2005 / 2006

RAMP METERING ANNUAL REPORT

District 7
Los Angeles and Ventura Counties

STATE OF CALIFORNIA
Governor Arnold Schwarzenegger

BUSINESS, TRANSPORTATION AND HOUSING AGENCY
Secretary Dale E. Bonner

DEPARTMENT OF TRANSPORTATION
Director Will Kempton

DIVISION OF OPERATIONS
OFFICE OF FREEWAY OPERATIONS
Ramp Metering Branch

April 2007

2005 / 2006

RAMP METERING
ANNUAL REPORT

DEPARTMENT OF TRANSPORTATION
DISTRICT 07

Los Angeles and Ventura Counties

DOUG FAILING
DISTRICT DIRECTOR

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RAMP METERING BRANCH

April 2007

RAMP METERING
ANNUAL REPORT
District 07

The District 7, 2005/2006 RAMP METERING ANNUAL REPORT has been prepared under the direction of the following registered engineer. The registered Civil Engineer attests to the technical information contained herein and has judged the qualifications of any technical specialists providing engineering data, upon which recommendations, conclusions and decisions are based.

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ACKNOWLEDGEMENTS

The RAMP METERING ANNUAL REPORT is prepared by the Office of Freeway Operations, Ramp Metering Branch in District 7. This report encompasses all of the work performed by the Ramp Metering Branch during the calendar years 2005 and 2006. In addition, it highlights in detail, the most important accomplishments attained by the Ramp Metering Branch in Los Angeles and Ventura Counties.

Team Leader

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Special thanks to Nabil Eskander for preparing all of the computer generated graphics illustrating Ramp Metering Branch productions for 2005 / 2006 calendar years.

We would like to thank and recognize the Ramp Metering Branch staff for their help in the compilation of this report:

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EXECUTIVE SUMMARY

The Caltrans District 7, Ramp Metering Annual Report documents accomplishments by the Ramp Metering Branch during 2005 and 2006 calendar years, and highlights major tasks performed during those 2 years in Los Angeles and Ventura Counties.

Caltrans is committed to using ramp metering as an effective traffic management strategy to maintain an efficient freeway system, by keeping it operating at or near capacity, and protecting the investment made in constructing the California Freeway system. Ramp Metering is an integral part of the system management concept, which focuses on implementing operational strategies to reduce congestion and increase safety on California's state highway system.

The Advanced Transportation Management System (ATMS), located in the Traffic Management Center (TMC), has been an important tool for the ramp metering operation. ATMS provides historical and real-time traffic data for on-ramps, off-ramps, Freeway-to-Freeway connectors and freeway mainlines. This data constitutes a vital and often primary source in determining the appropriate metering rates unique to each ramp meter location. In addition, ramp metering engineers using the ATMS display map for District 7, can modify ramp meter parameters and time of operation. This feature is often used when responding to major traffic incidents or lane closures due to unforeseen events or scheduled construction projects. Thus, the use of ATMS in District 7 leads to an increase in traffic flow efficiency, by allowing faster response to dynamic field situations.

The District continues to develop adaptive metering as a strategy through the continued testing of System Wide Adaptive Ramp Metering (SWARM). The most recent SWARM testing was conducted in December 2006, on the Rte 210 Freeway, which is part of the Route 210 Strategic Growth Plan project. This innovative metering technology promises to improve the efficiency of our metering system by operating the various ramp meters through a corridor in an integrated manner. This approach will be consistent with the Department's shift toward integrated corridor management, which is mandated through the Corridor Management Improvement Account. This is the centerpiece of the infrastructure bonds which were approved by the voters in 2006. SWARM, and other adaptive metering strategies, will continue to be evaluated, tested, and implemented, as we move forward in 2007 and beyond.

DISTRICT 07 RAMP METERING HISTORY

In 1965, the Freeway Operations Department was created in District 7, to locate, analyze and solve operational problems on the existing freeway system.

The first experimentation with ramp metering in District 7 occurred on a Labor Day weekend in the mid 1960's on the Southbound Route 14 connector to the Southbound Route 5 Freeway. The Southbound Route 14 connector was manually metered with temporary signals, thus preventing the Southbound Route 5 freeway from breaking down. The metering operation was a complete and instant success.

On April 11, 1967, the District's first two permanent fixed time ramp meters were installed on the northbound Hollywood Freeway (Route 101) at Sunset and Hollywood Boulevards.
The project was successful in relieving congestion on the freeway without seriously affecting surface street operations. Freeway delay was reduced by 75%.

In the early 1970's, District 7 created the Los Angeles Area Freeway Surveillance and Control Project (LAAFSCP). This experimental project, known as the 42-mile loop, was located on the Harbor Freeway (Route 110), Santa Monica Freeway (Route 10) and the San Diego Freeway (Route 405). The two primary objectives of the system were: first, to test and evaluate various techniques for improving movement of people and goods on the freeway by reducing delay, accidents and motorists' frustration and second, to integrate those techniques showing a great promise into an effective traffic management system.

The LAAFSCP project consisted of a vast network of traffic sensors, telemetry equipment, in addition to a computer system for traffic data processing. The system provided real-time traffic data, a map display and an operator's console. This was the beginning of the current Transportation Management Center (TMC).

The LAAFSCP project provided traffic engineers with data on a 24-hour basis, including mainline volumes, speeds, occupancies and ramp volumes. Additional information provided by the system included travel time and delay.

Traffic responsive ramp metering was tested in the LAAFSCP project**.** The traffic responsive logic showed a great improvement over the existing fixed-time traffic controllers.

Also in the early 1970's, District 7 developed "A Program to Upgrade and Control the Los Angeles Freeway Network". This program looked at sections of freeways that needed to be widened due to very heavy traffic demand. It was noted that as projects were completed, freeway congestion disappeared. However, as time went on, congestion returned since many motorists that were formerly taking city streets discovered the faster moving freeways. Ramp meters were then installed to control the input onto the freeway system discourage local short trips.

In 1992, the first connector meter in District 7 was installed on the Southbound Route 5 connector to the Southbound Route 110 Freeway. In 1993, Route 105 (Glenn Anderson Freeway) was opened to traffic. Design and construction of the 105 freeway included freeway to freeway connector meters. Implementation of connector metering was possible on Route 105, due to long and wide connectors providing adequate storage and sufficient sight distance for fast approaching vehicles, especially on heavy volume connectors. Route 105 has a total of 19 connector meters in District 07, 17 are currently in operation, and the other 2 were turned off due to safety concerns.

Today, ramp metering represents one important element of the Traffic Management System (TMS). The focal point of TMS is maximizing traffic flow on the freeway system by reducing congestion. Other elements of TMS include:

Freeway Surveillance Equipment – provides essential traffic data to the TMC for early detection of incidents and locates areas of traffic congestion. Freeway surveillance equipment is part of the ramp meter detection system and is installed and maintained by the Ramp Metering Branch, ITS Branch and Electrical Maintenance Branch.

- Closed Circuit Television (CCTV) – Cameras with pan, tilt and zoom capabilities are used to confirm the exact location, nature and severity of freeway incidents.

- Changeable Message Signs (CMS) – The TMC manages numerous signs located at key points on the freeway system. The TMC updates the display of CMS messages to provide major incident information, affecting traffic conditions. Estimated travel times are now displayed on selected CMS signs district wide. In the event of child abduction, CMSs are used by law enforcement to display Amber Alert messages.

- Highway Advisory Radio (HAR) – A short-range broadcast radio with transmitters located within the freeway right-of-way to provide motorists with updated informational messages such as directional advisories, traffic control restrictions as well as general information. HAR messages are remotely activated from the TMC.

- Freeway Service Patrol (FSP) – A team of 152 tow trucks patrolling 473 miles of Los Angeles County freeways to provide help to stranded motorists and quickly repair or remove disabled vehicles to relieve freeway congestion. Typical hours of operation are Monday through Friday between 4:00 AM and 9:00 PM, Saturday and Sunday from 8:00 AM until 8:00 PM.

RAMP METERING BASICS

Ramp meters are traffic signals placed on freeway entrance ramps or freeway connectors to control the flow of vehicles entering the freeway or moving from one freeway to another. They are designed to decrease congestion and improve the average speed of vehicles traveling on the freeway, by controlling vehicular flow at most inputs onto the mainline. By installing a traffic signal at the on-ramp, Caltrans can control the rate at which vehicles enter the freeway. Vehicles entering at short intervals are less likely to slow down flowing traffic and can merge onto the freeway without causing the traditional bottlenecks, associated with heavy on-ramp traffic volumes. In addition, metering has been proven to reduce rear end and sideswipe traffic collisions, especially during congestion periods.

The capacity of a freeway, in free-flow conditions, can easily exceed 2000 vehicles per hour per lane (vph/l). However, during congestion periods, this number often drops below 1500 vph/l. Thus, a free-flowing traffic lane can carry 33% more cars than a congested lane. It is in the public interest to keep the freeways moving at free flow conditions. Therefore, by breaking up vehicular platoons onto the mainline, ramp metering helps to increase the total number of vehicles accommodated by the freeway.

At some locations, where metered on-ramps include a High Occupancy Vehicle (HOV) by-pass lane, vehicles with two or more occupants, using these lanes, get priority access to the mainline freeway. This promotes carpooling which reduces the overall number of vehicles on the freeway. Additionally, ramp meters are used to discourage short distance travelers from using the freeway. During congestion periods, many city streets paralleling the freeways are underutilized. Thus, motorists using local arteries, to avoid the wait at the ramp meter, will realize that it might be faster to use city streets, especially for short distance trips, than opting for the freeway. As a result, mainline traffic congestion will improve, due to less vehicles entering or travelling on the freeway.

The following documents were prepared by Caltrans to guide in implementing ramp metering policy throughout the State:

Caltrans' policy on Ramp Metering is defined in Deputy Directive DD-35. See ATTACHMENT 3.

RAMP METERING POLICY PROCEDURES, dated August 1997, provides guidelines for implementing the Department's Ramp Metering Policy (DD-35).See ATTACHMENT 4.

Design of Ramp Metering Facilities is governed by "Ramp Meter Design Guidelines". Refer to REFERENCES, Item No. 1.

RAMP METERING BENEFITS

The effectiveness of ramp meter systems has always been called into question. It is difficult to quantify ramp metering benefits, without conducting a detailed study to compare with and without effects of ramp metering implementation.

In 2000, Minnesota Legislature passed a bill that required The Minnesota Department of Transportation (MnDOT) to study ramp metering effects in their State. Thus, MnDOT, responsible for managing freeway access in the Twin Cities (Minneapolis and St. Paul) metropolitan area, conducted a four month study aimed towards capturing these benefits.
Data was collected during two different time periods; ramp meters were turned on in the first period then turned off in the second. After analyzing the data from both periods, it was concluded that ramp metering is a cost-effective investment. the study revealed the following ramp metering benefits:
21% reduction in accidents
8% increase in speed
22% reduction in travel time
16.3% increase in throughput capacity

For detailed information, please refer to REFERENCES, Item No. 11.

In addition, there are simulation tools available that can quantify benefits of ramp metering, like TOPL.

TYPES OF RAMP METERING

There are three types of ramp meter operations in District 7:

1. Fixed Time/Time of Day
2. Local Traffic Responsive
3. System Wide Adaptive Ramp Metering (SWARM)

It should be noted that all three types of metering operation could be implemented according to the following two modes:

- One Car per Cycle Metering -- One vehicle per cycle per lane is permitted to enter the freeway. Assuming that green time is typically 2 seconds, the remaining cycle is red time, varying from 2 to 18 seconds. In District 7, the typica1 metering cycle (Red + Green) time does not exceed 12 seconds or 300 vehicles per hour per lane (vph/l), in order to minimize meter violations and minimize vehicle back-up onto local city streets.

