State Route 22/Interstate 405/Interstate 605

Corridor System Management Plan

August 2010

CALTRANS DISTRICT 12

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Corridor System Management Plan
State Route 22/Interstate 405/Interstate 605
(Orange County)

Executive Summary

Caltrans District 12

State Route 22/Interstate 405/ Interstate 605

Corridor System Management Plan

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1. Introduction

This document contains the Executive Summary for the Orange County State Route 22/Interstate 405/ Interstate 605 (SR-22/I-405/I-605) Corridor System Management Plan (CSMP) Final Report developed on behalf of the California Department of Transportation (Caltrans) by System Metrics Group, Inc. (SMG). A more detailed technical CSMP is available upon request.

This CSMP is the direct result of the November 2006 voter-approved Proposition 1B (The Highway Safety, Traffic Reduction, Air Quality, and Port Security Bond Act of 2006). This ballot measure included a funding program deposited into a Corridor Mobility Improvement Account (CMIA). The CMIA will partially fund the construction of High Occupancy Vehicle (HOV) connectors between SR-22 and I-405 as well as between I-405 and I-605. As a result, the SR-22 corridor defined for the CSMP includes SR-22 plus the sections of I-405 and I-605 found in Orange County. The section of I-605 is small, so this comprehensive performance assessment concentrates on SR-22 and I-405 (collectively called "SR-22 CSMP Corridor").

To receive CMIA funds, the California Transportation Commission (CTC) guidelines require that project nominations describe in a CSMP how mobility gains from funded corridor improvements would be maintained over time. A CSMP, therefore, aims to define how corridors will be managed, focusing on operational strategies in addition to the already funded expansion projects. The goal is to get the most out of the existing system and maintain or improve corridor performance.

This Executive Summary and the full technical CSMP represent the results of a study which included several key steps, including:

- Stakeholder Involvement
- Corridor Performance Assessment
- Bottleneck Identification and Causality Analysis
- Scenario Development and Analysis
- Conclusions and Recommendations.

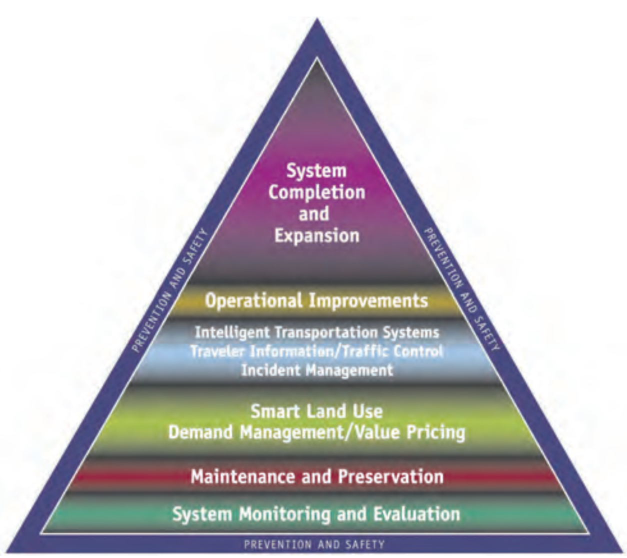
2. Background

Orange County's transportation system faces numerous challenges – the demand for transportation keeps rising, congestion is increasing, and infrastructure is aging. At the same time, traditional transportation finance mechanisms are not able to provide adequate funding to continue expanding the infrastructure and keep up with demand. Caltrans recognized that infrastructure expansion cannot keep pace with demand, and adopted a system management philosophy to address current and future transportation needs in a comprehensive manner.

Exhibit ES-1 illustrates the concept of system management as a pyramid. The exhibit shows that transportation decision makers and practitioners at all jurisdictions must expand their "tool box" to include many complementary strategies, including smart land use, demand management, and an increased focus on operational investments (shown in the middle part of the pyramid) to complement the traditional system expansion investments. All of these strategies build on a strong foundation of system monitoring and evaluation.

This CSMP aims to define how Caltrans and its stakeholders will manage the SR-22/I-405/I-605 corridors over time, focusing on operational strategies in addition to already funded expansion projects. The CSMP fully respects previous decisions (including land use, pricing, and demand management) and complements them with additional promising investment suggestions where appropriate. The CSMP development effort relies on complex analytical tools, including micro-simulation models, to isolate deficiencies and quantify improvements for even relatively small operational investments.

Exhibit ES-1: System Management Pyramid



The CSMP study team developed a calibrated 2008 Base Year model for the SR-22 and I-405 corridors. This model was calibrated using California and Federal Highway Administration (FHWA) guidelines. Following approval of a 2008 Base Year model, the study team developed a 2020 Horizon Year model to test the impacts of short-term programmed projects as well as future operational improvements. Caltrans and the study team agreed to 2020 as the Horizon Year since micro-simulation modeling captures operational strategies, but is typically suited for the short- to medium-term forecasting. Note that latent demand over and beyond the OCTA forecast demand was not accounted for in the analysis.

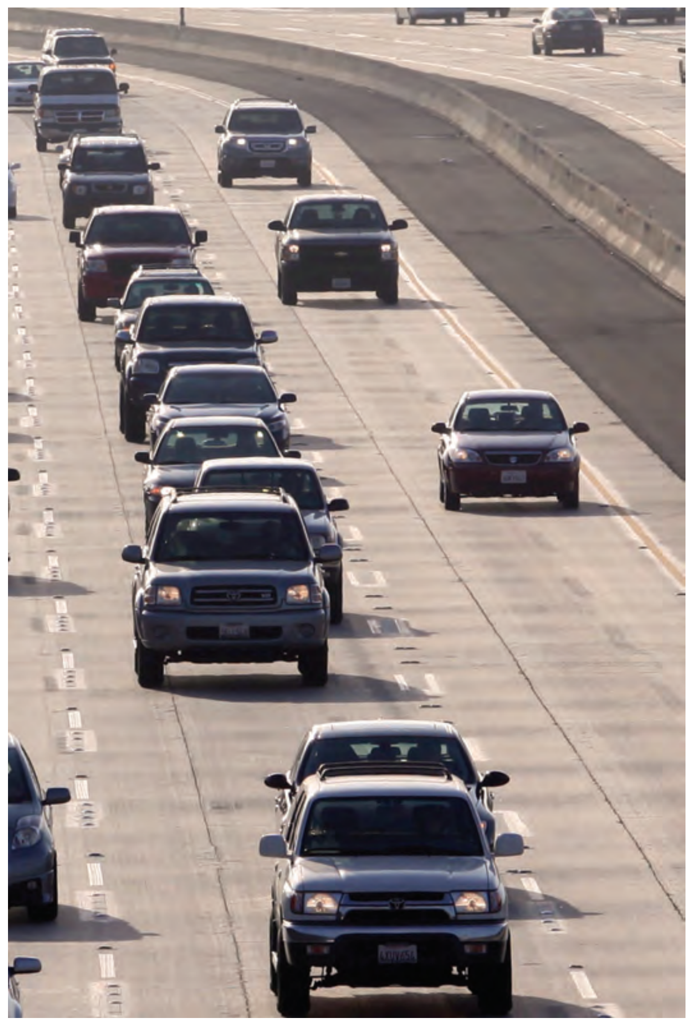
Caltrans develops integrated multimodal projects in balance with community goals, plans, and values. Caltrans seeks to address the safety and mobility needs of bicyclists, pedestrians, and transit users in all projects, regardless of funding. Bicycle, pedestrian, and transit travel is facilitated by creating "complete streets" beginning early in system planning and continuing through project delivery, maintenance, and operations. Developing a network of complete streets requires collaboration among all Caltrans functional units and stakeholders. As the first-generation CSMP, this report focuses more on reducing congestion and increasing mobility through capital and operational strategies. Future CSMP work will further address pedestrian, bicycle and transit components and seek to manage and improve the whole network as an interactive system.

3. Stakeholder Involvement

The SR-22/I-405/I-605 CSMP involved corridor stakeholders including representatives from cities bordering SR-22, I-405, and I-605; the Orange County Transportation Authority (OCTA); and the Southern California Association of Governments (SCAG). Caltrans briefed these stakeholders at critical milestones. Feedback from the stakeholders helped solidify the findings of the performance assessment, bottleneck identification, and causality analysis given their intimate knowledge of local conditions. Moreover, the corridor stakeholders have provided support and insight, and shared valuable field and project data without which this study would not have been possible. The stakeholders included representatives from the following organizations:

- Orange County Transportation Authority
- SCAG
- City of Costa Mesa
- City of Fountain Valley
- City of Garden Grove
- City of Huntington Beach
- City of Irvine
- City of Los Alamitos
- City of Orange
- City of Santa Ana
- City of Seal Beach
- City of Stanton
- City of Westminster

Caltrans would like to thank all of its partners for contributing to this CSMP development process. In addition, the CSMP development provided a venue for closer coordination between Caltrans planning and operations professionals, which is critical to the success of the system management approach.



4. Corridor Performance Assessment

This section briefly describes the SR-22/I-405/I-605 CSMP Corridor and summarizes the results of the comprehensive corridor performance assessment.

CORRIDOR DESCRIPTION

Exhibit ES-2 shows the SR-22/I-405/I-605 CSMP corridor. Within Orange County, the study corridor includes portions of three routes: SR-22, I-405, and I-605 in Orange County. The corridor begins at an interchange with all three freeways at the Los Angeles County border, where the CMIA HOV connector project is located. The corridor runs east along SR-22 (Garden Grove Freeway) to SR-55. The corridor also runs southeast along I-405 (San Diego Freeway) until it reaches I-5 (Santa Ana Freeway) just south of Irvine. The corridor includes a short, one-mile section of I-605 (San Gabriel River Freeway) as it heads north from the Los Alamitos Curve (SR-22/I-405/I-605) interchange to the Los Angeles County line.

SR-22 is 13-miles long and traverses a large part of Orange County, beginning in Seal Beach and continuing through Westminster, Garden Grove, and Santa Ana to SR-55. SR-22 intersects most of the north-south corridors in Orange County. The SR-22 portion of the study corridor includes four major freeway-to-freeway interchanges: I-605, I-405, I-5, and SR-55.

According to Caltrans traffic volumes reported for 2008, SR-22 carries between 96,000 and 251,000 annual average daily traffic (AADT). The highest volumes occur between Harbor Boulevard and the I-5/SR-57 interchange.

The portion of the study corridor along I-405 extends 24 miles, paralleling the Orange County coastline from I-5 to SR-22. The I-405 corridor portion includes four major freeway-to-freeway interchanges: I-5, SR-133, SR-55, and SR-73. The AADT for I-405 ranges between 190,000 at the I-5 interchange to 374,000 at the SR-22 interchange.

Roadway improvements were completed at several locations along the SR-22/I-405/I-605 CSMP corridor in the past few years to accommodate these volumes. In the spring of 2007, Caltrans completed an HOV lane in each direction of SR-22 along with several interchange improvements. On I-405, a $135.8 million project was completed in July 2005 to improve the I-405/SR-55 and the I-405/SR-73 interchanges in Costa Mesa.

In 2006, OCTA completed the San Diego Freeway (I-405) Major Investment Study (MIS), which considered the transportation needs of western Orange County. The MIS is part of OCTA's strategic effort to improve mobility on Orange County's corridors in the next 20 years. The MIS resulted in the adoption of a Locally Preferred Alternative that proposes adding one general purpose lane in each direction between Brookhurst Street and I-605 along with selective auxiliary lane additions. Caltrans and OCTA completed a Project Study Report/Project Development Support (PSR/PDS) document in 2008.

Three major public transportation operators provide service near the freeways in the SR-22 CSMP Corridor: OCTA, Southern California Regional Rail Authority (SCRRA) – commonly known as Metrolink, and Amtrak.

As the primary bus transit provider in Orange County, OCTA offers 81 fixed routes and paratransit bus service throughout the county. While none of these bus services runs on SR-22, two routes provide local bus service parallel to SR-22. Several express bus routes operate on I-405 (Routes 213A, 211, 212, 216, and 701). There exist several Park and Ride facilities near the study corridor (two on SR-22 and several along I-405 at major trip generators).

Exhibit ES-2: Orange County SR-22 CSMP Corridor Map

SCRRA is a joint powers authority that operates the Metrolink regional rail service throughout Southern California. Metrolink commuter rail service stops at 11 stations in Orange County and provides 44 week-day round trips on three lines. While none of the lines operates parallel to SR-22 or along the full length of I-405, the Orange County and Inland Em-pire-Orange County lines run along Edinger Avenue within a mile of I-405 in Tustin and Irvine.

Amtrak provides Pacific Surfliner train service along the same route as the Metrolink Orange County Line. Amtrak provides twelve daily trips, and Metro-link riders can use Pacific Surfliner service as part of the Rail 2 Rail cooperative program.

