.6	**0.36**
	10.7	17	0.7	17.5	**6.8**	0.7	**0.43**
	10.7	15	0.8	17.6	**6.9**	0.8	**0.49**
1551	10.7	24	0.5	17.6	**6.9**	0.5	**0.30**
	10.7	20	0.6	17.6	**6.9**	0.6	**0.36**
	10.7	17	0.7	17.5	**6.8**	0.7	**0.43**
	10.7	15	0.8	17.6	**6.9**	0.8	**0.49**
	10.7	13	0.9	17.2	**6.5**	0.9	**0.56**
	10.7	12	1	17.6	**6.9**	1	**0.61**
1542	10.7	24	0.5	17.6	**6.9**	0.5	**0.30**
	10.7	20	0.6	17.6	**6.9**	0.6	**0.36**
	10.7	17	0.7	17.5	**6.8**	0.7	**0.43**
	10.7	15	0.8	17.6	**6.9**	0.8	**0.49**
	10.7	13	0.9	17.2	**6.5**	0.9	**0.56**
	10.7	12	1	17.6	**6.9**	1	**0.61**
1543	9.3	22	0.5	16.2	**6.9**	0.5	**0.29**
	10.7	19	0.6	16.8	**6.1**	0.6	**0.38**
	10.7	16	0.7	16.5	**5.8**	0.7	**0.45**
	10.7	14	0.8	16.5	**5.8**	0.8	**0.52**
	10.7	13	0.9	17.2	**6.5**	0.9	**0.56**
	10.7	12	1	17.6	**6.9**	1	**0.61**