- Platoon Metering -- Two to three vehicles per cycle per lane are permitted. Typically, platoon metering is used at freeway connectors or heavy ramps, where traffic volumes exceed 900 vph/l.

1. Fixed Time/Time of Day

Fixed time ramp metering is the simplest form of ramp metering which breaks up platoons of vehicles entering the freeway. The ramp meter is programmed to operate based on a single or multiple fixed metering rates, for a pre-set metering period, based on historically averaged traffic conditions. Thus, the cycle length is "set" and does not change or respond to freeway mainline conditions. This is the primary drawback of this metering system. In addition, if the on-ramp gets congested, vehicle backup (Queue) reaches near city street, the Queue loop, usually located at the entrance of the ramp, will be triggered and the meter rate will increase to maximum rate (15 vehicles/minute/lane) until traffic back-up at the ramp is relieved. Metering rates can vary from 180 to 900 vph/l and 600 to 1320 vph/l for platoon metering. This type of ramp metering is used on a limited basis in District 7 when mainline loops are malfunctioning or during construction.

2. Local Mainline Traffic Responsive Metering

In addition to all the features of fixed time metering, local mainline traffic-responsive metering is directly influenced by the traffic conditions at the on-ramp and on the freeway mainline and just upstream of the ramp, during the metering period. If the volume and the loop detector occupancy on the mainline freeway drops below a set critical volume and critical occupancy, the controller can override the set metered rates and allow more cars on the freeway up to the point of turning the meters to a constant green light.
The primary criticism of local mainline responsive operation is that it reacts only to traffic conditions adjacent to the ramp and does not consider what is happening throughout the rest of the freeway system. Traffic responsive metering is widely used in District 7.

3. System Wide Adaptive Ramp Metering (SWARM)

As the name indicates, it adapts the local traffic responsive concept to a whole section of freeway. For additional information, please refer to "SYSTEM WIDE ADAPTIVE RAMP METERING" section of this report.

RAMP METERING TECHNOLOGY

ADVANCED TRANSPORTATION MANAGEMENT SYSTEM (ATMS)

The Advanced Transportation Management System (ATMS) was designed to assist in collection and dissemination of traffic information, in order to effectively manage the existing District 7 Transportation System. Refer to REFERENCES, Items No. 6, 7, and 14. The activities in the Traffic Management Center (TMC) are intended to reduce congestion and increase safety through the rapid detection of, response to, and removal of incidents on the freeway. Ramp Metering engineers using ATMS workstations, located in the TMC, can manage recurring congestion by remotely controlling ramp meter operation and analyzing freeway system efficiency, through historical report data.

Additional ATMS enhanced features include incident detection, closed circuit television (CCTV) cameras to view traffic conditions, use of changeable message signs (CMS) and highway advisory radio (HAR).
Ramp metering field hardware is the key element in providing data to the ATMS. The loop detector system on the freeway mainline, on-ramps, off-ramps, connectors, etc., is all tied to traffic controllers that send data to the ATMS. Ramp Metering, ITS and Electrical Maintenance personnel are responsible for new installations, operating, upgrading or modifying existing installations as well as maintaining all existing field elements.

CALTRANS District 7, Ramp Metering and ITS Branch signed a contract, in October 2006, with Delcan Technologies to modify the existing ATMS software. The goal is to make the ATMS more user friendly and be able to easily deploy the SWARM algorithm.

SYSTEM WIDE ADAPTIVE RAMP METERING (SWARM)

System Wide Adaptive Ramp Metering (SWARM) is a relatively new ramp meter operating system developed by National Engineering Technology (NET) Corporation, based on District 7's, ramp metering unit input and recommendations.

SWARM seeks to optimize traffic flow on the mainline by being responsive to actual and future conditions, throughout the system and to recurrent and non-recurrent congestion.

Types of SWARM

There are three basic types of SWARM: SWARM 1 operates system wide to predict congestion, SWARM 2a and SWARM 2b operate locally and are based on headway and storage respectively.

SWARM 1

SWARM 1 is system wide adaptive and based on a freeway network divided into SWARM sections. Each section begins and ends at a mainline vehicle detection station (VDS) identified as a bottleneck. SWARM 1 algorithm operates at designated bottleneck locations and controls vehicle flow of all upstream on-ramp locations linked to that bottleneck.

Since density is directly related to congestion, it is monitored at each bottleneck location. The algorithm requires a nominal saturation density threshold for each mainline VDS in the network. The algorithm attempts to estimate the density *n* minutes (user settable) in the future. When estimated density, at the bottleneck, exceeds saturation density, ramp meter rates will be computed in an attempt to proactively react to the predicted onset of congestion.
Starting at the bottleneck and working upstream, the computer calculates new metering rates based on the required volume reductions. Actual metering rates vary between maximum and minimum rate. Since rate adjustments may be positive or negative, excess or reduction values are propagated upstream.

SWARM 2a

SWARM 2a is local responsive based on headway (time between consecutive vehicles). It uses the density function to compute local metering rates and attempts to maintain headway such that maximum flow can be obtained.

SWARM 2b

SWARM 2b is local responsive based on storage. It computes the number of vehicles stored between two VDS stations and compares it to a maximum storage value. Metering rates are computed to maintain level of service (LOS) D as long as possible.

Combinations of SWARM

SWARM can be used in combinations, i.e., SWARM 1 and 2b can be combined. The controller uses the more restrictive rates of those recommended. Within a bottleneck segment, some controllers can be placed on local Time of Day mode, while others are placed in one of the SWARM modes. The use of the local Time of Day mode is especially useful at on-ramps that experience heavy back up and can not be further restricted.

Advantages of SWARM

It maximizes traffic flow on the mainline.

- It is responsive to actual traffic conditions throughout the system.
- It is responsive to recurring and non-recurring congestion.

Disadvantages of SWARM

- Ramp control and traffic surveillance devices must be connected to a computerized communications center.
- Communication lines have to be maintained at all times in order for SWARM to operate properly.
- SWARM requires accurate data from mainline and on and off-ramp detectors in order to work effectively.
- It is more complicated than local traffic responsive metering.

SWARM Testing

SWARM was tested in 2001 and 2002, on routes 210 and 405. Results of the route 210 study were published in the "PRELIMINARY SWARM STUDY REPORT" dated November 2001 and the "SWARM STUDY FINAL REPORT" dated October 2002. A brief summary was prepared following the route 405 study in 2002. Please refer to REFERENCES, Item Nos. 4, 5 and 16. Last SWARM testing took place on Route 210; Please refer to page 24 for details. Currently, there are proposals to test and possibly implement SWARM on Routes 10 and 710.

SATMS 3.0

SATMS is an acronym for Semi-Automatic Traffic Management System. SATMS 3.0 is a new computer processor chip developed recently by Caltrans ITS to upgrade the existing chips. The previous versions were SATMS 1, used only at on-ramps and SATMS C for both connector and on-ramp locations.

The primary goal for the SATMS chip upgrade is to make it compatible with the new ramp metering algorithm, known as SWARM. However other features were also added to the new chip in order to enhance the overall ramp meter operation.

In 2002, SATMS 3.0 chip was tested at several locations district wide. Once the testing phase was completed, the updated chip was installed at all on-ramp controller cabinets (except at Route 105 connectors). By the end of 2003, ramp meter operation was universal district wide as SATMS 3.0 chip replaced all previously existing ones.

The new features in the SATMS 3.0 chip are:

- Speed up the controller 170 initiation reset time following a power failure, which reduces the watchdog black out problem. Therefore, variation or brief interruption in power voltage level will have less effect on the operation of the ramp meter.

- The loss of communication Cycle Time is increased from one cycle (approximately 30 seconds) to ten cycles or around five minutes, in order to minimize frequent changes between Swarm and local Time of Day (TOD) modes. Thus, communication losses lasting no more than ten cycles would not affect the implementation of Swarm in the field; the controller would meter for up to five minutes, according to the last Swarm rate before communication failure occurred.

- Queue override maximum rate can be set by the Engineer to be lower than 15 vehicles per lane per minute. In addition the new chip provides the ability of linking the activation of the Queue override mode to mainline traffic condition by setting a threshold speed level (normally set at 35 mph) to control Queue activation.

- Queue Override mode created to speed up the metering rate when vehicular back up reaches the entrance of the on-ramp can be used with Swarm mode. If activated, the Queue override mode, in case of a ramp back up, will gradually increase the metering rate dictated by Swarm up to a maximum rate of 15 vehicles per lane per minute; Therefore, reducing the overflow of vehicles onto city streets.

- Whenever metering is initiated or terminated by Swarm or loss of communication cycle time exceeds ten cycles, the controller will apply one minute Green light at the beginning and end of each metering phase.

- Set improved default values for the SATMS 3.0 chip over the previous ones.

- Improve the program's traffic responsive feature.

- For Connectors only: Q2 loop operation is enhanced as follow:
  1. Q2 can be programmed to operate independently of Q1 to trigger green light, when backup occurs.
  2. Similarly to on-ramps Queue 1 Override maximum rate can be set at lower than 15 vehicles per lane per minute. In addition, Queue 1 and 2 activation modes can be controlled by mainline threshold speed level set by the engineer.

During the course of 2005/2006, Ramp Metering Branch was working with ITS Branch to revise the SATMS 3.0 microchip, in order to develop a microchip that is less sensitive to sporadic traffic flow changes.

This new SATMS revision will include the following:
- Normalize the real-time occupancy reading, by averaging the last two occupancy readings.
- Smoothing off the gradual increase in the Traffic Responsive Rate, according to a settable integral. This feature will delay the rest in green mode and greatly reduce any unnecessary occurrences.

- Link the watchdog safety switch to address "0F4", so it can be detected by the ATMS.

Testing of the new SATMS microchip is scheduled for spring 2007.

RESPONSIBILITIES OF
RAMP METERING BRANCH, ELECTRICAL MAINTENANCE BRANCH AND INTELLIGENT TRANSPORTATION SYSTEM (ITS) BRANCH

Electrical Maintenance and ITS Branch work as a team with the Ramp Metering Branch. Thus, ramp metering engineers are responsible for the operation of ramp meters district-wide, report all trouble issues to both Electrical Maintenance and ITS Branch, for prompt repairs. In addition, as a way to exchange ideas and resolve any outstanding issues related to the repair and improvement of the ramp metering system, these groups meet on a quarterly basis.

RAMP METERING BRANCH

The ramp metering system in the District is regularly inspected and observed through routine field surveillance and frequent ATMS observation. Ramp Metering Engineers are responsible for the ramp meter programmed software as well as the proper operation of ramp meters district-wide. Ramp Metering operation software consists or a "Ram Map" package which includes a program sheet, Time of Day (TOD) table and a detailed loop detector (sensor) diagram layout, in addition to an electrical as-built plan showing all of the hardware. Ramp Meter hardware includes signals, controllers, loop detectors, signing, striping and advance warning devices. Area Engineers (lead workers) are assigned ramp meters by routes or segments of routes. Other engineers within the Ramp Metering Branch assist the Area Engineers. For more details, please refer to ATTACHMENT 3 and Ramp Metering Branch Production.

ELECTRICAL MAINTENANCE BRANCH

Electrical Maintenance responds to ramp meter malfunctions reported by CHP, Ramp Metering Branch, ITS Branch and the general public, if related to hardware and electrical problems. As a routine procedure, Electrical Maintenance performs a 120-day check of all ramp metering equipment. The following main actions are performed by the Electrical Maintenance technician during this check:

- Maintenance of Freeway Meter Signals

Meter signals should be checked for damage, proper operation, and timing every 120 days. This check should include the following items as a minimum:

(A) Field Inspection

(1) Visual check of indications.