The major commercial airport serving Orange County, John Wayne Airport, also known as Santa Ana Airport (SNA), is located in the southern portion of the corridor at the intersection of three freeways (i.e., I-405, SR-55, and SR-73). Other major special event facilities located near the SR-22, I-405, and I-605 corridors include :

- Angel Stadium of Anaheim and the Honda Cen-ter, located less than three miles north of the SR -22/I-5 interchange on SR-57
- The Disneyland Resort and Theme Park, located approximately three and a half miles north of SR -22 on Harbor Boulevard
- Seven major universities and colleges
- Eight major medical centers and hospitals
- Five major shopping malls
- Seal Beach Naval Weapons Station

CORRIDOR PERFORMANCE ASSESSMENT

The SR-22/I-405/I-605 CSMP focuses on four categories of performance measures:

- *Mobility* describes how quickly people and freight move along the corridor.
- *Reliability* captures the relative predictability of travel time along the corridor.
- *Safety* provides an overview of collisions along the corridor.
- *Productivity* quantifies the degree to which traffic inefficiencies at bottlenecks or hot spots reduce flow rates along the corridor.

For each performance area, SR-22 and I-405 results are presented and discussed separately.

Mobility

Two primary measures quantify mobility in this report: delay and travel time. Each is estimated from field automatic detection data and forecasted using macro or micro-simulation models. The Performance Measurement System (PeMS) [1] provides access to the historical freeway detection data needed to estimate the two mobility measures. PeMS collects detector volume and occupancy data on the freeway, which are used to estimate speed, delay and travel time.

Delay

Delay is defined as the observed travel time minus the travel time during free flow conditions (assumed 60 miles per hour). It is reported as vehicle-hours of delay.

Exhibit ES-3 shows the average weekday daily vehicle-hours of delay for each month for SR-22 between 2002 and 2004 for mainline lanes as well as between 2008 and 2009 and for mainline and HOV lanes. The break in the reporting periods occurs because there was no detection on SR-22 between 2005 and part of 2008, while the HOV lanes were being constructed.

Exhibit ES-4 shows the same trends for I-405, but for the continuous five-year period from 2005 to 2009. Results are shown for both the mainline and HOV lanes.

For the SR-22 mainline

, performance assessments were conducted for two periods: 2002 to 2004 (pre-construction) and 2008 to 2009 (post-construction). The same performance assessment was conducted for the SR-22 HOV facility, but during the post-construction years of 2008 and 2009 when detection quality was high. For the I-405 mainline and HOV facilities, performance assessments were conducted for the continuous five-year period of 2005 to 2009.

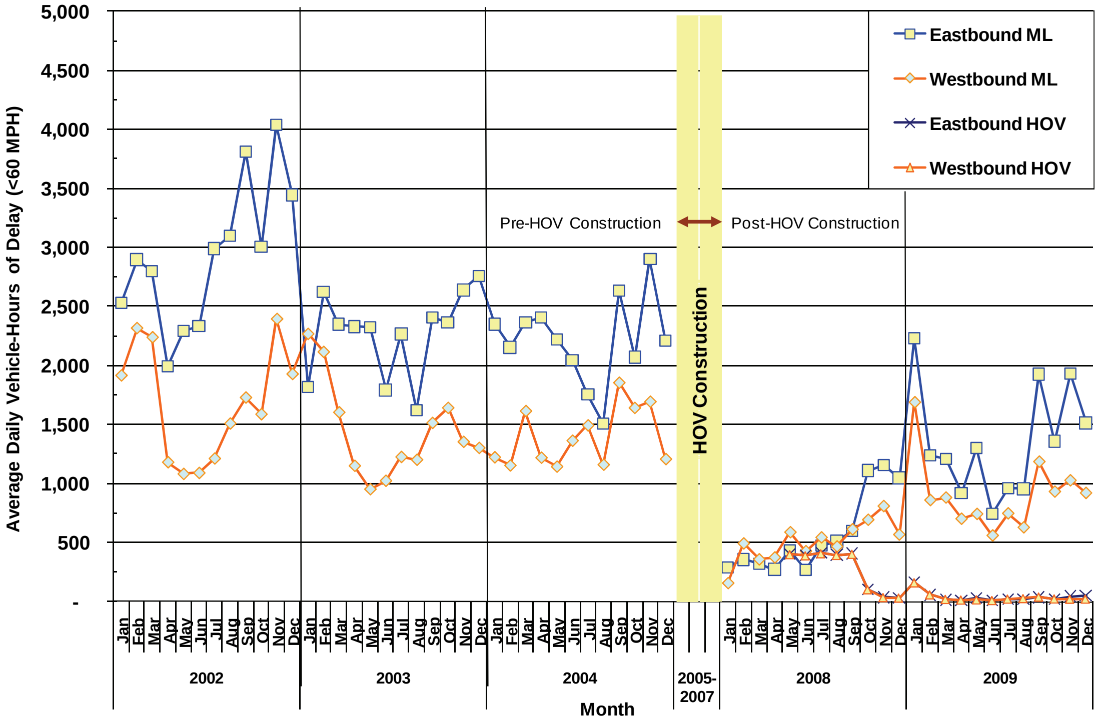
ES-3 reveals the following delay trends on the SR-22 mainline and HOV facilities:

- Eastbound mainline delay is 50 to 60 percent higher than westbound delay.
- The fall and early winter seasons tend to experience the highest congestion levels.
- Following the construction of the HOV lanes in 2007, congestion on the mainline lanes declined by approximately 43 percent, which could be due to the HOV facility and the economic downturn of 2008.
- HOV congestion is minimal, rarely exceeding 100 vehicle-hours of delay for any given month.

Exhibit ES-4 provides comparable delay trends for I-405:

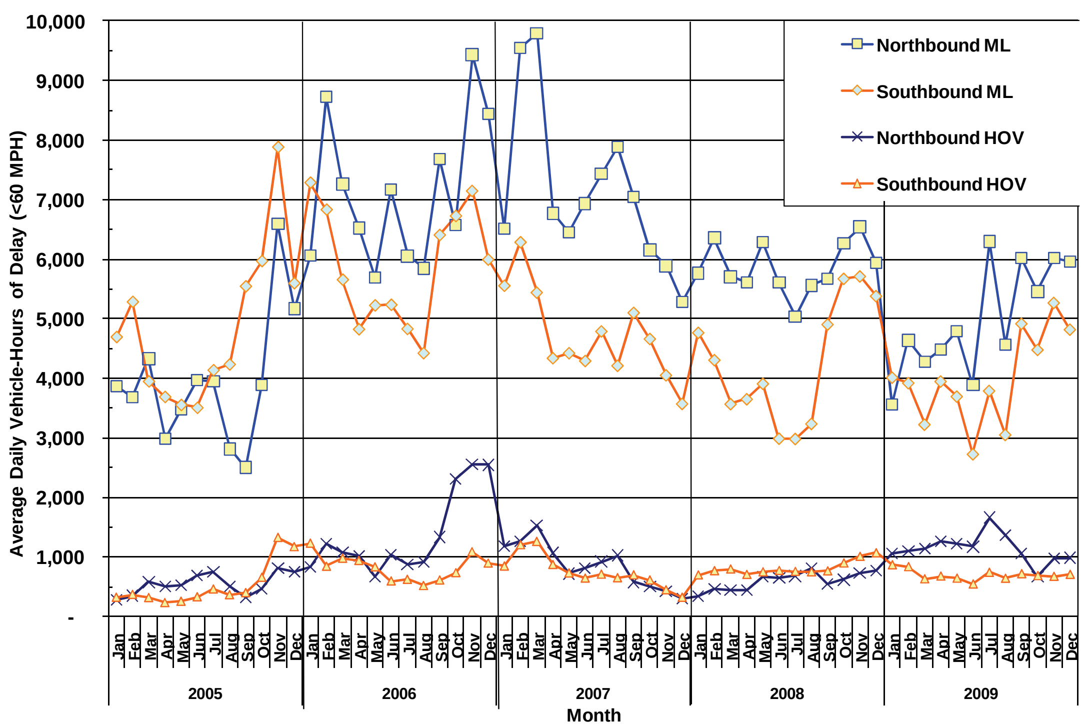
- Northbound mainline delay is approximately 33 percent higher than southbound delay.
- Congestion on the mainline lanes has been declining steadily since 2007. It is now just slightly higher than 2005 levels.
- HOV congestion is minimal, at approximately 500 vehicle-hours of delay for any given month.

Exhibit ES-3: SR-22 Mainline and HOV Weekday Delay by Month (2002-2009)



Source: Caltrans automatic detector data

Exhibit ES-4: I-405 Mainline and HOV Weekday Delay by Month (2005-2009)



Source: Caltrans automatic detector data

Delay can be grouped into two components: severe delay and other delay. *Severe delay* occurs when speeds are below 35 mph and other delay occurs when speeds are between 35 and 60 mph. Severe delay represents breakdown conditions. "Other" delay represents conditions approaching or leaving the breakdown congestion, or areas that experience temporary slowdowns. However, it can also be a leading indicator of future severe delay.

Exhibits ES-5 (SR-22 mainline lanes) and ES-6 (I-405 mainline lanes) show average severe and other daily vehicle-hours of delay by day of the week. Exhibit ES-5 reveals the following delay trends on the SR-22 mainline lanes:

- On the mainline lanes, severe delay makes up approximately two-thirds of all weekday delay on the corridor in either direction. This reflects the extreme congestion that corridor travelers face during peak periods. HOV severe delays (not shown in the exhibit, but found in detailed final report) tend to average approximately 50 percent of total delay.
- A surprising finding is that Saturday delays in the eastbound direction were almost as high as weekday delays between 2002 and 2004. However, Saturday delays declined dramatically after construction of the HOV facility in 2007.
- Friday is the peak travel day, followed by Thursday and Wednesday.
- On the HOV facility (not shown in the exhibit), Wednesday was the peak day.

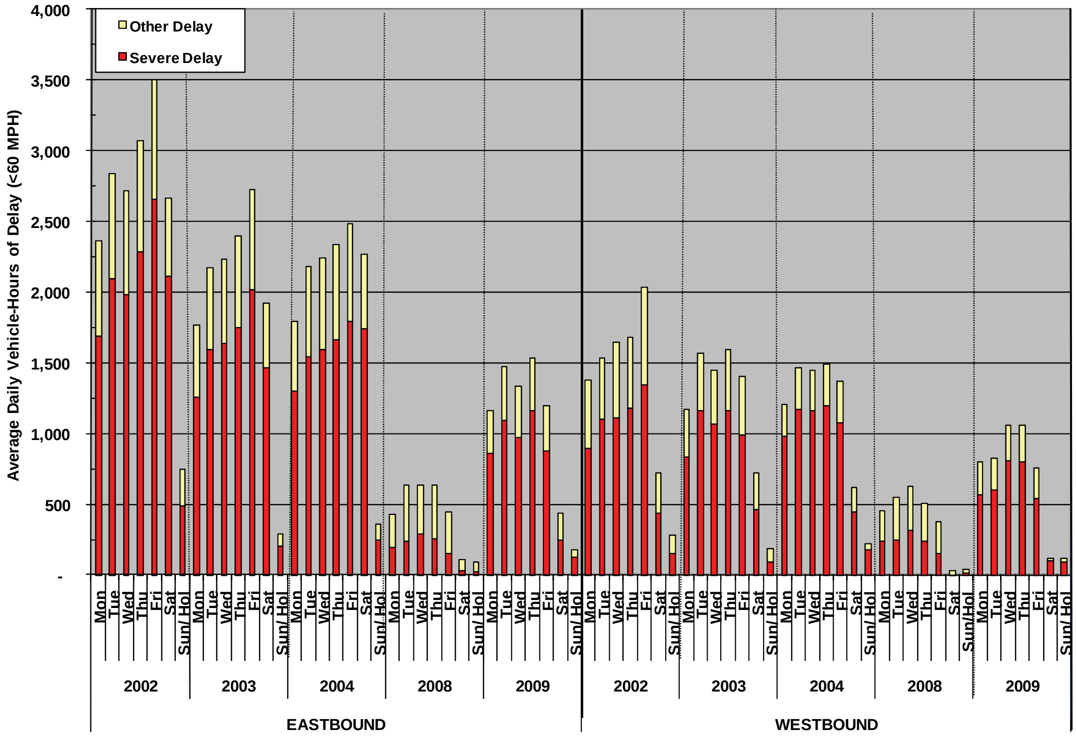
Exhibit ES-6 provides comparable information for the I-405 mainline lanes:

- On the mainline lanes, severe delay makes up approximately two-thirds of all weekday delay on the corridor in either direction. HOV severe delays (not shown in the exhibit, but found in detailed final report) are similar to I-405 mainline delays and average approximately 67 percent of total delay.
- As with SR-22, Friday is the peak day for both I-405 mainline lanes and HOV lanes, followed by Thursday and Wednesday.
- Both northbound and southbound directions show similar patterns except that the northbound lanes experience more congestion in general than the southbound lanes.