(2) Signal indication alignment.

(3) Hardware (hand-hole covers, signs, poles, backplates, etc.).

(4) Pullbox covers (broken, missing, and clear of dirt or debris).

(5) Visual check of service cabinet and equipment locks.

(6) Visual check of loops in roadway (if possible).

(B) Cabinet Interior

(1) Controller unit indicator lights and display.

(2) Function and timing.

(3) Detector indicator lights and operation.

(4) Check output devices, including interconnect systems.

(5) Thermostat and ventilation system including filter.

(6) Clean cabinet and interior components.

(7) Check documentation (timing sheets, schematics, wiring plans, etc, and inspection noted on cabinet login card).

(C) Cabinet Exterior

(1) Condition of surface (paint, damage, graffiti).

(2) Condition of locks and handles.

(3) Operation of Police panel switches.

- Meter Timing and Operation

Initial timing of meter signals and any subsequent changes in timing are the responsibility of the Ramp Metering Branch.

Maintaining the timing is the responsibility of the Division of Maintenance or the district Electrical Maintenance Branch.

ITS BRANCH

ITS Branch provides technical support for the Transportation Management Center (TMC). This includes ramp metering and ATMS. ITS main duties are:

1. Test and develop new software related to metering operation.
2. Set up the configuration of ATMS.
3. Review electrical design plans for new projects.
4. Monitor and correct any discrepancies found on the ATMS data reports such as icons, loop configuration, etc.
5. Check system electrical operation and final compliance in accordance to the contract documents or as builds on all new and replacement equipment.
6. Test and maintain communication lines between field equipment and TMC.

RAMP METERING BRANCH PRODUCTION

Ramp Metering Branch production was divided into work categories as follows:

1. Surveillance and Monitoring of ramp operation.
    - Charts describing Ramp Metering production:
        A. Number of Opened Controller Cabinets (Figure 1)
        B. Issues Reported to ITS or Electrical Maintenance (Figure 2)
        C. Traffic Counts 2005 (Figure 3)
        D. Traffic Counts 2006 (Figure 4)
        E. Modify Ram Pages (Figure 5)
        F. Projects Reviewed (Figure 6)
        G. Complaints & Inquiries 2005 (Figure 7)
        H. Complaints & Inquiries 2006 (Figure 8)
2. Route 210 Strategic Growth Plan – Congestion Relief Project
3. Ramp Meter Counts
        A. Various Routes
        B. Route 210, Congestion Relief Project
4. Capital Project Review
5. Permit Project Review
6. Metered Ramp Data Summary
7. Ramp Meter Development Plan (RMDP)
8. Ramp Metering Procedure Manual Addendum
9. Testing of new Vehicle Detection Technologies
10. Convert existing ramp HOV bypass lane to a metered HOV or mix flow lane.
11. SWARM Testing and Implementation
12. Major Ramp Metering Operational study
13. Ramp Metering Annual Report

The following sections summarize in depth the amount of work performed for each of these categories. All data included in the sections below was obtained from Weekly Ramp Meter Reports filed by all Ramp Metering Engineers.

1. *Surveillance and Monitoring of Ramp Operation*

Currently, District 7 has 870 metered on-ramps and 19 freeway to freeway connectors, making it the largest ramp metering district. The Ramp Metering Branch periodically performs field surveillance and corrects minor software and hardware problems associated with the metering operation. Staff observe traffic backups on the ramp, verify appropriate metering rates and check for any malfunction with signal lights or advanced warning signs. If the meter is off during metering hours, the controller software program and cabinet hardware will be checked in order to diagnose the problem; minor issues will be corrected, while major problems are reported to Electrical Maintenance or ITS Branch for repairs.

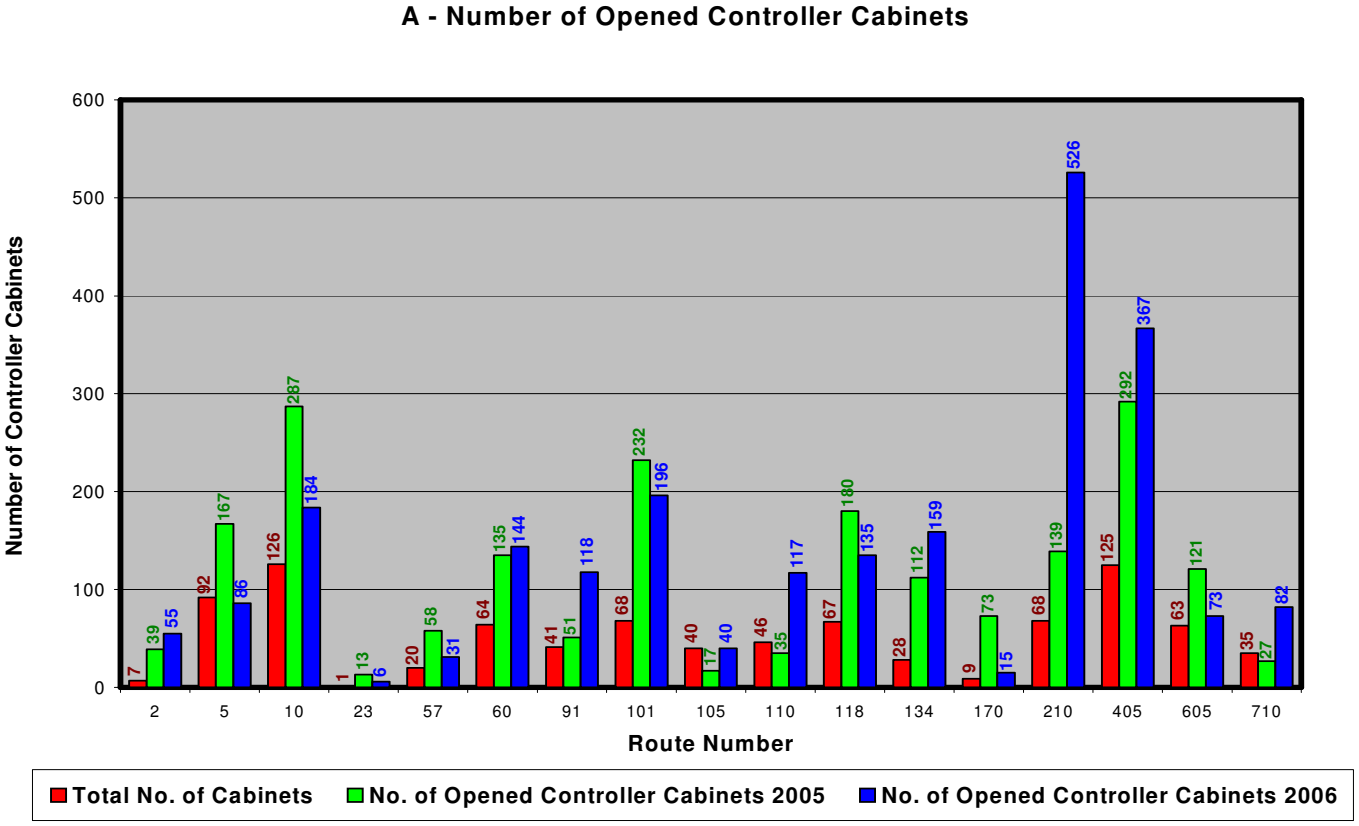


Figure 1

During the course of 2006, the Ramp Metering Branch opened and checked 2334 ramp-meter controller cabinets compared to1987 cabinets, in 2005 (Refer to Figure. 1). The reason for checking these controller cabinets varied from simply verifying the operation of the ramp meter to performing corrections or updates to the programmed software, and in some cases, resetting or replacing minor cabinet hardware.

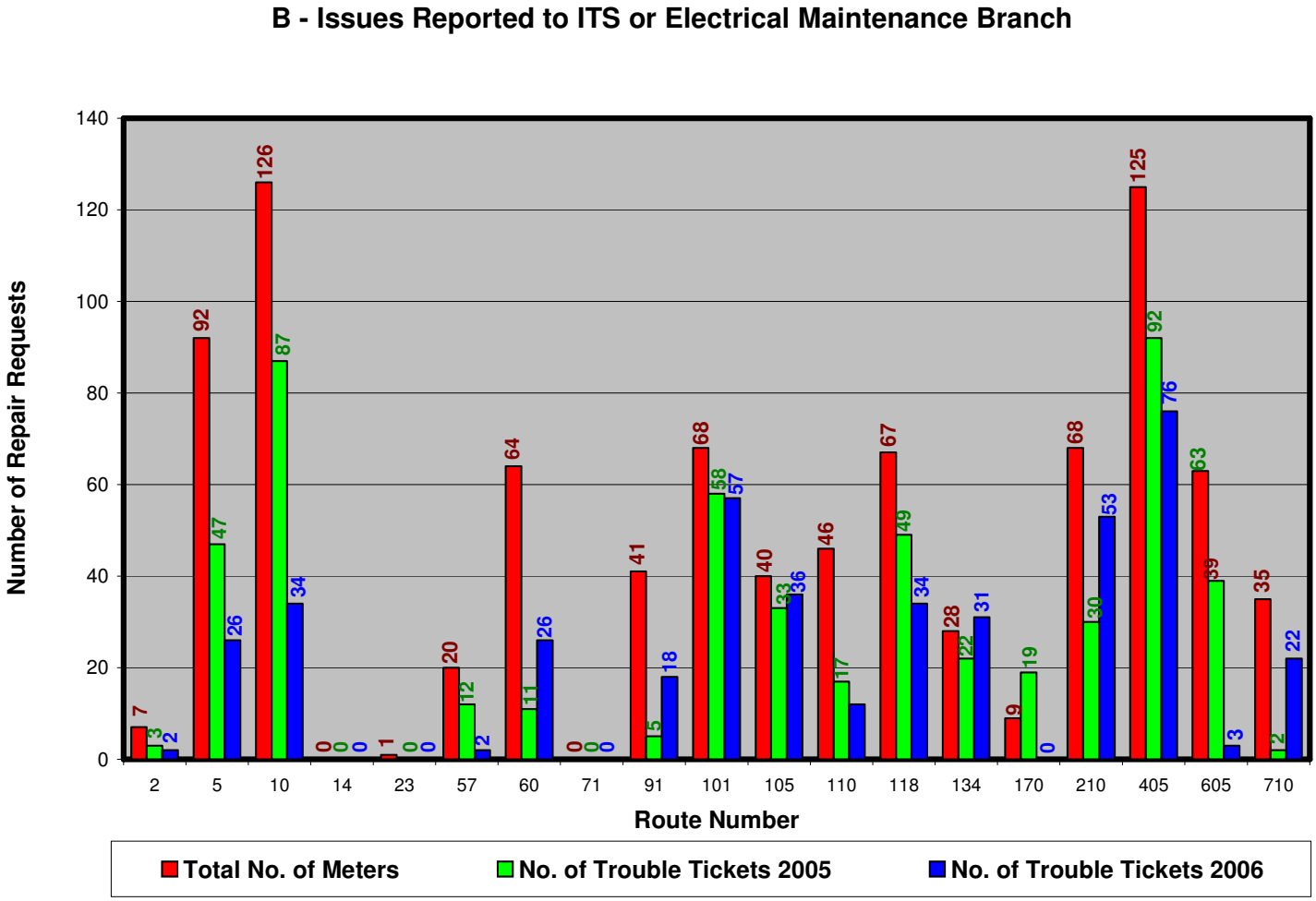


Figure 2

When a ramp meter problem cannot be fixed by the Ramp Metering Branch, the issue is reported to either ITS Branch or Electrical Maintenance Branch for repairs. In 2006, 432 ramp-metering problems were reported compared to 527, in 2005 (Refer to Figure. 2).

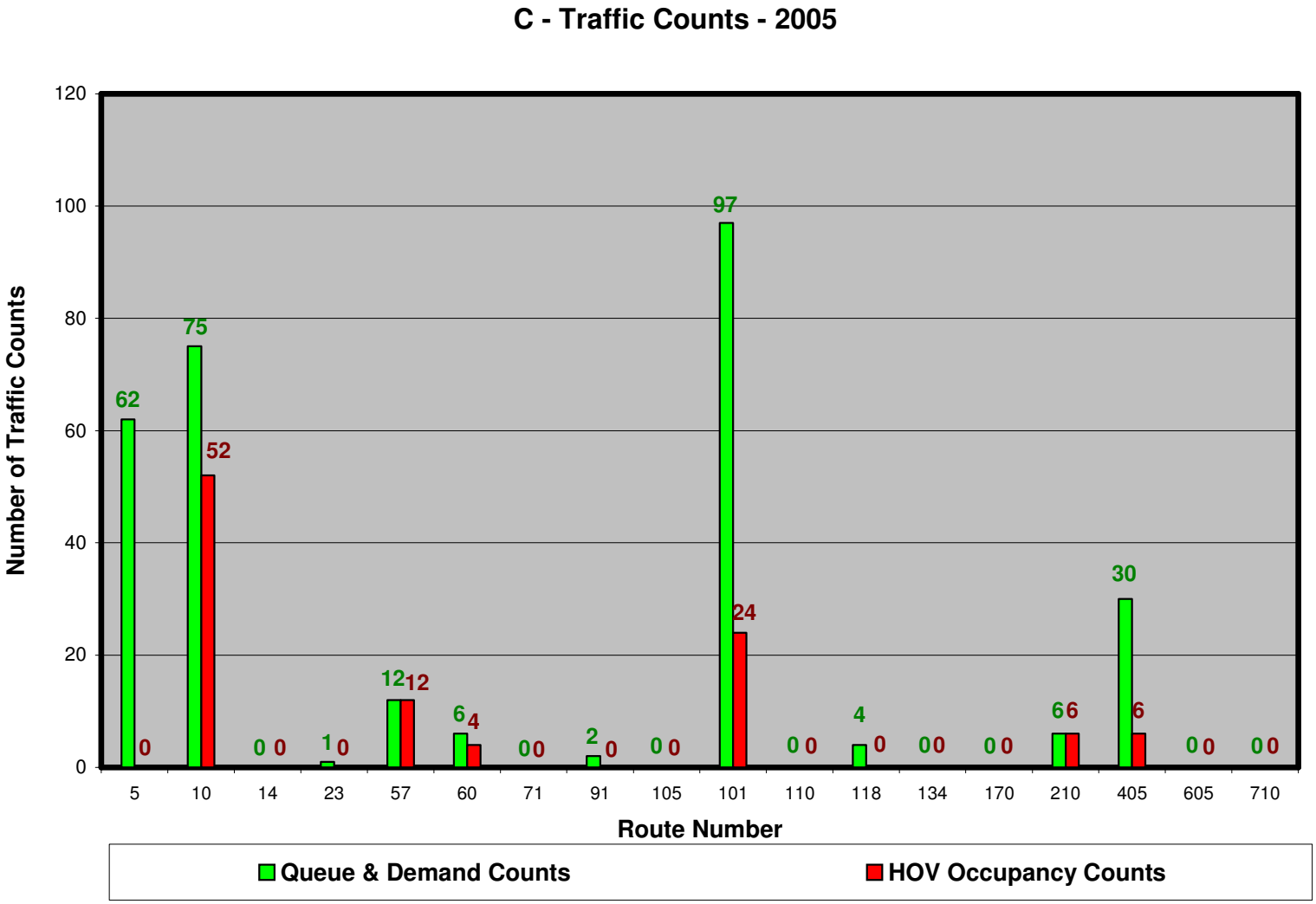


Figure 3

The Ramp Metering Branch performed a total of 295 traffic volumes counts (Queue and Demand), in addition to 104 HOV Occupancy counts in 2005. These counts were conducted whenever the district received a complaint from the public or local agencies, or when a ramp meter is activated again following an extended period of downtime. Traffic counts are also conducted whenever a newly installed ramp meter is turned on for the first time.

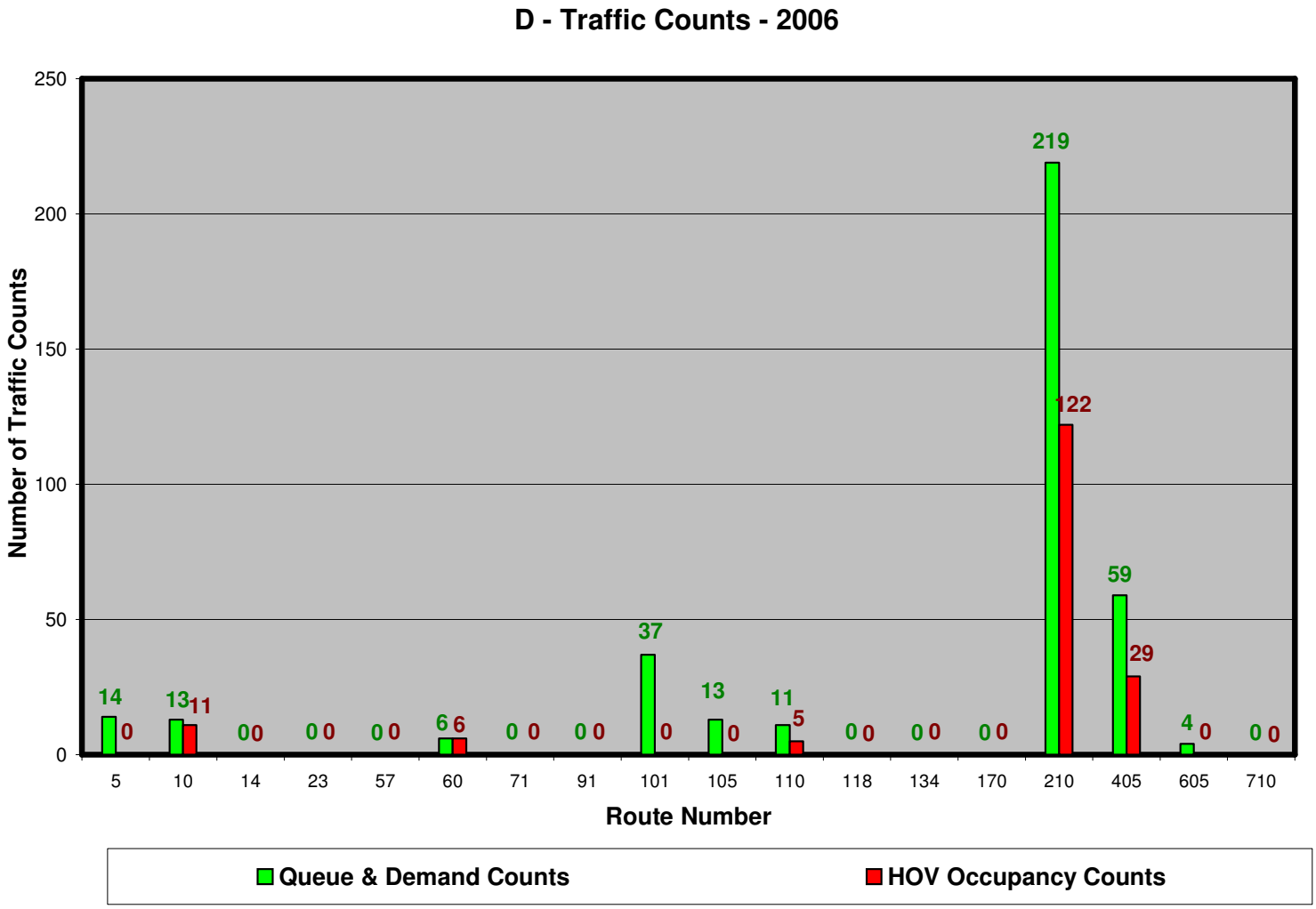


Figure 4

The Ramp Metering Branch conducted a total of 376 traffic volume counts(Queue and Demand) and 173 HOV Occupancy counts in 2006. Most of the counts were on Route 210 as part of the Route 210 Strategic Growth Plan – Congestion Relief Project (Refer to Figure 4).

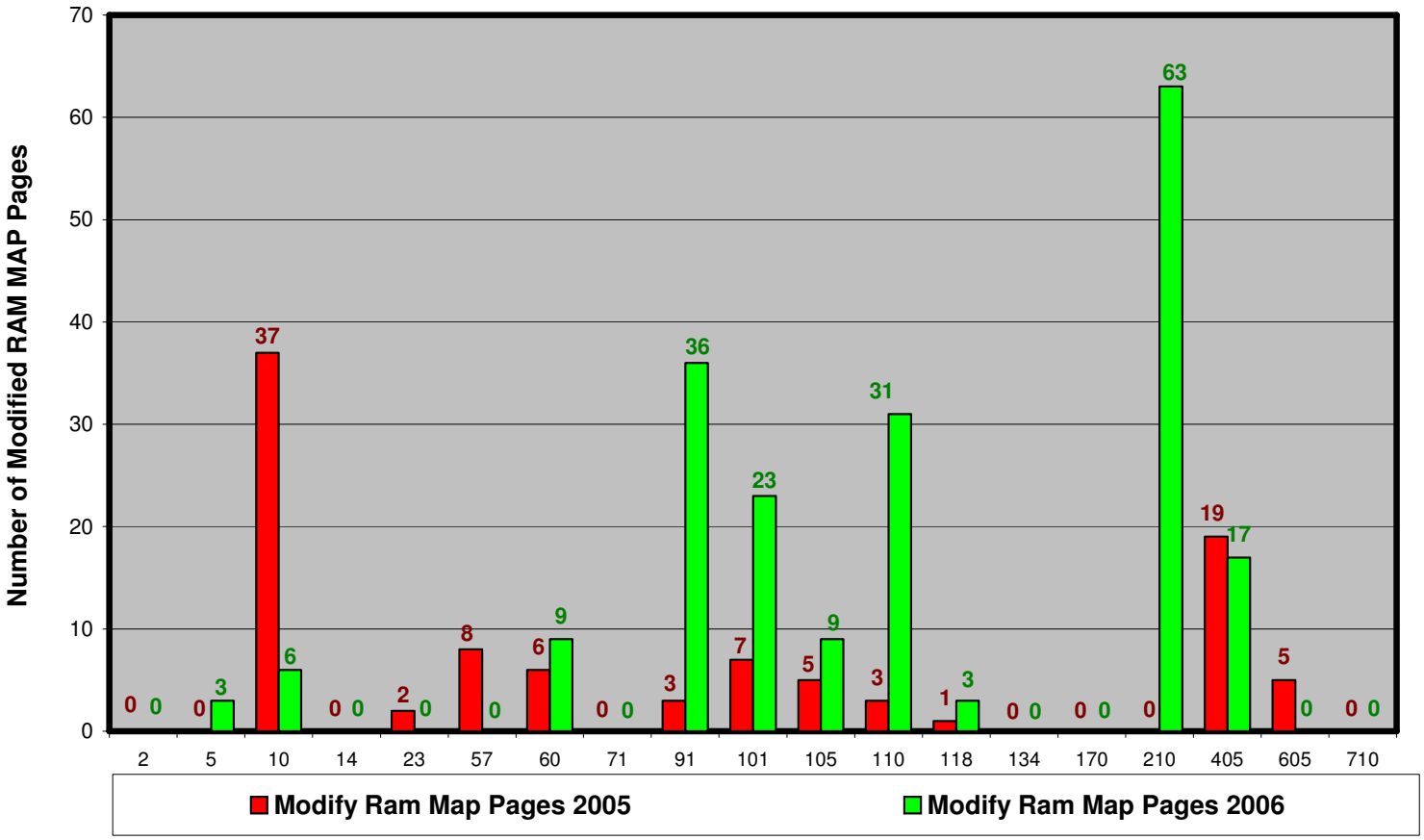


Figure 5

The Ramp Metering Branch modified 202 RAM MAP files in 2006, compared to 96, in 2005. RAM MAP files contain numerical values programmed into the SATMS 3.0 software to properly operate the ramp meter (Refer to Figure 5).