Exhibits ES-7 and ES-8 summarize average annual weekday delay by hour of the day over the period from 2002 to 2004 (pre-HOV construction period) and from 2008 to 2009 (post-HOV construction) for the mainline eastbound and westbound directions for SR-22. These exhibits allow planners and decision makers to understand the trend in peak period delay spiking and peak period spreading by comparing the intensity and duration of peak period congestion. Note that the HOV lanes are not shown in this summary report since they follow similar peaking trends as the mainline lanes. The technical report contains the HOV delay by hour results. A few notes on these two exhibits for SR-22:

- In both directions, 2002 was the peak year for congestion with 2008 having the lowest congestion. In 2009, delay began to increase from 2008 lows.
- In the eastbound direction, there are two peaks: One in the AM between 7:00 AM and 8:00 AM, and another PM peak at 3:00 PM. There is a smaller peak at 5:00 PM as well, but it is not as pronounced as the 3:00 PM peak. Westbound, there is a significant PM peak at 5:00 PM.

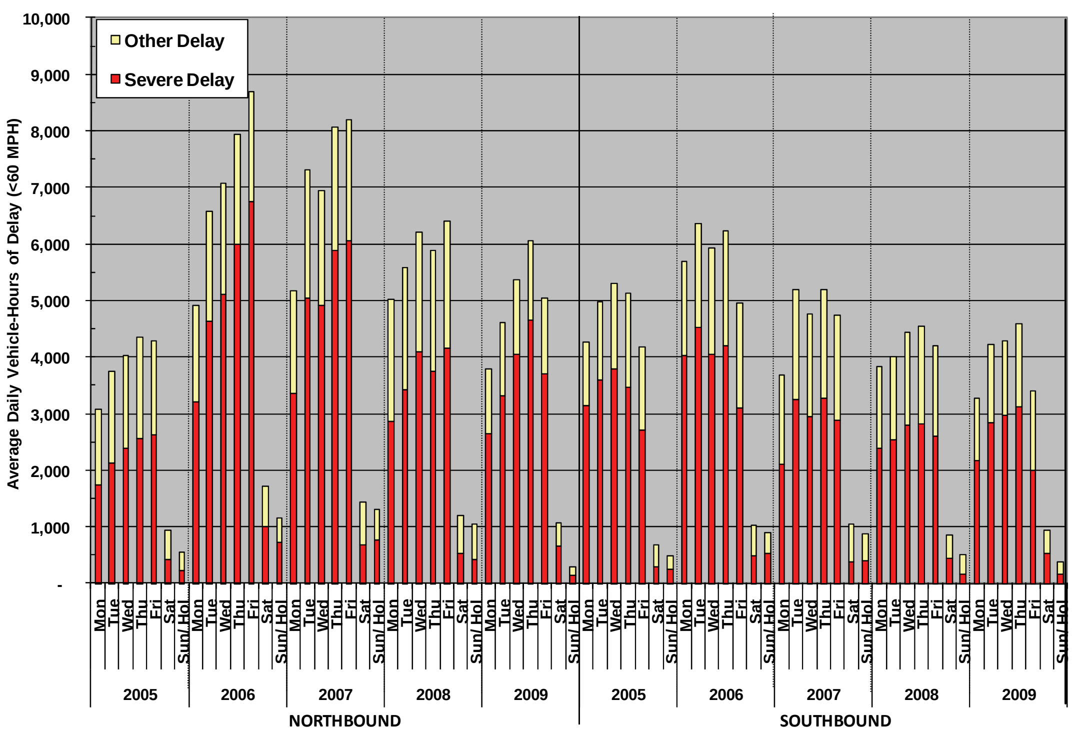
Exhibit ES-5: SR-22 Mainline Lane Delay by Day of Week (2002 to 2009)



Source: Caltrans automatic detector data

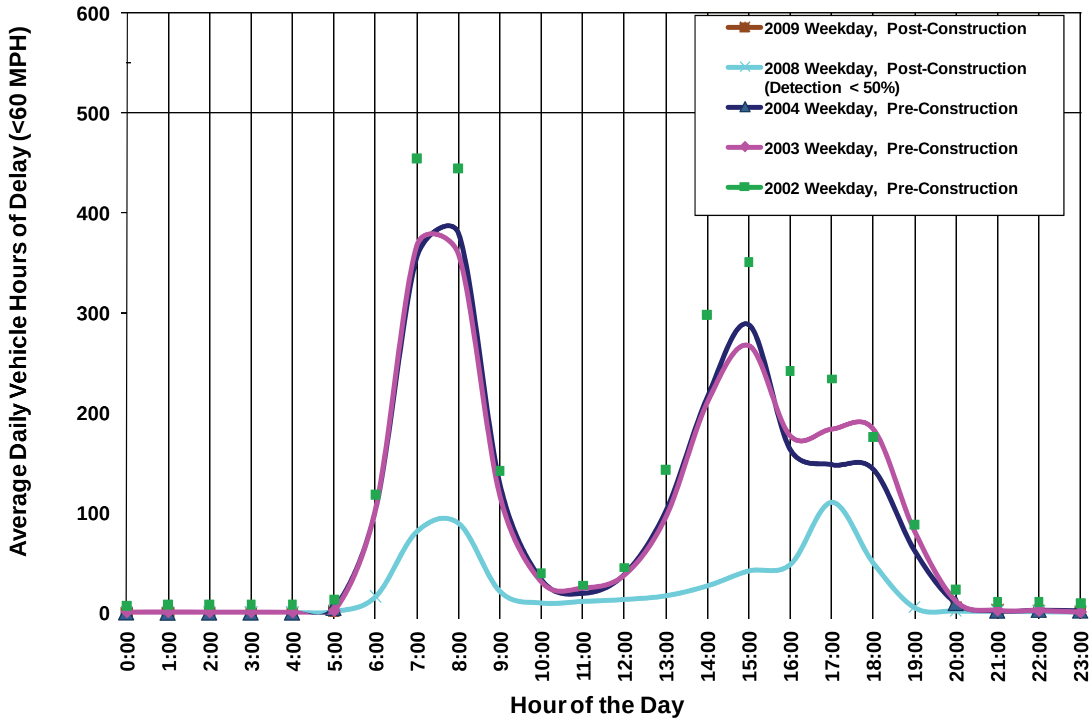
Note: Due to poor detection on SR-22 in 2008, delay may be underreported for 2008

Exhibit ES-6: I-405 Mainline Lane Delay by Day of Week (2005 to 2009)



Source: Caltrans automatic detector data

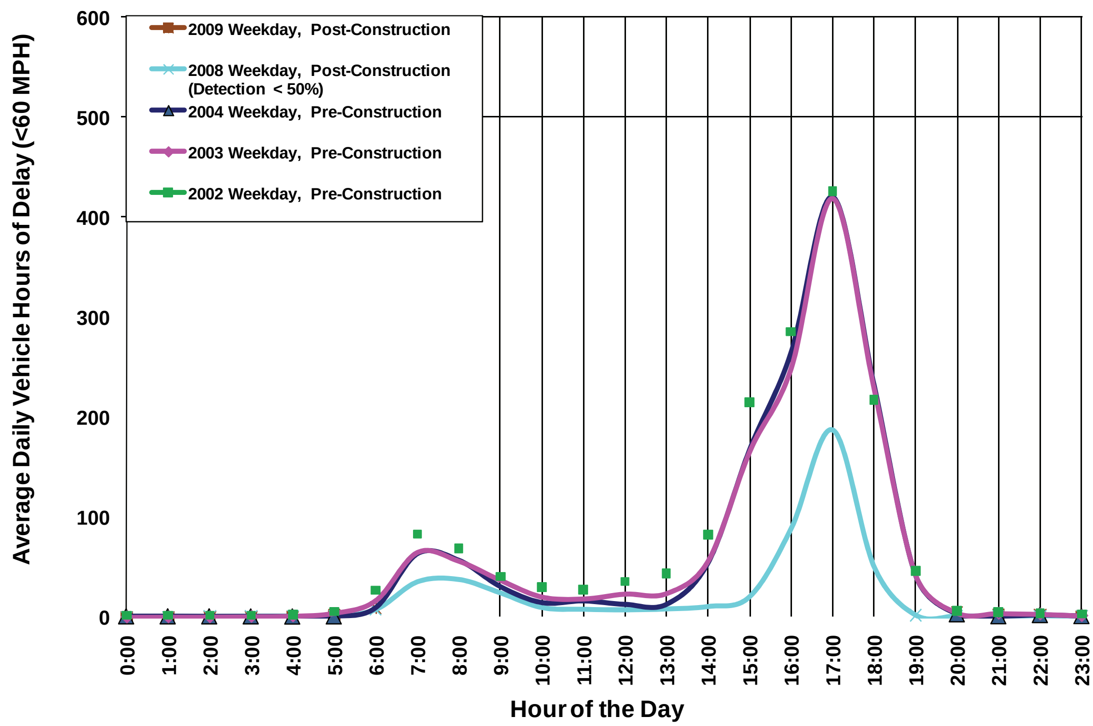
Exhibit ES-7: Eastbound SR-22 Mainline Lanes Hourly Delay (2002-2009)



Source: Caltrans automatic detection data

Note: Due to poor detection on SR-22 in 2008, delay may be underreported for 2008.

Exhibit ES-8: Westbound SR-22 Mainline Lanes Hourly Delay (2002-2009)



Source: Caltrans automatic detection data

Note: Due to poor detection on SR-22 in 2008, delay may be underreported for 2008.

Exhibits ES-9 and ES-10 summarize average similar data for the I-405 mainline northbound and southbound directions. These exhibits cover the period from 2005 to 2009. As with SR-22, the results for the I-405 HOV lanes are not shown in this executive summary. A few notes on these two exhibits for I-405:

- The two directions show peaking in both time periods, with the 8:00 AM and the 5:00 PM hours being the most congested. Northbound PM peak period delay is the highest of either direction. The northbound AM peak is about one-half as congested as the PM peak. The AM peak hour is about as congested as the southbound AM and PM peaks.
- After experiencing significant congestion in 2005 and 2006, the southbound AM period delays are now only slightly higher than the PM peak and are less than the northbound peak delay levels.

Travel Time

The travel time performance measure represents the average time it takes for a vehicle to travel the entire distance of the corridor. In the case of SR-22, this is the time to travel the 13 miles from the western to eastern termini of SR-22. In the case of I-405, the travel time is the time to travel 24 miles from the I-5 interchange in the south to the SR-22 interchange in the north. Caltrans detection data were used to compute and analyze travel times.

Exhibits ES-11 and ES-12 present mainline travel times for SR-22, while Exhibits ES-13 and ES-14 show mainline travel times for I-405. HOV travel times are reported in the detailed final report.

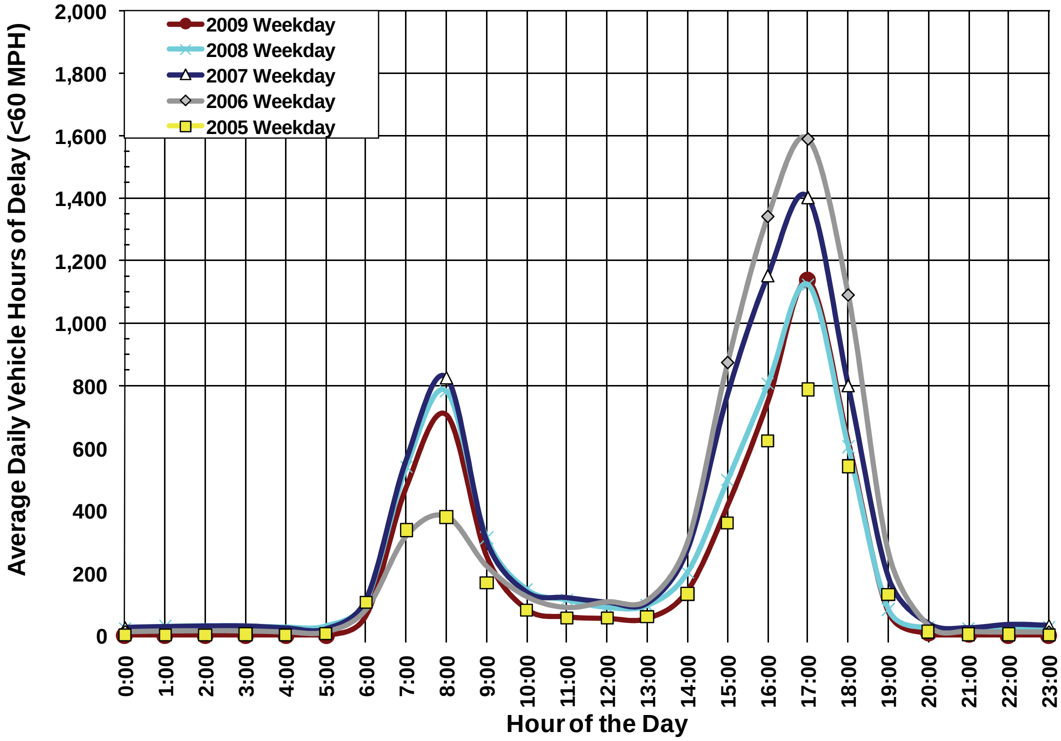
A few notes about the SR-22 travel times presented in Exhibits ES-11 and ES-12:

- Eastbound mainline lanes experienced typical travel times of 15 to 17 minutes in the AM peak period during the pre-construction period from 2002 to 2004. However, during the post-construction period in 2008 and 2009, travel times decreased to roughly 14 minutes.
- Westbound mainline lanes also experienced an improvement in travel times as depicted in Exhibit ES-12. From 2002 to 2004, the westbound direction experienced travel times of approximately 17 minutes during the PM peak hour and about 11 to 12 minutes during the off-peak hours. In 2009, travel times decreased to less than 15 minutes during the PM peak period.