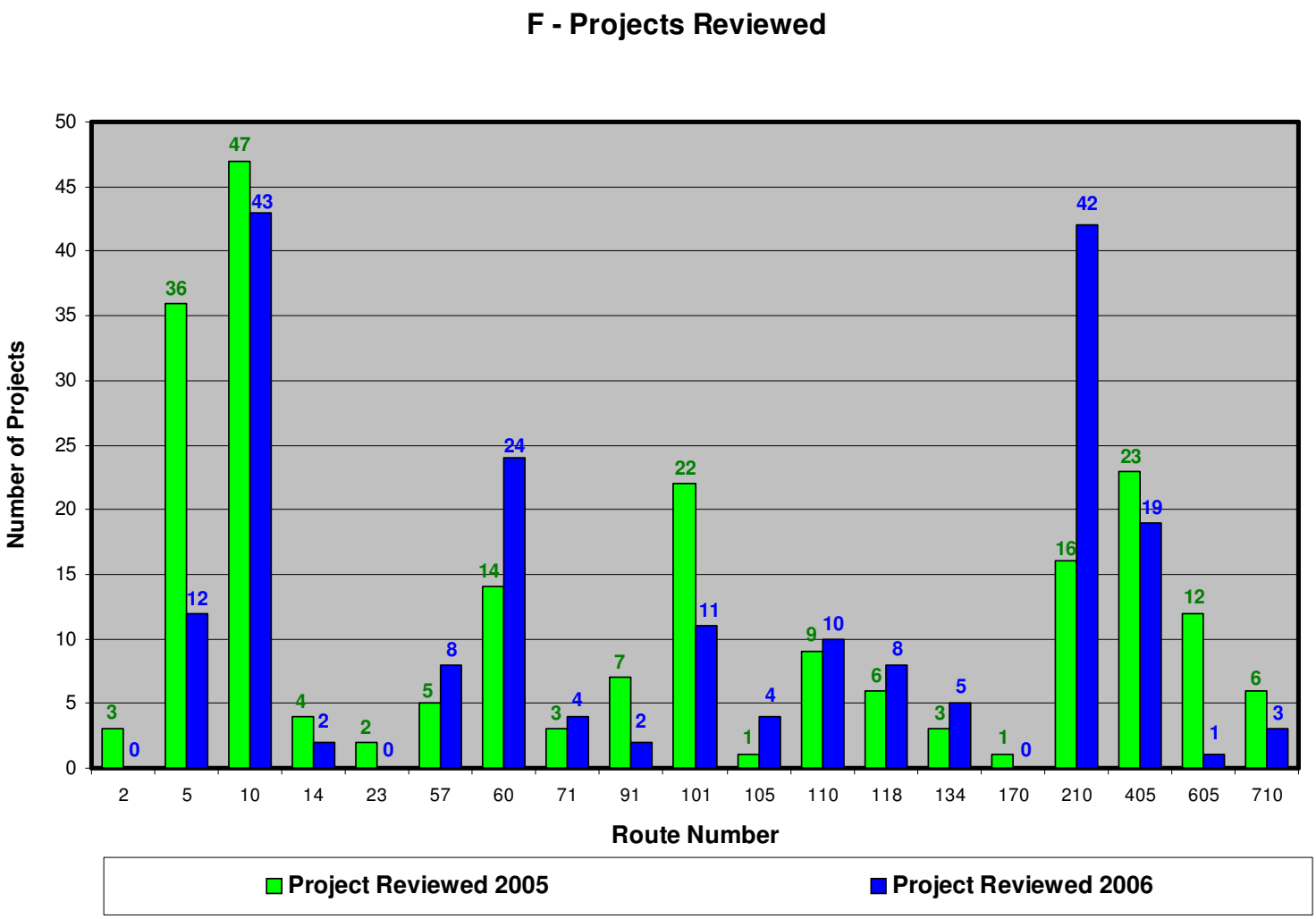


Figure 6

The Ramp Metering Branch reviewed 244 Projects in different stages of design and construction in 2006 and 225 Projects in 2005 (Refer to Figure 6).

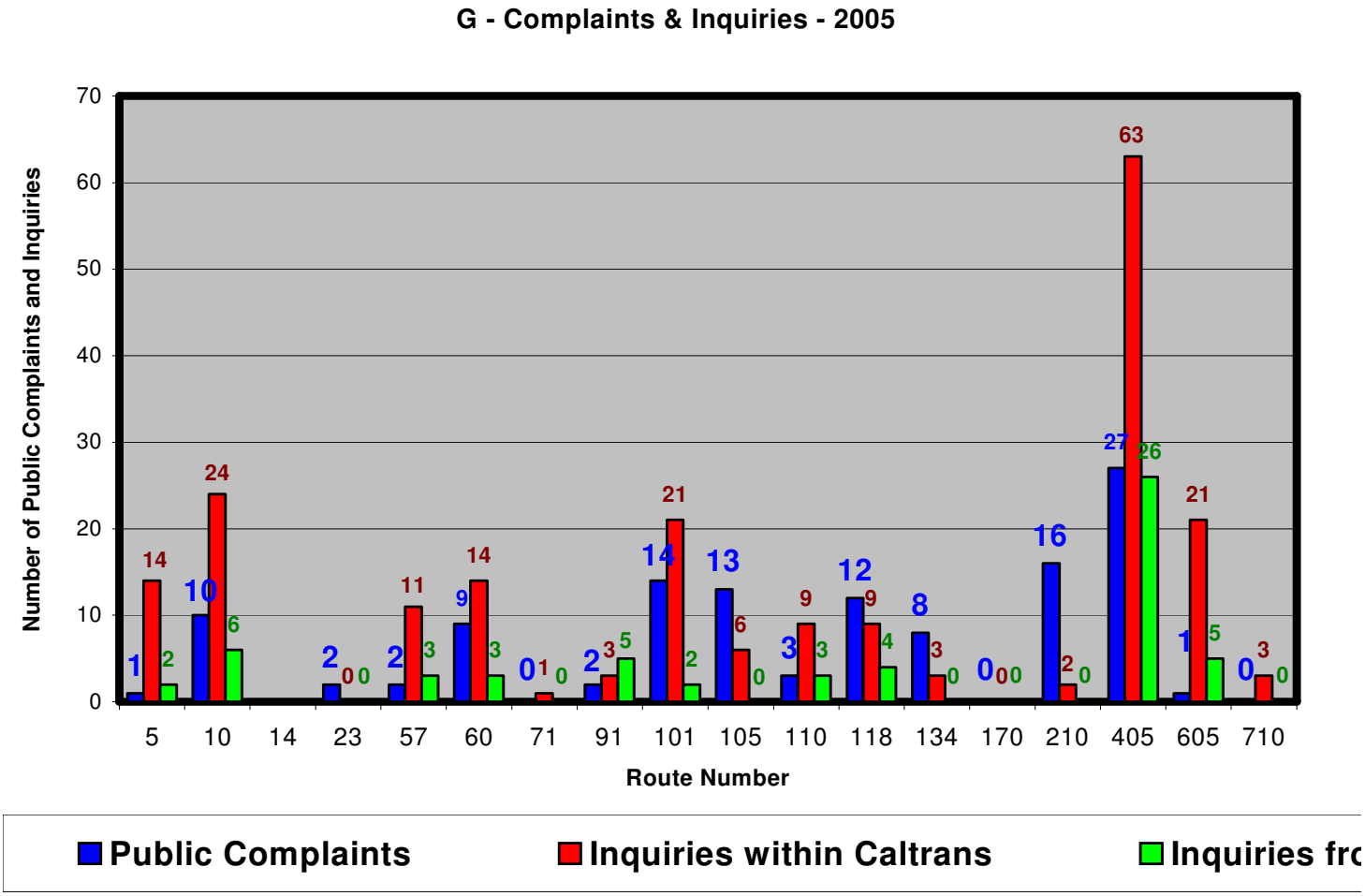


Figure 7

The Ramp Metering Branch provided traffic data, including manual Queue and Demand counts, ATMS generated reports and as-built plans to various Caltrans Branches and Public Agencies. In 2005 and 2006, the branch received 280 inquiries for each year. In addition, the Ramp Metering Branch recorded and responded to 122 Public Complaints in 2005 and 86 in 2006 respectively (Refer to figure 7 and 8).

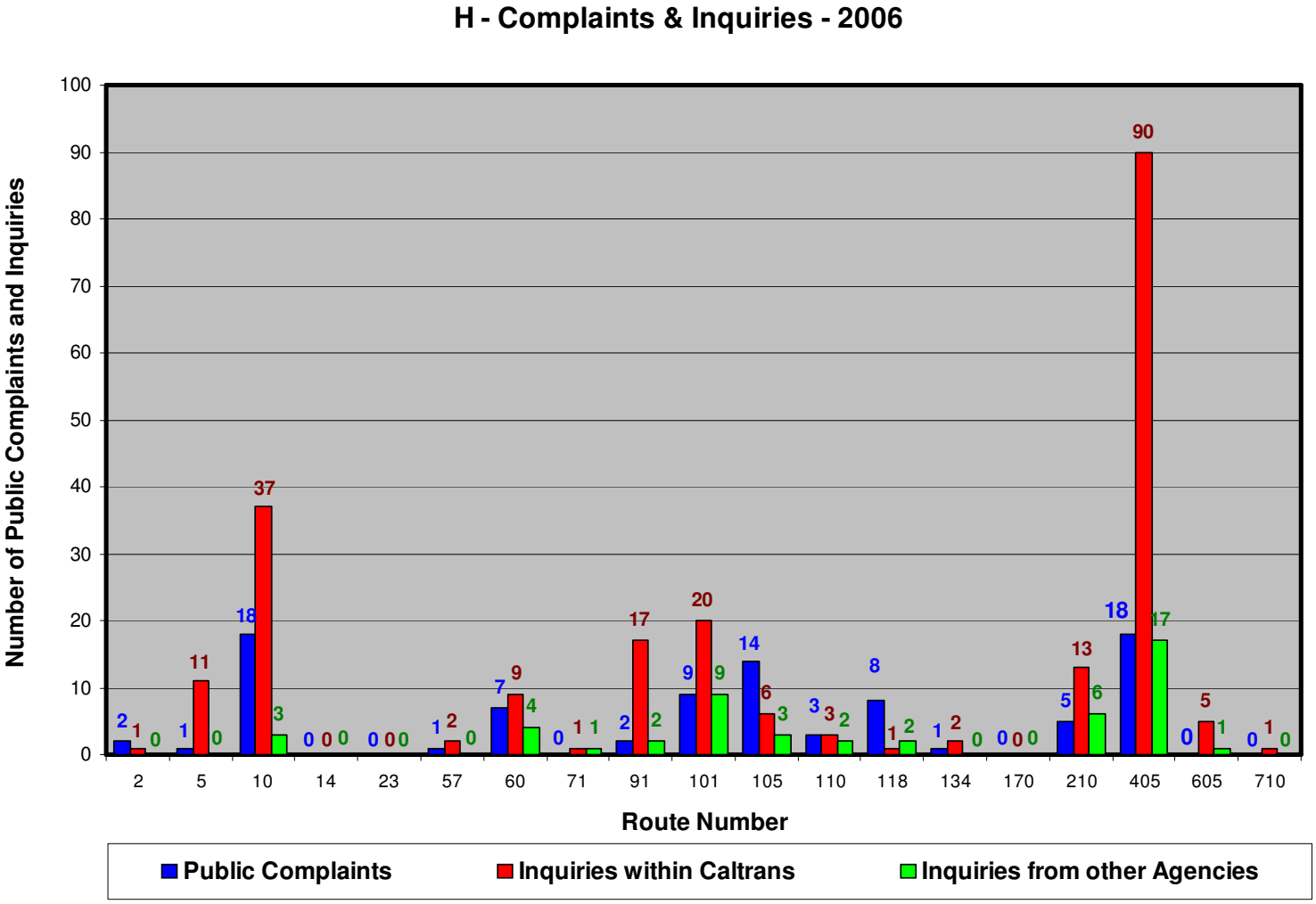

H - Complaints & Inquiries - 2006
Number of Public Complaints and Inquiries
100
90
80
70
60
50
40
30
20
10
0
2 1 0
1 11 0
18 37 3
0 0 0
0 0 0
1 2 0
7 9 4
0 1 1
2 17 2
9 20 9
14 6 3
3 3 2
8 1 2
1 2 0
0 0 0
5 13 6
18 90 17
0 5 1
0 1 0
2
5
10
14
23
57
60
71
91
101
105
110
118
134
170
210
405
605
710
Route Number
Public Complaints
Inquiries within Caltrans
Inquiries from other Agencies

FIGURE 8

2. Route 210 Strategic Growth Plan – Congestion Relief Project

The Route 210 Strategic Growth Plan consists of 2 congestion relief projects. The first project, EA 257401 extends from post mile 26.00 (City of Pasadena) to post mile 52.00 (San Bernardino County Line). This project proposes to design and install all necessary ramp metering hardware elements necessary for a freeway ramp metering control algorithm, SWARM (System Wide Adaptive Ramp Metering) program, and to evaluate this algorithm, along the Eastbound and Westbound Interstate 210 corridor which has been metered. The Project consists of metering 4 connectors, from Northbound Route 57 and Northbound Route 605 to East and Westbound Route 210. Metering of 12 existing HOV bypass lanes and conversion of 20 existing HOV bypass lanes into metered lanes are also included in the project.
The second project, EA 258001 from post mile 0.31 (Route 5) to 24.92 (Route 134). This project proposes to design and install ramp metering on the Western segment of the Route 210 freeway; at the present time this section of Route 210 does not have ramp meters. The Project consist of metering 5 connectors, from Eastbound Route 118, Northbound Route 2 and Eastbound Route 134 to East and Westbound Route 210. Metering of 39 on-ramps (HOV by-pass lanes included), metering of 2 existing HOV by-pass lanes, conversion of 1 existing HOV by-pass lane into metered lane and of the installation of 29 RTMS (Remote Traffic Microwave Sensor).

In order to capture the benefits of the metering installation in these two projects, before and after studies will be conducted, so that the generated improvements can be quantified. The study will compare the following:

1. ATMS mainline reports involving volume and occupancy, and to speed plots, so that travel time savings and delay reduction benefits can be quantified.

2. Manual on-ramp volume and queue count data, so that metering related congestion can be observed and quantified.

3. Field observations of overall traffic flow and notes of physical and dynamic bottlenecks, so that recommendations for geometric and/or lane striping improvements can be made.

3. RAMP METER COUNTS

There are two types of traffic counts conducted by the Ramp Metering Branch:

A. Queue and Demand (Q & D) count
B. High Occupancy Vehicle (HOV) count
C. Violation Rates count

"Queue and Demand" counts are performed to study the operation of metered ramps, which include time and extent of traffic backup (Queue) due to ramp metering. In addition to measuring the peak vehicular demand at the ramp, the types of vehicles and time intervals for the ramp are also recorded.

Queue and Demand information helps to implement an effective ramp metering strategy, as metering rates are implemented according to type and volume of traffic demand at the on-ramp, in relation to mainline traffic conditions.

"HOV" counts are conducted at metered on-ramps with an HOV bypass lane. The purpose of these counts is to determine time intervals, types of vehicles (truck, buses, motorcycles), vehicle occupancy (2, 3 …persons per vehicle). The percentage of usage of the HOV lane, in relation to the metered mix-flow lane, is calculated with this information. In addition, the number of HOV lane violations is recorded. If the violation rate is determined to be high, this information is forwarded to the California Highway Patrol for enforcement.

These two types of counts should be conducted, on a yearly basis, at all active ramp meter locations. However, due to time constraints and limited resource allocations, these counts are currently performed as needed, usually as a result of public complaints, or upcoming projects, or developments impacting the operation of the ramp meter. Thus, if a public complaint related to excessive back-up on the ramp is received, a "Queue and Demand" count might be conducted to properly investigate the problem and adjust the metering rate if needed. In addition, if a project to construct a new ramp or modify an existing one is being proposed, then a traffic count will be conducted, in order to assist in the new design. On-ramp Counts might also be conducted during major studies (SWARM testing), or large scale projects, such as like the Route 5 Widening and HOV project.

A. Various Routes.

   During the 2005 calendar year, the Ramp Metering Branch conducted 295 "Queue and Demand" and 104 "HOV" counts. However, in 2006, 376 "Queue and Demand" and 173 "HOV Occupancy" counts were conducted respectively.

B. Route 210 Congestion Relief Project.

   Manual Queue and Demand, and HOV Counts were performed on the entire stretch of Route 210 between 4/25/2006 and 06/06/2006. These counts were conducted at all 107 on-ramp locations, located within the two project limits.

4. Capital Project Review

The Ramp Metering Branch reviews numerous projects and gets involved in ramp meter related issues, during the following stages of a project:

1. PID (Project Initiation Document)
2. PSR (Project Study Report)
3. PR (Project Report)
4. All stages of PS&E (Plans Specifications and Estimate)

In addition, the Ramp Metering engineers also keep track of the project's progress throughout the construction stage.

5. *Permit Project Review*

The Ramp Metering engineers review and comment on ramp meter related issues involved in permit projects, and oversight projects, which are usually prepared by consultants on behalf of local cities, counties or other agencies.

6. *Metered Ramp Data Summary*

The Ramp Metering personnel collect information for the METERED RAMP DATA SUMMARY. Information gathered includes but is not limited to the following items:

- Ramp type and configuration
- Number of lanes
- Ramp storage length
- "Meter On" signs
- HOV and pullout locations
- Metering hours
- Metering rates
- Inventory of loops
- Signing
- Striping

The above information is useful for the following purposes:

- To provide a database for the "RAMP METER DEVELOPMENT PLAN" report.
- To generate a master list detailing all deficiencies and to forward it to the ITS group for repairs.
- To replace on-ramp traffic loops, detector cards and reconfigure detector loop connections (DLC), when needed, at numerous traffic controller cabinets, in preparation of the SATMS 3.0 installation.

7. *Ramp Meter Development Plan (RMDP)*

The first 10-year RMDP report was completed in 1997 and was due to be updated by 2007. However, an updated RMDP report was initiated in 2004 and published in July of 2005. This 10-year report contained an inventory of all on-ramps (metered and non-metered), metered connectors, in addition to a listing of on-ramps proposed or funded to be metered, within the next 10 years. For detailed information, please refer to REFERENCES, Item No. 2.

8. Ramp Metering Procedure Manual Addendum

The Ramp Metering Procedure Manual Addendum has been on the Caltrans website since 2006. Refer to the District 7 website, under Freeway Operations Publications.

9. Testing of New Vehicle Detection Technologies

Vehicle detection applications for Ramp Metering designed by Iteris, were tested at Jefferson Blvd. on-ramp to NB Route 405 (San Diego Fwy). This application, consisting of a video detection system, in conjunction with applicable software, is used to replace the exiting Demand and Passage loops with zones of detection areas. Field testing and observations were conducted by ramp metering personnel, along with Iteris technical support to help refine the original software, as numerous modifications were performed to enhance the ramp metering operation. This effort to fine tune this new technology is still on-going, in order to ensure its proper operation. However, lack in resource allocations for this specific task has halted the testing progress of this new technology. Further testing should resume when and if resources in this field will be provided. A Video detection system is ideally suited for ramps, where loops have a high failure rate due to heavy traffic, or on bridges or viaduct locations, where embedded devices are prohibited. In addition, video detection allows for reconfiguration of the detection zones, when travel lanes are realigned due to construction.

Vehicle detection applications for Ramp Metering were also tested during 2005 along Washington Blvd on-ramp to NB Route 710. This ramp location was chosen to be tested due to its geometrical configuration by the Consultant Econolite Control Products. Many field testing and observations were conducted by Ramp Metering personnel along with Econolite technical support. The results were not satisfactory, and the camera was removed, and the testing was halted.

In District 07, the Third Street on-ramp to EB Route 60 has been designated as a new technology test location. Several mainline traffic detection technologies (Cameras, Radar systems, etc) have been installed at this ramp; these installations are continuously monitored and compared, in order to evaluate their performance.

10. Convert Existing Ramp HOV Bypass Lane to a Metered HOV OR Mix Flow Lane

In 2006, the Ramp Metering Branch conducted three traffic studies at three different metered on-ramps in District 7 and as a result of this study it was decided to convert the existing ramp HOV bypass lane into a metered lane. This mitigation improved the traffic congestion at the interchange and added more storage capacity at the on-ramps. The three ramps are:

- LA – 405 Southbound @ Mulholland / Skirball Center Drive.
- LA – 101 Eastbound @ Laurel Canyon Blvd.

- LA – 05 Northbound @ Colorado Boulevard, PM 25.90 (scheduled for future construction).

11. SWARM Testing and Implementation.

SWARM was tested on Eastbound and Westbound Route 210, from Baseline Rd. at Los Angeles / San Bernandino County line(PM 52.00) to Marengo, in the City of Pasadena just east of the Route 134 Interchange (PM 26.00). The testing took place between November 7, 2006 and December 14, 2006. This testing was the first for SWARM since the Route 405 study in January of 2002. Along with SWARM testing, travel time runs on Route 66, paralleling the Route 210 Freeway, were performed between October 24th, and December 14th, 2006. All study data for SWARM and travel time runs were submitted to the consultants, Cambridge Systematic. This data will be compiled and analyzed as part of the Route 210 Growth Plan – Congestion Relief Project.

12. Major Ramp Metering Operational Studies

1. LA-10-WB @ Crenshaw Blvd, PM 11.20;
This study was requested by MTA to evaluate the ramp meter operation at Crenshaw Blvd. on-ramp to the westbound Route 10 (Santa Monica Freeway) in the City of Los Angeles. MTA was concerned with their buses experiencing delay in the vicinity of the Crenshaw Blvd. on-ramp to Route 10.

2. LA-5- NB & SB from Artesia Blvd to Lakewood Blvd, PM 0.01 to PM 8.41;
The Planning Branch requested the Ramp Metering Branch to collect traffic data on all on-ramps, off-ramp, and intersections in the vicinity to complete a traffic modeling as part of the Transportation Management Plan for the future HOV widening project and Carmenita Interchange reconstruction project. On-ramp Queue and Demand traffic counts were performed at 27 locations. Off-ramp directional traffic counts were performed at 17 locations, and at 57 intersection directional locations.

REFERENCES

1. "Ramp Meter Design Guidelines", Caltrans, January 2000.