Some additional notes about I-405 travel times presented in Exhibits ES-13 and ES-14:

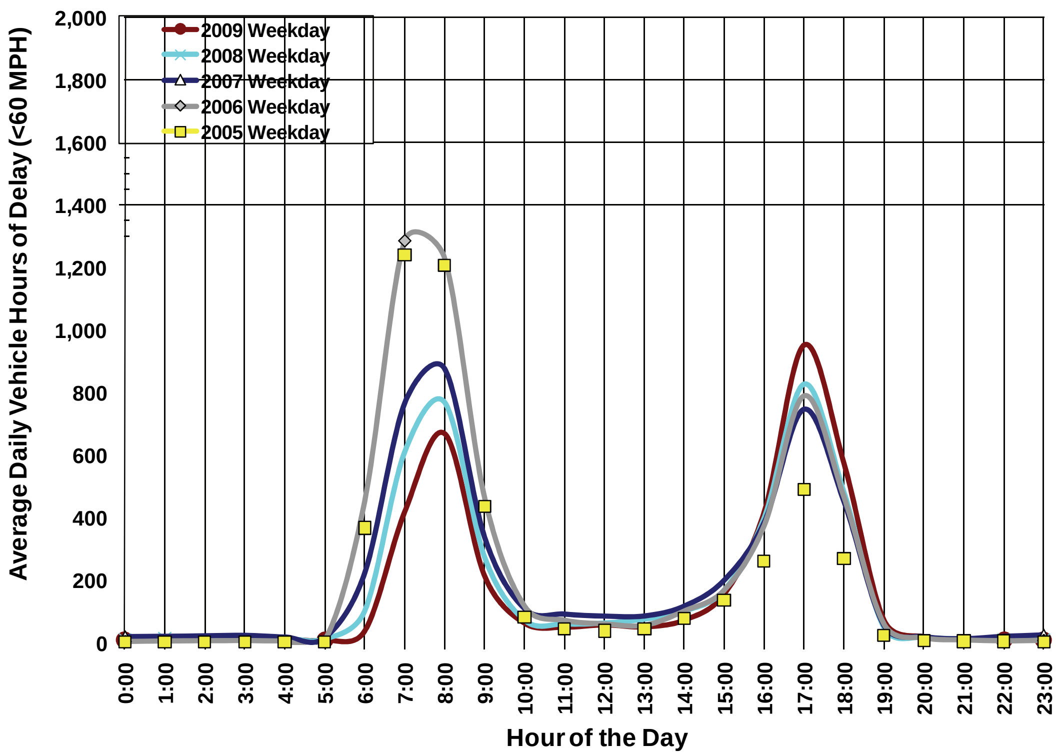
- Exhibit ES-13 shows the travel times for the I-405 Corridor for each year between 2005 and 2009. Similar to the delay results, northbound mainline travel times were highest during the PM peak period. During the PM peak, it took a vehicle about 33 minutes to drive the corridor in 2009. This is seven minutes faster than it took to drive the corridor in 2006, the most congested year.

Exhibit ES-9: Northbound I-405 Mainline Lanes Hourly Delay (2005-2009)



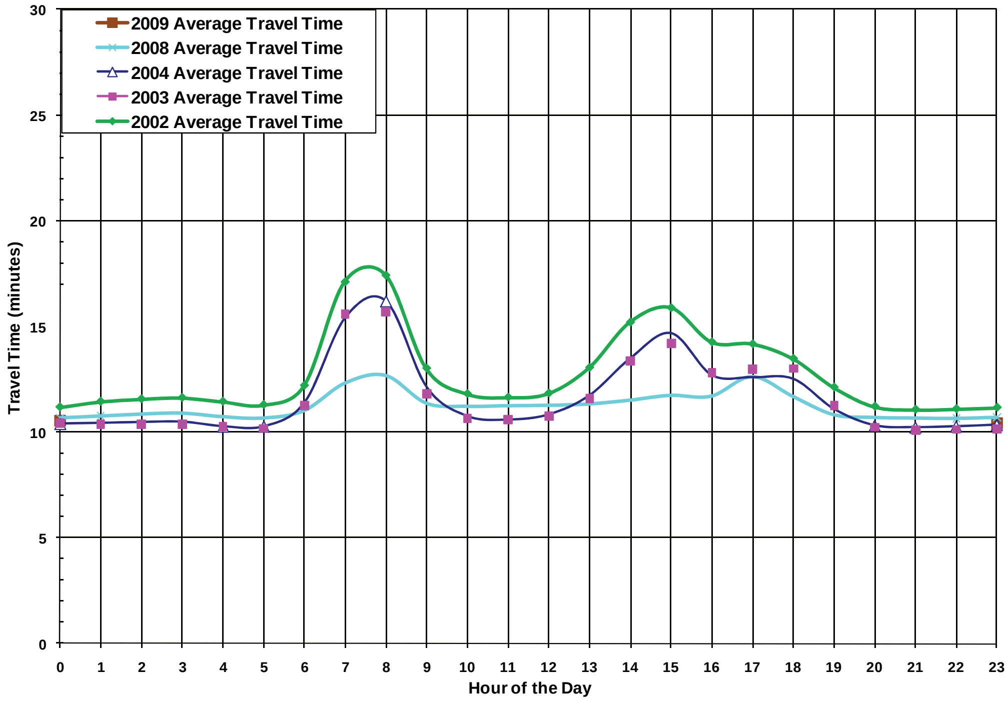
Source: Caltrans automatic detection data

Exhibit ES-10: Southbound I-405 Mainline Lanes Hourly Delay (2005-2009)



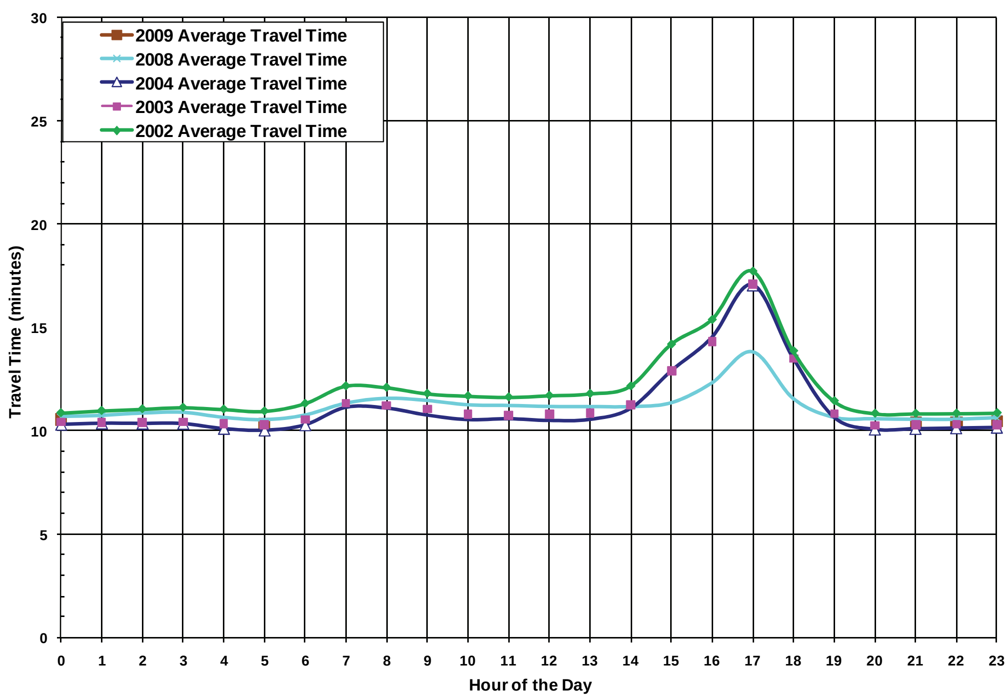
Source: Caltrans automatic detection data

Exhibit ES-11: Eastbound SR-22 Mainline Lanes Travel Time by Hour (2002-2009)



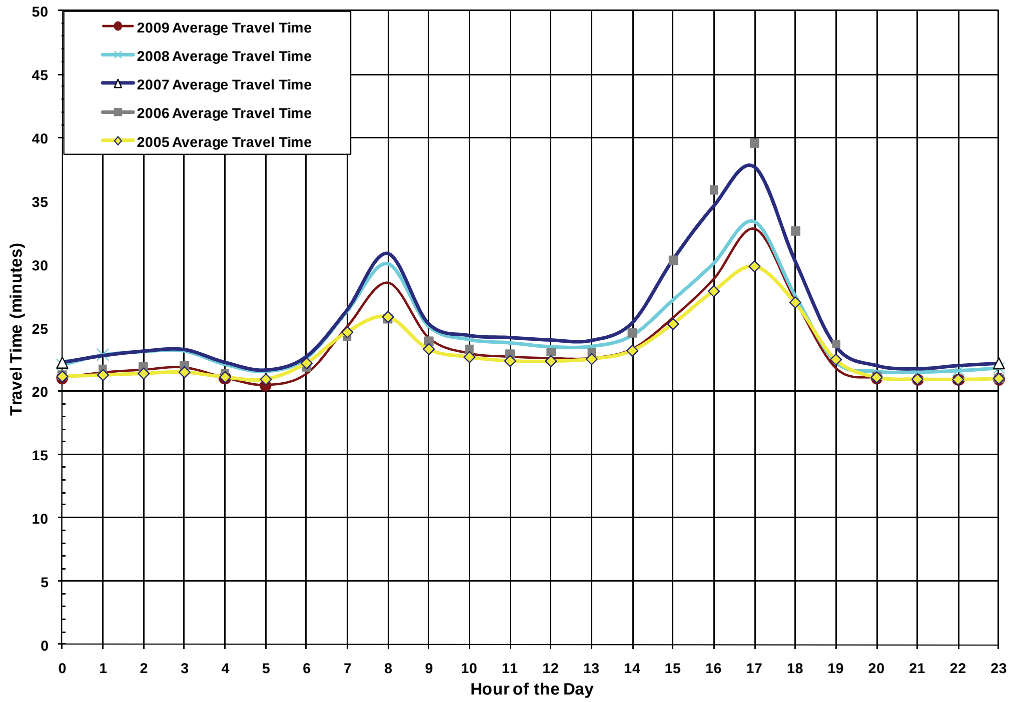
Source: Caltrans automatic detection data
Note: Due to poor detection on SR-22 in 2008, travel times may be underreported for 2008.

Exhibit ES-12: Westbound SR-22 Mainline Lanes Travel Time by Hour (2002-2009)



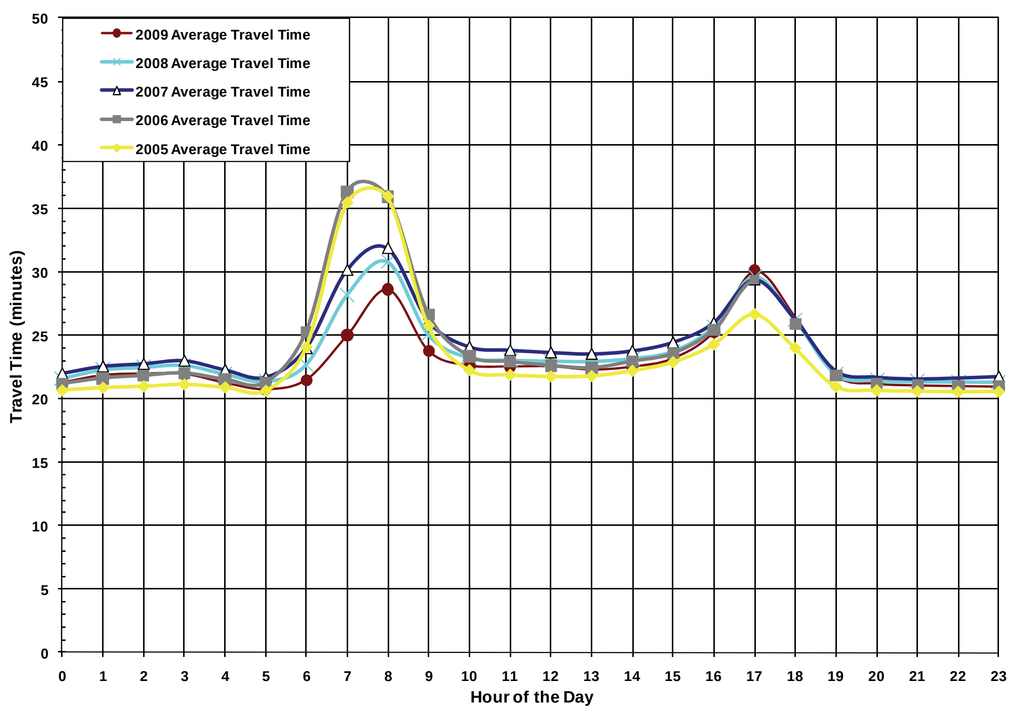
Source: Caltrans automatic detection data
Note: Due to poor detection on SR-22 in 2008, travel times may be underreported for 2008.

Exhibit ES-13: Northbound I-405 Mainline Lanes Travel Time by Hour (2005-2009)



Source: Caltrans automatic detection data

Exhibit ES-14: Southbound I-405 Mainline Lanes Travel Time by Hour (2005-2009)



Source: Caltrans automatic detection data

Reliability

Reliability captures the degree of predictability in travel time. Reliability focuses on how travel time varies from day to day and reflects the impacts of accidents, incidents, weather, and special events. Improving reliability is an important goal for transportation agencies and efforts to accomplish this include incident management, traveler information, and special event planning.

To measure reliability, the CSMP uses the "buffer index", which reflects the additional time required (over and beyond the average) to ensure an on-time arrival 95 percent of the time. In other words, if a person must be on-time 95 days out of 100 (or 19 out of 20 workdays per month), then that person must add additional time to their average expected travel time to ensure an on-time arrival. That additional time is the buffer time. Severe events, such as collisions, could cause longer travel times, but the 95th percentile represents a balance between days with extreme events (e.g., major accidents) and other, more "typical" travel days.

Exhibits ES-15 and ES-16 illustrate the variability of travel time for the SR-22 mainline lanes for non-holiday weekdays in 2008. The detailed final report shows the buffer index for the years 2002 through 2004 and 2008 to 2009 for both mainline and HOV lanes. This Executive Summary reports only mainline data for 2008 since that year was the base for modeling.

The following observations on reliability for SR-22 are worth noting:

- In 2008, neither direction of SR-22 experienced extreme variations in travel time.
- The average travel time variability never slowed significantly and even the 95th percentile travel time did not exceed the travel time at 35 mph (shown by the red dashed line).

Exhibits ES-17 and ES-18 show similar variability charts for the I-405 corridor. As with SR-22, the detailed final report shows both mainline and HOV facility results for the years 2005 to 2009. This Executive Summary shows just the 2008 mainline results, since 2008 is the base year for modeling.

The following observations on reliability for I-405 are worth noting:

- The northbound 5:00 PM peak hour was the most unreliable in addition to being the slowest hour in the northbound direction. To arrive on time 95 percent of the time a driver would have to add nearly seven minutes to the average commute time of 33 minutes and allow up to 40 minutes total.
- The most unreliable hour in the southbound direction was 8:00 AM, when a driver would have to add nearly 10 additional minutes for on-time arrival.

It is important to keep track of the reliability statistic, in part to evaluate incident management improvement strategies, and in part to gauge the effectiveness of safety projects delivered.

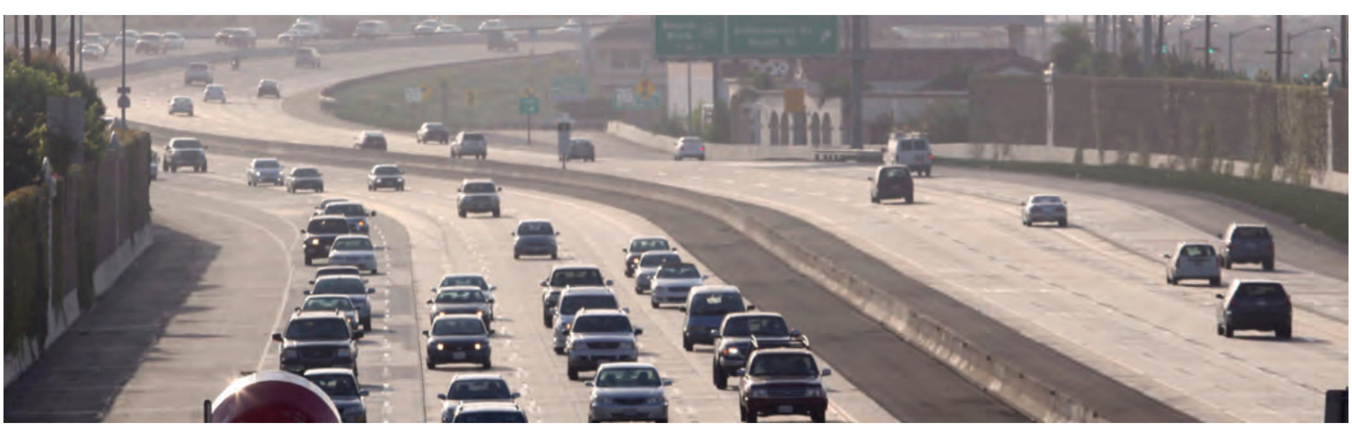
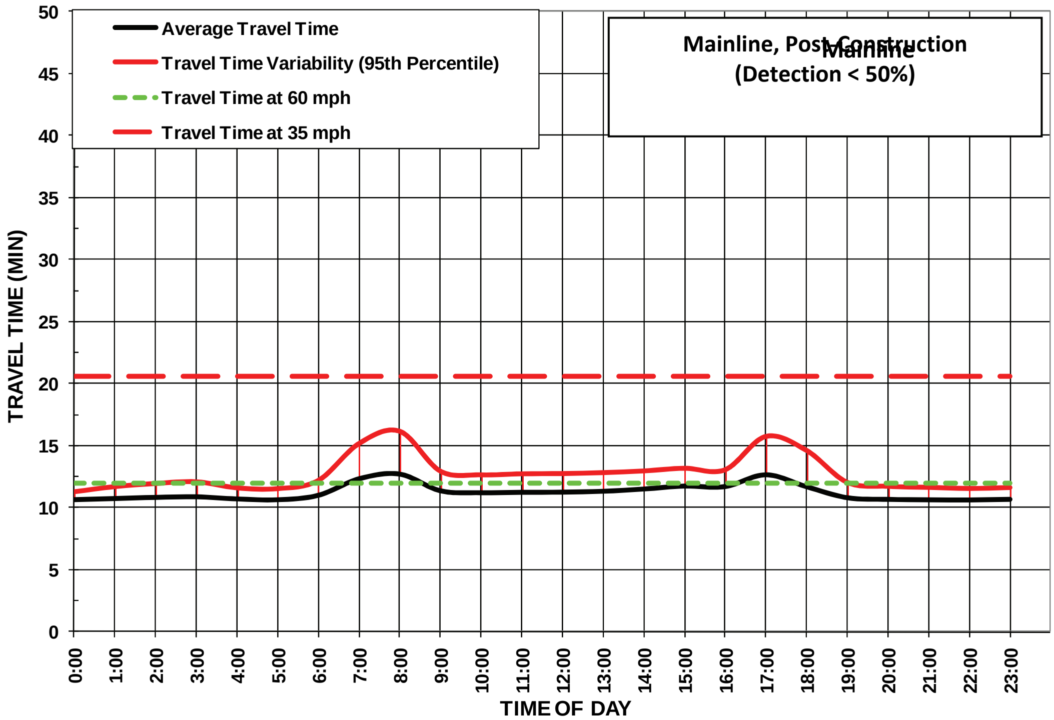
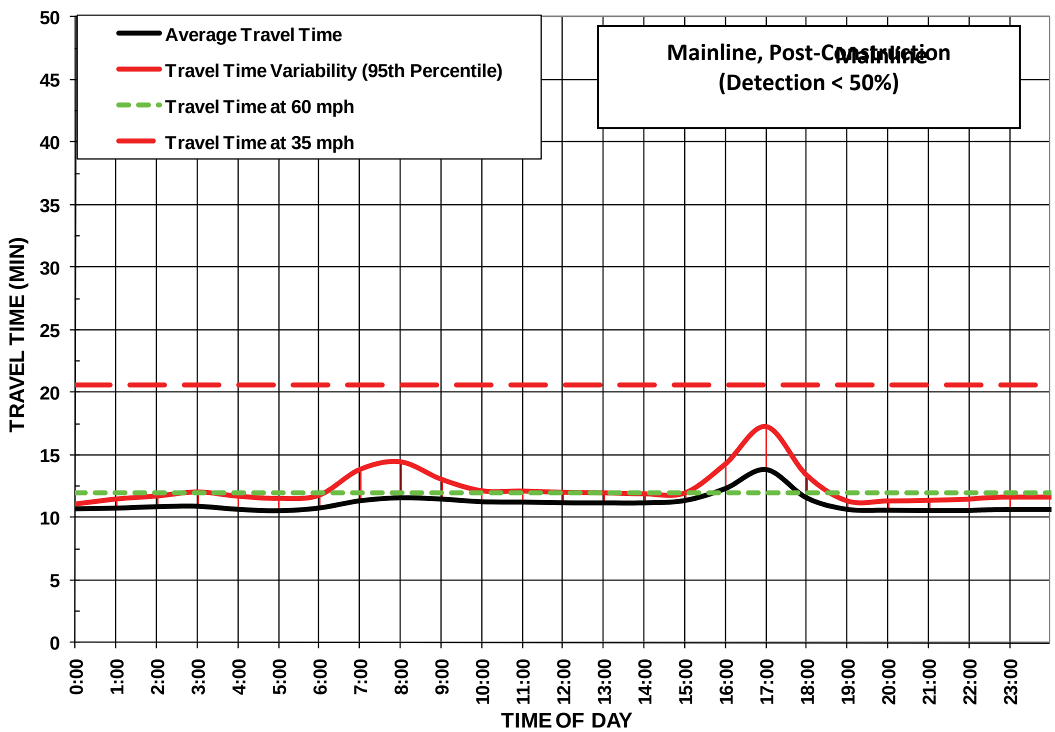


Exhibit ES-15: Eastbound SR-22 Mainline Travel Time Variation (2008)



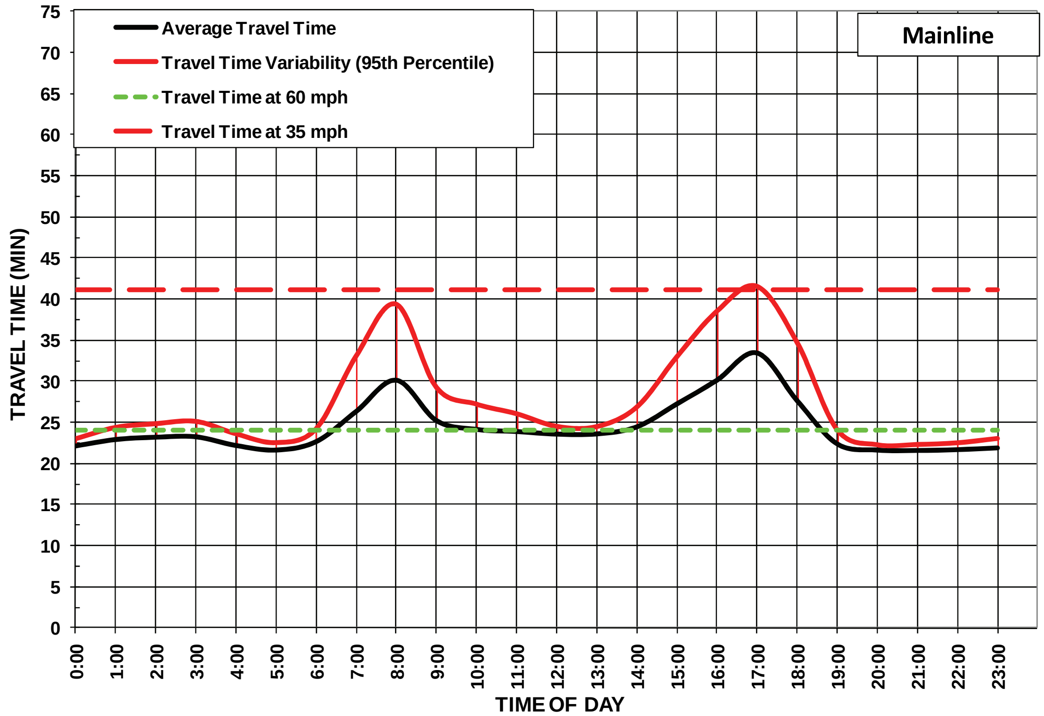
Source: Caltrans automatic detection data
Note: Due to poor detection on SR-22 in 2008, travel time variation may be underreported or 2008.