2. **"Ramp Meter Development Plan", Wahib Jreij & Mohamed Iqbal Toorawa, April 2004.**

3. **Amended "Ramp Metering Procedure Manual", Rafael Benitez-Lopez, November 2005.**

4. "Preliminary SWARM Study Report", Hanh Pham, November 2001.

5. "SWARM Study Final Report", Hanh Pham, October 2002.

6. "ATMS User's Manual", National Engineering Technology Corporation, June 2000.

7. "ATMS Traffic Engineer's Manual", National Engineering Technology Corporation, June 2000.

8. "Highway Capacity Manual", Transportation Research Board, 2000.

9. "Traffic Manual", Caltrans

10. "Highway Design Manual", Caltrans

11. "Twin Cities Ramp Meter Evaluation", Cambridge Systematics Inc., November 27 2001.

12. "Traffic Bulletin No. 4 - Notes on Freeway Capacity", Karl Moskowitz and Leonard Newman, July 1962.

13. "Traffic Bulletin No. 16 – Introduction to Capacity", Leonard Newman, April 1969.

14. "Ramp Meter Operation Plan", National Engineering Technology Corporation, December 2001.

15. "Basic Ramp Control", M.K. Kim, Caltrans

16. Route 405 SWARM Study Summary, Wahib Jreij & Fady Al-Awar, January 2003.

ATTACHMENTS

ROUTE RESPONSIBILITIES

Afsaneh Razavi (Ramp Metering Branch Chief)

Phone (213) 897-0267

AREA ENGINEER: Wahib Jreij — Phone: (213) 897- 8483

Co/Rte	PM Limits	Limits	Assigned	Ph. Ext	Meters
LA-10	18.39/48.30	Route 101 to San Bernardino C.L.	Jreij / Dumaplin	7-8483	80
LA-210	25.00/52.00	Route 134 to San Bernardino C.L.	Jreij / Akramian	7-0247	62
LA-57	0.00/12.00	Orange County Line to Route 210	Jreij / Dumaplin	7-8842	20
LA-60	0.00/30.50	East LA Inter. to San Bernardino C.L.	Jreij / Dumaplin	7-8483	64
LA-71	0.30/4.80	San Bernardino C.L. to Route 10	Jreij / Dumaplin	7-8842	3
				Total	**229**

AREA ENGINEER: Iqbal Toorawa — Phone: (213) 897- 9133

Co/Rte	PM Limits	Limits	Assigned	Ph. Ext	Meters
LA-91	6.01/20.74	Vermont to Orange County Line	Toorawa / Eskander	7-9133	41
LA-110	0.00/20.36	Route 47 to Rte 05	Toorawa / Eskander	7-4356	42
LA-110	20.36/31.91	Route 05 to end of Freeway	Toorawa	7-9133	0
LA-110	Connector	(E/W)/B 105 to N/B 110	Benitez	7-1666	1
LA-110	Connector	E/B 105 to S/B 110	Benitez	7-1666	1
LA-110	Connector	W/B 105 to S/B 110	Benitez	7-1666	1
LA-110	Connector	S/B 5 to S/B 110	Toorawa	7-9133	1
LA-105	0.00/18.14	Airport (LAX) to Studebaker	Benitez	7-1666	31
LA-105	Connector	N/B 405 to E/B 105	Benitez	7-1666	1
LA-105	Connector	S/B 405 to E/B 105	Benitez	7-1666	1
LA-105	Connector	N/B 110 to E/B 105	Benitez	7-1666	1
LA-105	Connector	S/B 110 to W/B 105	Benitez	7-1666	1
LA-105	Connector	S/B 110 to E/B 105	Benitez	7-1666	1
LA-105	Connector	N/B 710 to W/B 105	Benitez	7-1666	1
LA-105	Connector	N/B 710 to E/B 105	Benitez	7-1666	1
LA-105	Connector	S/B 710 to E/B 105	Benitez	7-1666	1
LA-105	Connector	S/B 710 to W/B 105	Benitez	7-1666	1
				Total	**127**

AREA ENGINEER: Hanh Pham — Phone: (213) 897- 8772

Co/Rte	PM Limits	Limits	Assigned	Ph. Ext	Meters
LA-2	14.08/23.44	Glendale Blvd to Route 210	Pham / Akramian	7-0247	7
LA-134	0.0/13.34	Route 170 to Route 210	Pham / Akramian	7-8772	28
LA-405	0.00/12.95	Orange County Line to Route 110	Pham / Atefyekta	7-9292	37
LA-405	12.95/21.44	Route 110 to Route 105	Torchin	7-6576	23
LA-405	Connector	E/W 105 to S/B 405	Benitez	7-1666	1
Attachment 1				Total	**96**

ROUTE RESPONSIBILITIES

Afsaneh Razavi (Ramp Metering Branch Chief)

Phone (213) 897-0267

AREA ENGINEER: Hamid Kalkatechi — Phone: (213) 897- 0294

Co/Rte	PM Limits	Limits	Assigned	Ph. Ext	Meters
LA-5	21.10/88.61	Rte 110 to Kern County Line	Kalkatechi / Atef.	7-0294	44
LA-10	1.88/18.33	4th Street to East LA Interchange	Benitez	7-1666	46
Ven-33	0.00/5.66	Route 101 to Casitas Vista Road	Kalkatechi / Atef.	7-0294	0
LA-101	11.60/38.19	Rte 101/134/170 Int. to Ventura C.L.	Kalkatechi / Atef.	7-0294	36
Ven-101	0.00/43.62	LA County Line to Santa Barbara C.L.	Kalkatechi / Atef.	7-0294	0
Ven-126	0.00/13.24	Route 101 to LA County Line	Kalkatechi / Atef.	7-0294	0
Ven-126	0.00/13.24	Route 101 to Hallock Drive	Kalkatechi / Atef.	7-0294	0
LA-138	0.00/1.80	Route 5 to Gorman Post	Kalkatechi / Atef.	7-0294	0
LA-170	14.57/20.55	Route 101 to Route 5	Kalkatechi / Atef.	7-0294	9
LA-210	00.00/25.00	Route 134 to Rte 5	Kalkatechi / Atef.	7-0294	6
				Total	**141**

AREA ENGINEER: Jack Kao — Phone: (213) 897- 9183

Co/Rte	PM Limits	Limits	Assigned	Ph. Ext	Meters
LA-5	0.00/21.10	Orange County Line to Rte 110	Kao	7-9183	48
LA-605	9.61/26.00	Route 05 to Route 210	Kao / Dumaplin	7-8842	30
LA-605	0.00/9.61	Orange County Line to Route 05	Kao	7-9183	31
LA-605	Connector	E/B 105 to N/B 605	Benitez	7-1666	1
LA-605	Connector	E/B 105 to S/B 605	Benitez	7-1666	1
LA-710	6.80/32.70	Route 1 to Route 210	Kao	7-9183	33
LA-710	Connector	E/W 105 to S/B 710	Benitez	7-1666	1
LA-710	Connector	E/W 105 to N/B 710	Benitez	7-1666	1
				Total	**146**

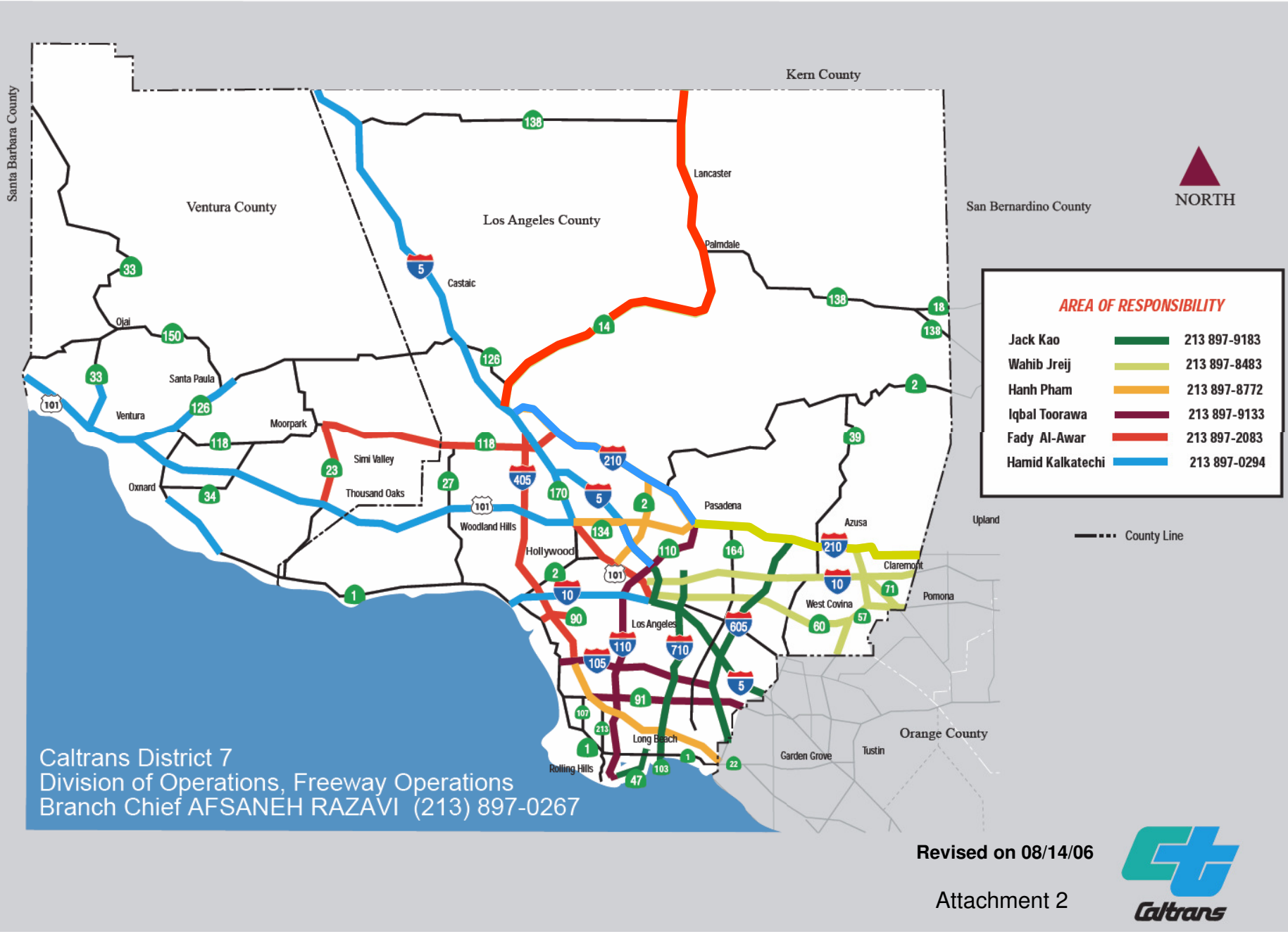
AREA ENGINEER: Fady Al-Awar — Phone: (213) 897- 2083

Co/Rte	PM Limits	Limits	Assigned	Ph. Ext	Meters
LA-14	24.79/77.01	Route 5 to Kern County Line	Al-Awar	7-2083	0
LA-101	0.18/11.60	Mission Rd to 101/134/170 Int.	Al-Awar	7-2083	32
LA-118	0.00/14.08	Ventura County Line to Route 210	Al-Awar	7-2083	14
Ven-118	18.20/32.60	Route 23 to LA County Line	Al-Awar	7-2083	53
Ven-23	3.20/11.60	Route 101 to Route 118	Al-Awar	7-2083	1
LA-405	48.64/39.40	Route 05 to Route 101	Al-Awar	7-2083	18
LA-405	39.40/21.44	Route 101 to Route 105	Torchin	7-6576	45
LA-405	Connector	W/B 105 to N/B 405	Benitez	7-1666	1
LA-90	0.92/3.28	Route 1 to Slauson	Torchin	7-6576	0
				Total	**164**

Attachment 1

Total number of Meters in District 07 **903**

DISTRICT 7 RAMP METER AREA MAP



Revised on 08/14/06

Attachment 2

California Department of Transportation
DEPUTY DIRECTIVE

Number:	DD-35
Refer to Directorís Policy:	08-Freeway System Management
Effective Date:	1-3-95
Supersedes:	P&P 91-01

Title: Ramp Metering

POLICY

Caltrans is committed to using ramp metering as an effective traffic management strategy to maintain an efficient freeway system and protect the investment made in constructing freeways to keeping them operating at or near capacity flow rates.