Exhibit ES-16: Westbound SR-22 Mainline Travel Time Variation (2008)



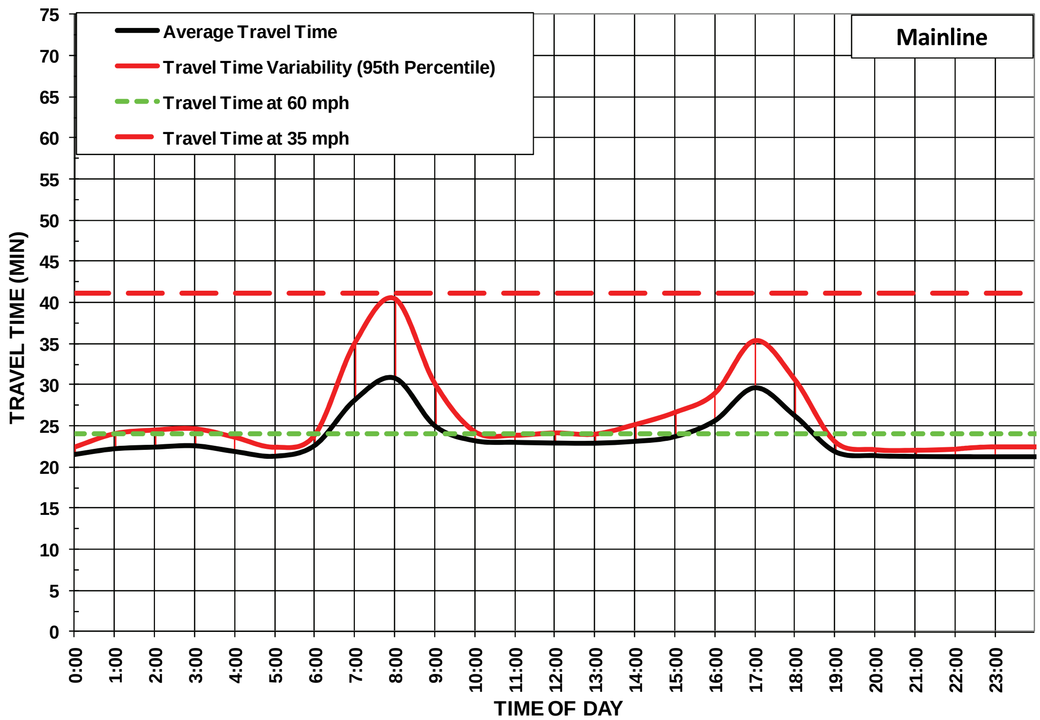
Source: Caltrans automatic detection data
Note: Due to poor detection on SR-22 in 2008, travel time variation may be underreported or 2008.

Exhibit ES-17: Northbound I-405 Mainline Travel Time Variation (2008)



Source: Caltrans automatic detection data

Exhibit ES-18: Southbound I-405 Mainline Travel Time Variation (2008)



Source: Caltrans automatic detection data

Safety

The adopted performance measures to assess safety involve the number of accidents and the accident rates computed from the Caltrans Traffic Accident Surveillance and Analysis System (TASAS). TASAS is a traffic records system containing an accident database linked to a highway database. The highway database contains descriptive elements of highway segments, intersections and ramps, access control, traffic volumes and other data. TASAS contains specific data for accidents on State Highways. Accidents on non-State Highways are not included (e.g., local streets and roads).

The safety assessment in this report intends to characterize the overall accident history and trends in the corridor. It also highlights notable accident concentration locations or readily apparent patterns. This report is not intended to replace more detailed safety investigations routinely performed by Caltrans staff.

Exhibits ES-19 and ES-20 show the SR-22 total number of accidents by month for the eastbound and westbound directions, respectively. Exhibits ES-21 and ES-22 show similar information for I-405.

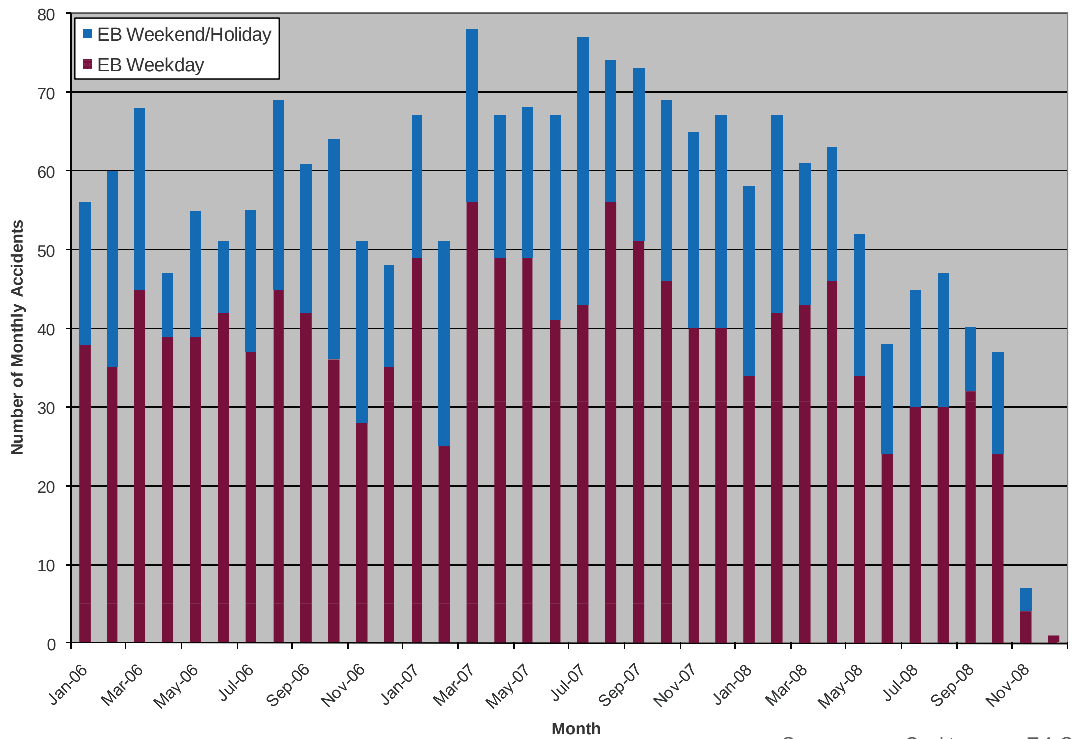
The accidents reported for the study corridor are not separated by mainline and HOV facility. The exhibits summarize the latest available three-year data from January 1, 2006 through December 31, 2008.

From 2006 to 2008, the eastbound SR-22 experienced as many as 80 collisions per month, while the westbound direction experienced up to 65 collisions per month. This is consistent with the corridor having greater congestion in the eastbound direction than westbound. In the eastbound direction, the number of accidents increased from 2005 to 2007, but sharply decreased in 2008. In the westbound direction, the corridor experienced a steady decrease in accidents through the three-year period.

The decrease in accidents on SR-22 from 2007 to 2008 in both directions may be attributed to the widening and improvements made to the corridor.

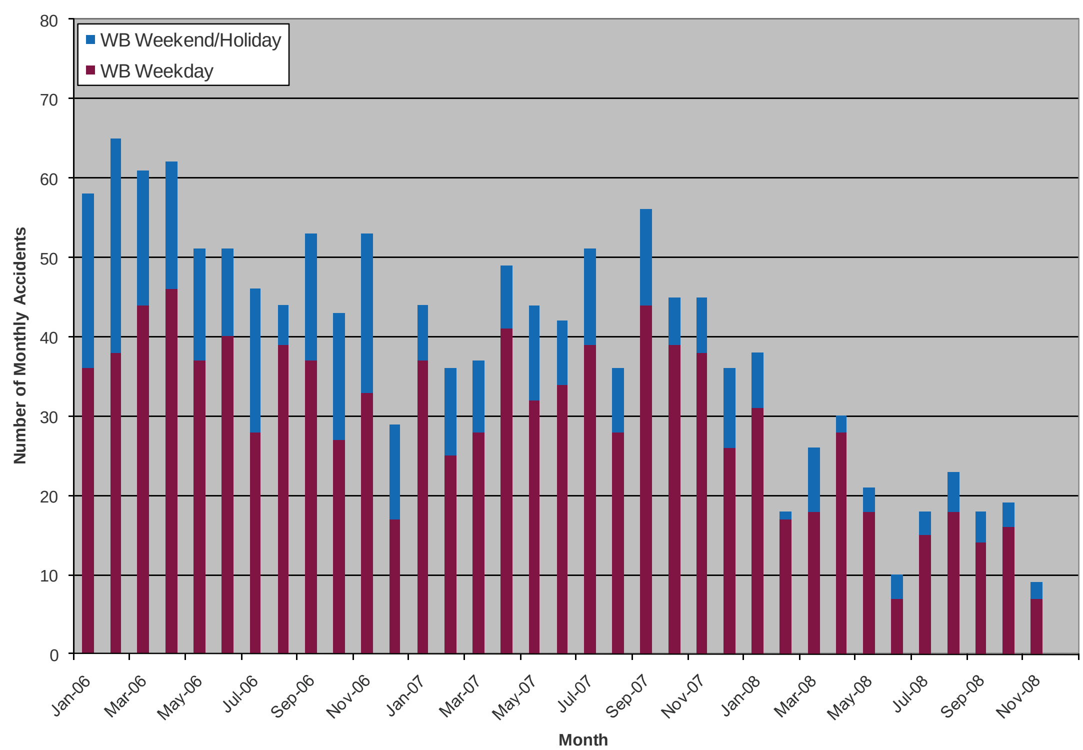
From 2006 to 2008, the northbound I-405 experienced as many as 160 collisions per month (over five per day), while the southbound experienced as many as 125 collisions per month (four per day). This is consistent with the corridor having experienced greater congestion in the northbound direction than the southbound. In both directions of the corridor, the vast majority of accidents occurred on the weekdays (80 percent) compared to the weekend. Overall, both directions of the corridor experienced a decrease in accidents from 2006 to 2008.

Exhibit ES-19: Eastbound SR-22 Monthly Accidents (2006-2008)



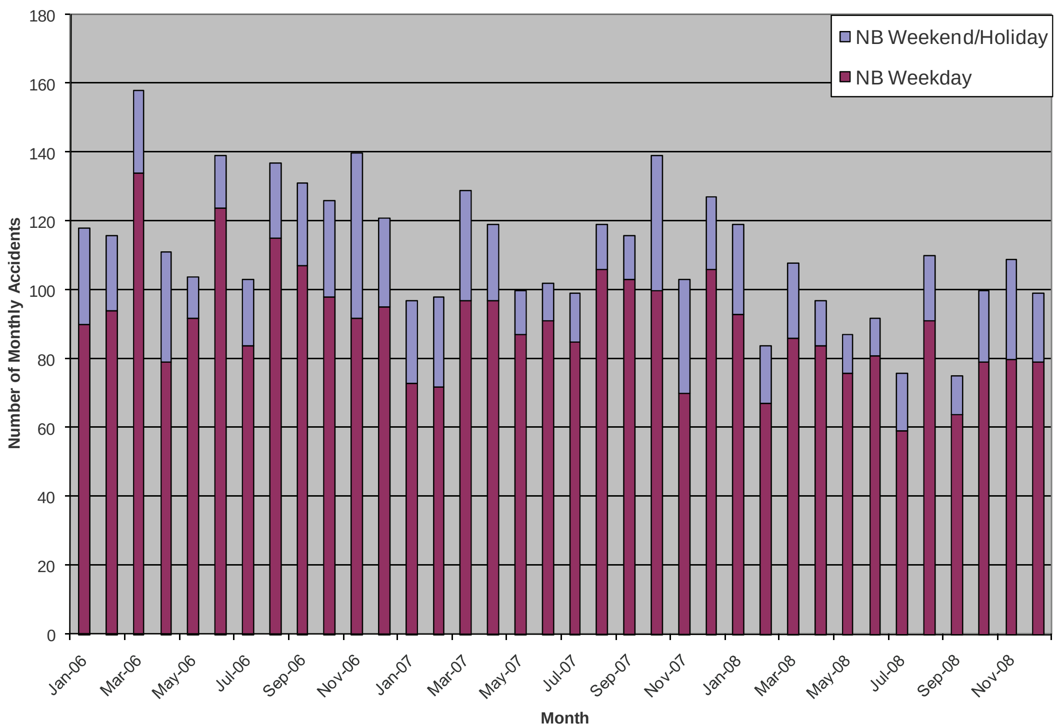
Source: Caltrans TASAS

Exhibit ES-20: Westbound SR-22 Monthly Accidents (2006-2008)



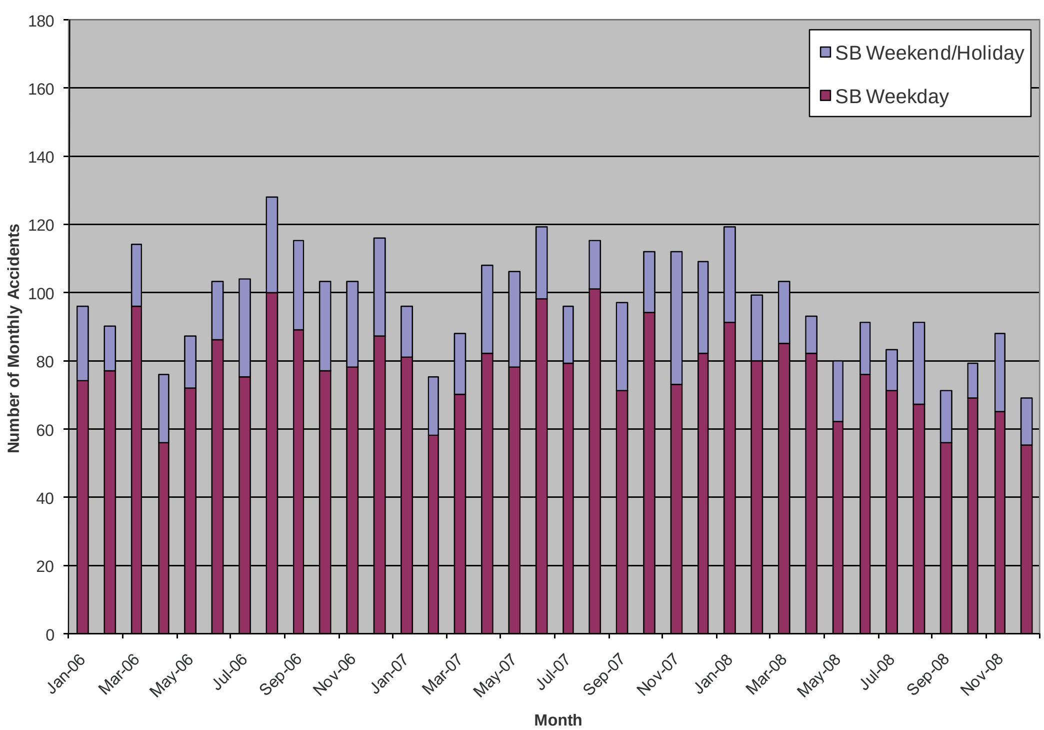
Source: Caltrans TASAS

Exhibit ES-21: Northbound I-405 Monthly Accidents (2006-2008)



Source: Caltrans TASAS Selective Accident Retrieval Report

Exhibit ES-22: Southbound I-405 Monthly Accidents (2006-2008)



Source: Caltrans TASAS Selective Accident Retrieval Report

Productivity

Productivity is a system efficiency measure used to analyze the throughput of the corridor during congested conditions. Restoring lost productivity is a focus of CSMPs.

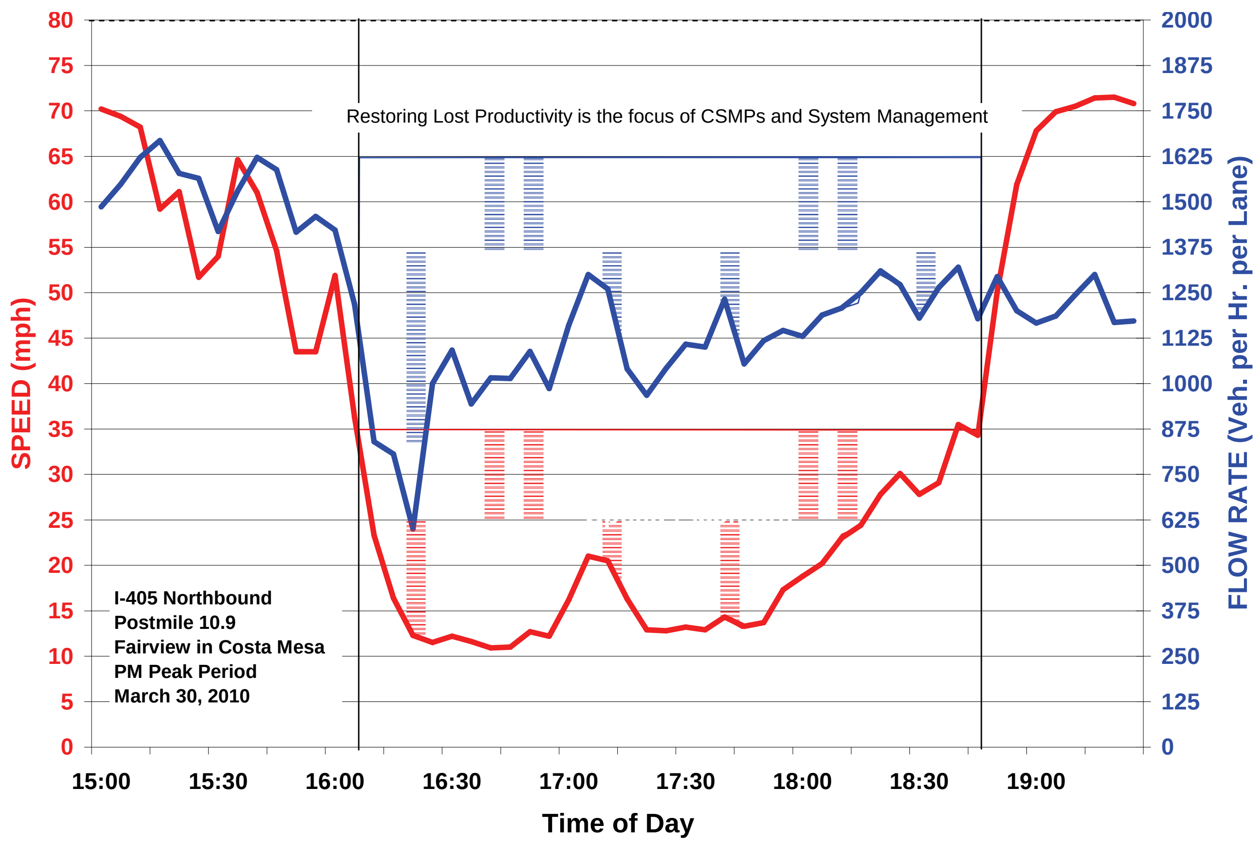
Exhibit ES-23 illustrates how congestion leads to lost productivity. The exhibit uses observed I-405 data from automatic sensors for a typical spring 2010 afternoon peak period. It shows speeds (in red) and flow rates (in blue) on northbound I-405 at Fairview Avenue, one of the most congested locations on the freeway.

Flow rates (measured as vehicle-per-hour-per-lane or "vphpl") at Fairview Avenue between 3:00 PM and 4:00 PM averaged around 1,600 vphpl, which is slightly less than a typical peak period maximum flow rate. Generally, freeway flow rates over 2,000 vphpl cannot be sustained over a long period.

Once volumes approach this maximum flow rate, traffic becomes unstable. With any additional merging or weaving, traffic breaks down and speeds can rapidly plummet to below 35 mph. In essence, every incremental merge takes up two spots on the freeway for a short time. However, since the volume is close to capacity, these merges lead to queues. Rather than accommodating the same number of vehicles, flow rates also drop and vehicles back up, creating bottlenecks and associated congestion.

At the location shown in Exhibit ES-23, throughput drops around 30 percent on average during the peak period (from over 1,600 just over 1,000 vphpl). This six-lane segment therefore operates as if it were a four-lane road just when demand is at its highest. Stated differently, just when the corridor needed the most capacity, it performed in the least productive manner and effectively lost lanes. This loss in throughput can be aggregated and presented as "Equivalent Lost-Lane-Miles."

Exhibit ES-23: Lost Productivity Illustrated



The average weekday (non-holiday) mainline equivalent lost lane-miles by period and year on SR-22 are shown in Exhibit ES-24. Exhibit ES-25 shows similar information for I-405. A few notes on these two exhibits:

- On SR-22 mainline lanes, productivity improved dramatically following the construction of the HOV facility in 2007. In the eastbound direction during the AM peak period, lost-lane miles decreased from 1.7 in 2004 to 1.0 in 2009. Data from 2008 were not discussed in this section given the limited detection during that year.
- In the westbound direction of SR-22 during the PM peak, lost-lane miles declined from 1.9 in 2004 to 0.8 in 2009.
- On the I-405 mainline lanes, the largest productivity losses occurred during the AM peak period in the southbound direction and during the PM peak period in the northbound direction.
- From 2005 to 2009, productivity gains were made in both directions of the I-405 mainline lanes. The most notable occurred during the AM in the southbound direction from 2006 to 2007, when lost-lane miles decreased from 6.0 to 3.9.
- In the northbound direction of the I-405 mainline lanes, a significant improvement was evident during the PM peak from 2007 to 2008, when lost-lane miles declined from 6.0 to 4.0.

Exhibit ES-24: SR-22 Mainline Average Daily Equivalent Lost Lane-Miles by Direction and Period (2002-2009)

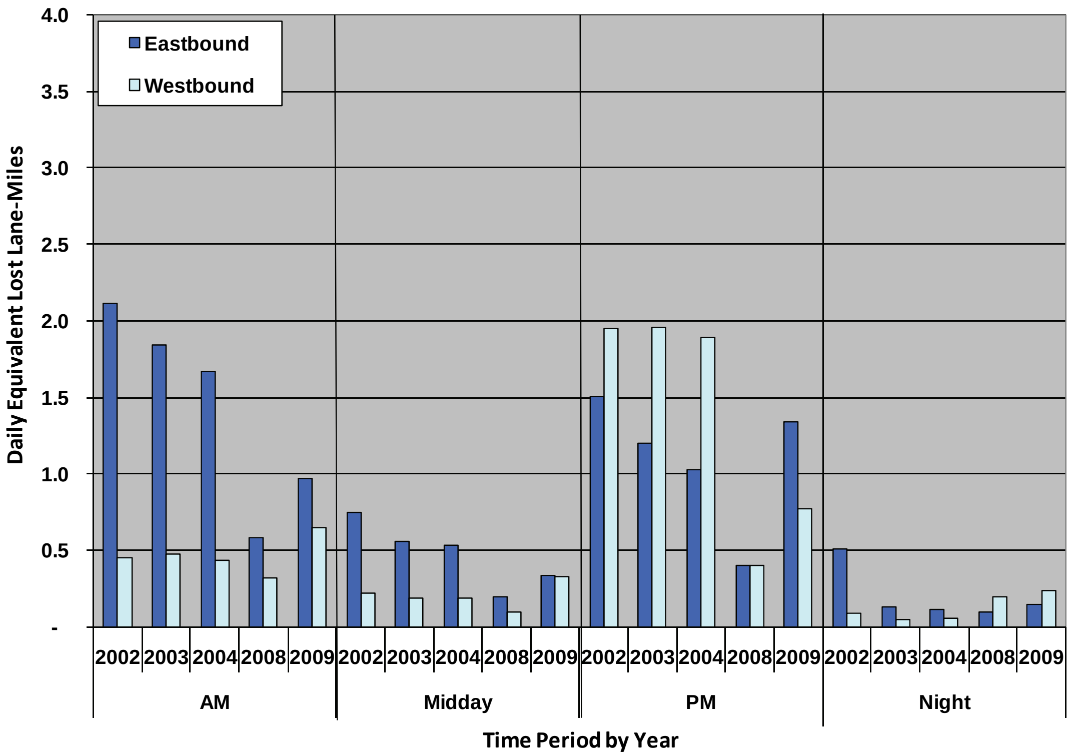
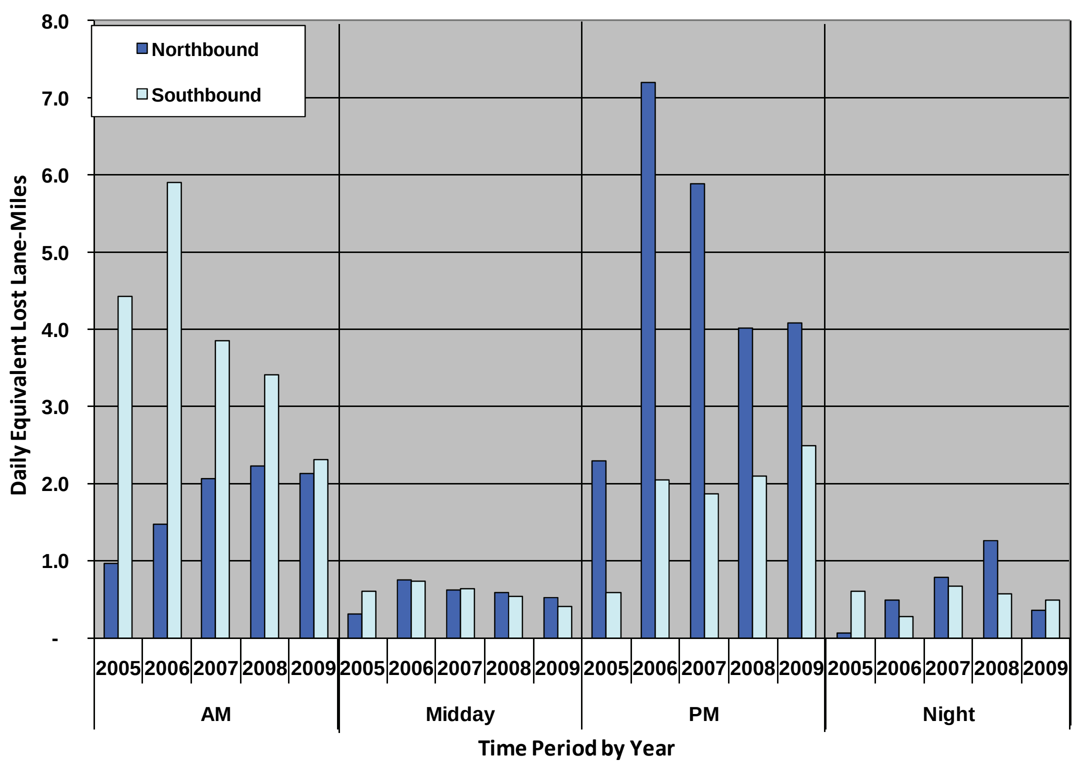