DEFINITION/BACKGROUND

Ramp metering is the common method of ramp entry control. It has been an effective tool in reducing congestion on California freeways since the late 1960ís. Caltrans has installed over 1300 ramp meters throughout the state and proposes their installation on all urban freeway entrance ramps where metering will improve or maintain effective operations along freeway corridors.

RESPONSIBILITES

The Traffic Operations Program Manager is responsible for the development, review and dissemination of policies, guidelines, and procedures for ramp metering (see Ramp Metering Policy Procedures).

The State and Local Project Development Program Manager is responsible for the development and review of geometric design standards for ramp metering and supports the inclusion of ramp metering in projects within freeway segments identified in the Ramp Meter Development Plan.

District Directors are responsible for developing local agency support for ramp metering; implementing ramp metering policies and procedures; and providing justification for deviation from established policy and procedures.

APPLICABILITY

Any employees involved with ramp metering activities.

ORIGINAL SIGNED BY
LEE F. DETER
Deputy Director
Maintenance and Operations

Attachment 3

RAMP METERING POLICY PROCEDURES

State of California
Business, Housing and Transportation Agency
Department of Transportation
Traffic Operations
August 1997

Attachment 4

RAMP METERING POLICY PROCEDURES

I. PURPOSE

The purpose of these procedures is to provide guidelines for implementing the Department's ramp metering policy (DD-35).

II. BACKGROUND

Metering has proven to be an effective traffic operations tool to maximize the efficiency of a corridor. The primary objective of metering is to reduce congestion and the overall travel time of the total traffic stream - on both freeway and surface streets. Ramp metering reduces congestion by:

- Maintaining more consistent freeway throughput.
- Utilizing the capacity of the freeway corridor more efficiently.
- Providing incentives for increased use of carpools, vanpools, and public transit by including preferential lanes, which offer timesavings to High Occupancy Vehicles (HOV) at ramp meters.

Secondary benefits include the reduction of congestion-related accidents and air pollution. Ramp meters operate most effectively when upstream mainline traffic is controlled. This control can be accomplished by installing additional ramp meters, metering freeway to freeway connectors or mainline control. These procedures focus on the implementation of ramp metering systems through a coordinated effort involving Caltrans planners, designers, operations personnel, local agency staff, the California Highway Patrol (CHP), and the public.

III. PROCEDURES

A. It is the District's responsibility to maintain an acceptable level of service on the freeway system, to make the most effective use of each transportation corridor, and to protect the public's investment in the system.

   Each District that currently operates, or expects to operate, ramp meters within the next ten years shall prepare a Ramp Meter Development Plan (RMDP) identifying the freeway segments, including freeway to freeway connectors, that are expected to be metered within this period. The RMDP should also identify freeway segments where upstream mainline control is necessary to maintain effective overall freeway operations. The RMDP shall be updated biennially and be included in local Congestion Management Plans.

Attachment 4

B. Projects, which propose the modification of an existing interchange or the construction of a new interchange within the freeway segments identified in the RMDP, regardless of funding source, should include provisions for ramp meters. This applies to all projects that have an approved Project Study Report dated July 1991 or later (the date of the original Policy and Procedure). These provisions, as defined in the Ramp Meter Design Guidelines, should include right of way, geometric to accommodate vehicle storage and HOV bypass lanes, ramp meter equipment, and CHP enforcement areas. Projects which propose additional capacity within freeway segments identified in the RMDP shall include provisions for ramp meters and shall implement the ramp meters at all entrance ramps within the project limits. In freeway segments identified in the RMDP where mainline control is necessary to maintain effective overall freeway operation, additional freeway capacity should not be constructed without an analysis of the operational impacts to downstream segments. Districts are responsible for performing appropriate environmental studies for ramp metering projects.

C. The District will work in partnership with metropolitan planning organizations; regional transportation planning agencies, and congestion management agencies to program ramp metering projects and develop implementation plans. Coordination and consultation should be documented and concurrence may be obtained in any form the District considers appropriate.

D. The Ramp Meter Design Guidelines prepared by the Division of Traffic Operations, in cooperation with the Division of State and Local Project Development, and the CHP shall be used when designing ramp metering facilities. This document is a compilation of design information and operational practices used statewide.

E. HOV preferential lanes shall be considered wherever ramp meters are installed. The need for HOV bypass lanes should be included in the Project Study Report, Project Information Report, Project Report, and Environmental Document. If an HOV preferential lane is not included in a proposal to ramp meter, the reasons should be addressed in the appropriate document.

The District is responsible for consulting with the CHP on project features, which affect enforcement activities such as HOV lane violations, enforcement pads, etc. Coordination and consultation should be documented.

Attachment 4

F. When selecting the appropriate metering method for the HOV preferential lane, the following criteria should be used:

Control: An analysis of HOV traffic volumes shall be made to determine the impact on mainline traffic flows. Where adverse impacts exist, consideration should include metering the HOV preferential lane and/or more restrictive metering of the SOV lane(s). Consideration should be given to metering the HOV preferential lane if platoons from local signalized intersections adversely affect the operation of the freeway. Storage capacity and effects to local arterials should also be addressed.

Merge Conditions: Prior to entering the freeway, all vehicles on the on-ramp should be provided with adequate space to safely merge with each other. The safest merge condition is when the speeds of the merging vehicles are identical. When the speed differentials between HOVs and SOVs are excessive, consideration should be given to metering the HOV lane. All ramps should be designed in accordance with the Ramp Meter Design Guidelines, which detail adequate merging distances.

Enforcement: The ability to safely enforce occupancy violations of HOV lanes is essential. The CHP should be consulted for their recommendation of enforcement operations at each HOV preferential lane location.

Corridor Operations: In corridors where ramp meters are already operational, the existing metering method may be used as criteria for additional installations in the same corridor. Should alternate metering methods be proposed along a corridor, local agencies should be consulted.

The criteria listed above can be applied to new and existing ramp meter installations. If it is being applied to an existing ramp meter, the following criteria should also be used:

Accident History: The accident history of the ramp needs to be investigated. If either the ramp or any portion of the freeway within 500 feet of the ramp gore has been flagged as a high accident concentration location (Table C), each accident report should be reviewed in detail to determine whether or not the HOV operation during the metered period was a contributing factor. If evidence suggests that it could have been a contributing factor to the accident, consideration should be given to metering the HOV preferential lane.

Attachment 4

G. Districts shall provide justification for deviation from the policy and these procedures and concurrence shall be obtained from the Headquarters Traffic Operations District Liaison. Deviations from design standards require the approval of the Project Development Coordinator in the Office of Project Planning and Design.

H. The Division of Traffic Operations provides District personnel with technical assistance and support on the design and operation of ramp meter systems and assists in the preparation of the District's RMDP.

Attachment 4

CONTENTS OF EXCEPTION TO RAMP METERING POLICY FACT SHEET

PROJECT DESCRIPTION

Briefly describe the project. Note the type of project and/or major elements of work to be done.

RAMP METERING POLICY NON-COMPLIANCE FEATURES

Describe the proposed or existing ramp metering policy non-compliance feature(s). (Note: Deviations from advisory or mandatory design standards shall be addressed as required by the *Project Development Procedures Manual,* the *Highway Design Manual* and applicable District Directives.) Design exceptions to standards to be attached to Ramp Meter Policy Fact Sheet.

REASON FOR THE EXCEPTION

Be thorough but brief. Supportive factors may include right-of-way or space constraints, environmental concerns, inordinate costs, etc. Show an estimate of the added cost above the proposed project cost that would be required to conform to the ramp metering policy for which exception is being documented. The estimate does not have to be highly developed but must be realistic.

FUTURE CONSTRUCTION

Describe any planned future projects in the immediate vicinity of the requested ramp meter exception, but do not make any commitments (e.g., ramp metering as part of future projects) unless there is a certainty that they can be followed through.

PROPOSED EXCEPTION REVIEWS AND CONCURRENCE

Note reviews by HQ Traffic Operations, the District Liaison and District Office of Traffic Systems. Give dates of reviews and discuss any comments that were made and their disposition.

REMARKS

Note clarifying remarks. Discuss impacts on project delivery schedule and project costs, if any. Discuss impacts of ramp metering policy non-compliance features.

ATTACHMENTS

Provide a locations map and/or vicinity map for the project, indicating the location of the requested exception(s) to the ramp metering policy. Also provide cross-sections and/or special details as necessary to illustrate the policy non-compliance condition. Letters, resolutions, traffic studies, etc., which help to clarify the reasons for the exception request, may be attached.

SIGNATURE SHEET

The Fact Sheet signature page shall conform to the attached.

Attachment 5

Dist-Co-Rte-KP
Source Unit – EA
Project Cost

FACT SHEET

EXCEPTION TO
RAMP METERING POLICY

(Insert Registered C.E. Seal)

Prepared by:

_____	_____	_____
(Name), Registered C.E.	Date	Telephone

Approval recommended by:

_____	_____	_____
(Name), Project Manager	Date	Telephone

Concurrence by:

_____	_____	_____
(Name), District Liaison HQ Traffic Operations	Date	Telephone

Approved by:

_____	_____
(Name), District Division Chief, Operations	Date

Attachment 5

State of California **Business, Housing and Transportation Agency**

M e m o r a n d u m

To: DISTRICT DIVISION CHIEFS – Operations **Date:** July 31, 2000
DISTRICT DIVISION CHIEFS – Design
DISTRICT DIVISION CHIEFS – Planning **File:**

From: DEPARTMENT OF TRANSPORTATION
Traffic Operations
Mail Station 36

Subject: Ramp Metering Policy on High Occupancy Vehicle (HOV) Preferential Lanes

The purpose of this memorandum is to clarify and re-affirm the California Department of Transportation (Caltrans) policy on HOV preferential lanes at ramp meter locations. Caltrans is committed to its current policy: **An HOV preferential lane shall be provided at all ramp meter locations.**

The January 2000 edition of the Ramp Meter Design Manual now addresses the circumstances under which exceptions to this policy may be warranted. See 'Modifications to Existing HOV Preferential Lanes' located in Section 'I' of Chapter One:

- Underutilization of an existing lane plus the need for additional right-of-way for storage
- The availability of an alternate HOV entrance ramp within 2 Km
- The availability of a direct HOV access (drop) ramp

Exceptions shall be handled on a location-by-location basis. Conversions may require Federal Highway Administration actions or concurrence. The District Division Chief for Operations, in consultation with the Headquarters Traffic Operations Liaison, is responsible for approving and documenting decisions to remove HOV preferential lanes. These policies and exceptions also apply to new and reconstruction projects. Districts should refer to the "Exception to Ramp Metering Policy" located in the Appendix of the Ramp Meter Design Manual or contact your Headquarters Traffic Operations Liaison for assistance.

Original Signed By

KIM NYSTROM
Program Manager
Traffic Operations

cc: Mr. Robert Buckley
Program Manager
Design and Local Programs

Ms. Joan Sollenberger
Program Manager
Transportation Planning

Attachment 6