Exhibit ES-25: I-405 Mainline Average Daily Equivalent Lost Lane-Miles by Direction and Period (2005-2009)



5. Bottleneck Identification and Causality Analysis

Exhibit ES-26 summarizes the bottleneck locations on SR-22, the period these bottlenecks are active, and the causes of the bottlenecks. Exhibit ES-27 shows similar information for I-405. Exhibits ES-28 and ES-29 are maps of the corridor showing the bottleneck locations on the two freeways for the AM and PM peak periods, respectively.

Major bottlenecks are the primary cause of congestion and lost productivity. By definition, a bottleneck is a location where traffic demand exceeds the effective carrying capacity of the roadway. In most cases, the cause of a bottleneck relates to a sudden reduction in capacity, such as a lane drop, merging and weaving, driver distractions, a surge in demand, or a combination of factors.

The specific location and causality of each major SR-22 and I-405 bottleneck were verified by multiple field observations on separate weekdays. Many bottleneck locations were videotaped to validate specific locations and causes and to assist in micro-simulation model calibration.

The detailed final report fully explains the process and results of the bottleneck identification and causality analysis.

Exhibit ES-26: SR-22 Bottleneck Locations and Causality

Dir	Bottleneck Location	Causality	Active Period		Location
			AM	PM	CA
Eastbound	Euclid On	High demand at on-ramp and mainlines	✓	✓	R7.0
	Harbor On	High demand at on-ramp and mainlines	✓	✓	R8.1
	Fairview On	Lane drop causes weaving b/n Fairview On & the City Dr/I-5	✓	✓	R9.0
	I-5 Off/City Drive IC	Exit facility cannot accommodate demand	✓	✓	R9.7
	I-5 On/Town and Country Off	Crossweaving b/n I-5 On and Town and Country Off		✓	R11.3
Westbound	NB I-5 On	High flows and crossweaving at SR-22		✓	R10.5
	Garden Grove On	Mainlines cannot accommodate demand from the two ramps		✓	R8.6
	Valley View Off	Lane drop from four to three lanes		✓	R1.1
	I-405 On	Lane drop from three to two lanes and crossweaving @ I-405		✓	R0.7

Exhibit ES-27: I-405 Bottleneck Locations and Causality

Dir	Bottleneck Location	Causality	Active Period		Location
			AM	PM	CA PM
Northbound	Sand Canyon Off	Lane drop	✓		2.6
	Jeffrey/University On	Consecutive on-ramp merges	✓	✓	4.1
	SR-73/Fairview On	Uphill grade and reduced mainline capacity		✓	10.9
	Euclid On	Weaving		✓	12.9
	Brookhurst On	Platoon of vehicles from collector/distributor		✓	14.0
	SR-39 On	Platoon of vehicles from collector/distributor	✓	✓	16.8
	SR-22 On	Lane drop on SR-22 on-ramp	✓	✓	20.9
Southbound	I-605 On	A lane drop occurs at I-405 merge	✓	✓	23.5
	Seal Beach On	Crossweaving b/n Seal Beach Blvd On/SR-22 Off	✓	✓	22.5
	Valley View/SR-22	High demand	✓	✓	20.5
	SR-39 On	Consecutive on-ramp merges	✓	✓	16.6
	Warner On	Platoon of vehicles from on-ramp	✓	✓	14.7
	Talbert On	Mainline cannot accommodate flow	✓		13.3
	Bristol Off	Crossweaving between two ramps	✓		9.7
	MacArthur Off	Consecutive SR-55 on-ramp merges	✓	✓	7.8
	Culver On	Mainline cannot accommodate flow	✓	✓	5.7
	Jeffrey/University On	Mainline cannot accommodate flow	✓	✓	4.0
	Sand/Shady Canyon On	High on-ramp and mainline demand	✓	✓	2.9

Caltrans staff indicated that additional bottleneck locations on I-405 likely exist at the following locations:

- Jamboree On (northbound)
- SR-55 Interchange (northbound)
- Irvine Center Drive (southbound)
- SR-133 Interchange (southbound)
- I-5 Interchange (southbound)

Exhibit ES-28: Map of Major SR-22/I-405 AM Existing Bottlenecks

Exhibit ES-29: Map of Major SR-22/I-405 PM Existing Bottlenecks

6. Scenario Development and Analysis

Fully understanding how a corridor performs and why it performs that way sets the foundation for evaluating potential solutions. Several steps were required to develop evaluate improvements, including:

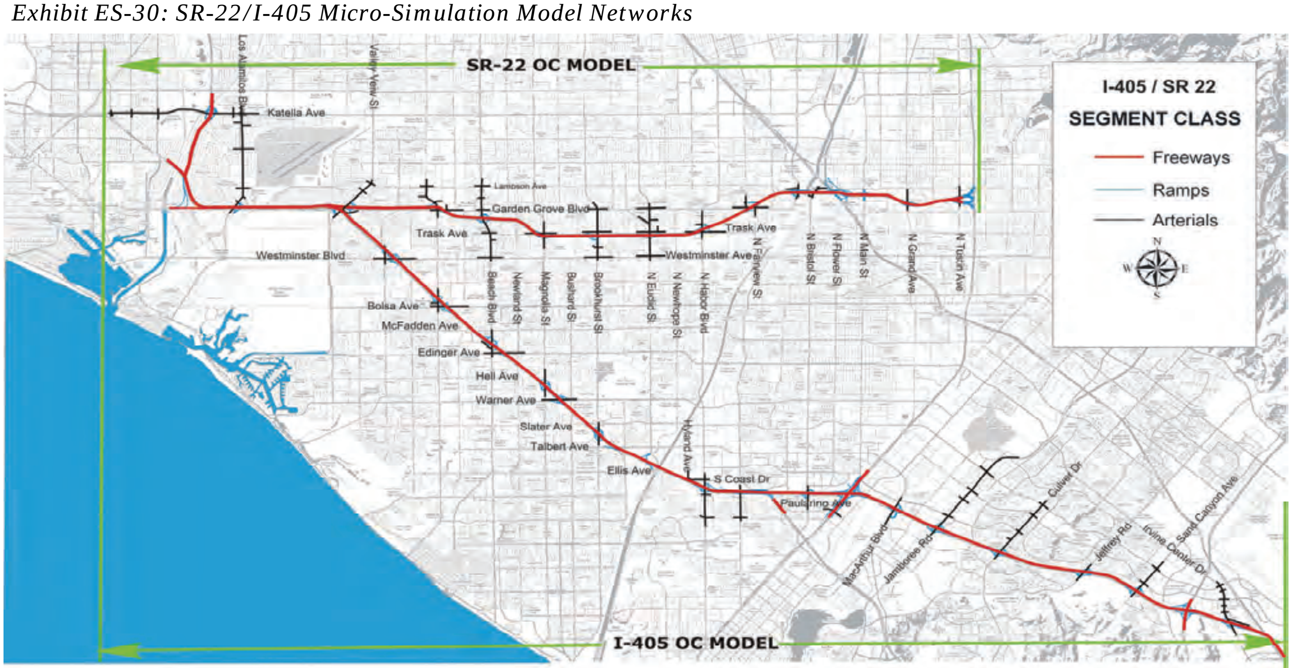
- Developing traffic models for the 2008 base year and 2020 long-term demand
- Combining projects in a logical manner for modeling and testing
- Evaluating model outputs and summarizing results
- Conducting benefit-cost assessments of scenarios.

TRAFFIC MODEL DEVELOPMENT

The study team developed separate traffic models for SR-22 and I-405 using Paramics micro-simulation software. It is important to note that micro-simulation models are complex to develop and calibrate for a large urban corridor. However, they are one of few tools capable of providing a reasonable approximation of bottleneck formation and queue development. Therefore, such tools help quantify the impacts of operational strategies, which traditional travel demand models cannot.

Exhibit ES-30 shows the SR-22/I-405/I-605 road network included in the models. All freeway interchanges were included as well as on and off-ramps. Note that only certain arterials were included. Adding more arterials would have challenged the calibration process and delayed the overall project. The study team calibrated the two base year models against 2008 conditions presented earlier. This was a resource-intensive effort, requiring several submittal and review cycles until the model reasonably matched bottleneck locations and relative congestion levels. After acceptance of the base year model, the team also developed a model with 2020 demands extrapolated from the OCTA 2030 travel demand model. Caltrans selected 2020 as the horizon year to test operational improvements and other system management strategies. These models were then used to evaluate different scenarios (combinations of projects) to quantify the associated congestion-relief benefits and to compare the project costs against their benefits.

Exhibit ES-30: SR-22/I-405 Micro-Simulation Model Networks



SCENARIO DEVELOPMENT FRAMEWORK

The study team developed a framework for combining projects into scenarios. It would be desirable to evaluate every possible combination of projects. However, this would have entailed thousands of model runs. Instead, the team combined projects based on a number of factors, including:

- Projects already been completed since the 2008 base year or fully programmed and funded were combined and separated from projects that were not, and tested with both the 2008 and 2020 models.
- Corridor Mobility Improvement Account (CMIA) projects were separated from the others and tested with both the 2008 and 2020 models.
- Short-term operational projects (delivered typically by 2015) were grouped into scenarios to be tested with both the 2008 and 2020 models.
- Long-term projects (delivered typically after 2015, but before or by 2020) were used to develop scenarios to be tested with the 2020 model only.

The study assumes that projects developed before 2015 could reasonably be evaluated using the 2008 base year model. The 2020 forecast year for this study was consistent with the OCTA regional travel demand model origin-destination matrices.

When OCTA updates its travel demand model and SCAG updates its Regional Transportation Plan (RTP), Caltrans may wish to update the micro-simulation model with revised demand projections.

Project lists used to develop scenarios were from the Regional Transportation Improvement Program (RTIP), the RTP, Measure M2, SR-91 Implementation Plan, Transportation Corridor Agencies (TCA) improvements, Riverside County Transportation Commission (RCTC) improvements, and other sources (such as special studies). The study team eliminated projects that do not directly affect mobility. For instance, sound wall, landscaping, or minor arterial improvement projects were eliminated because micro-simulation models cannot evaluate them.

Scenario testing performed for the SR-22/I-405/I-605 CSMP differed from traditional alternatives evaluations or Environmental Impact Reports (EIRs). Traditional alternatives evaluations or EIRs focus on identifying alternative solutions to address current or projected corridor problems, so each alternative is evaluated separately and results among competing alternatives are compared resulting in a locally preferred alternative. In contrast, for the SR-22/I-405/I-605 CSMP, scenarios build on each other in that a scenario contains the projects from the previous scenario plus one or more projects as long as the incremental scenario results show an acceptable level of performance improvement.

Exhibits ES-31 and ES-32 summarize the approaches used and scenarios tested for SR-22 and I-405 models, respectively. It also provides a general description of the projects included in the 2008 and 2020 micro-simulation runs.

Exhibit ES-31: SR-22 Micro-Simulation Modeling Approach

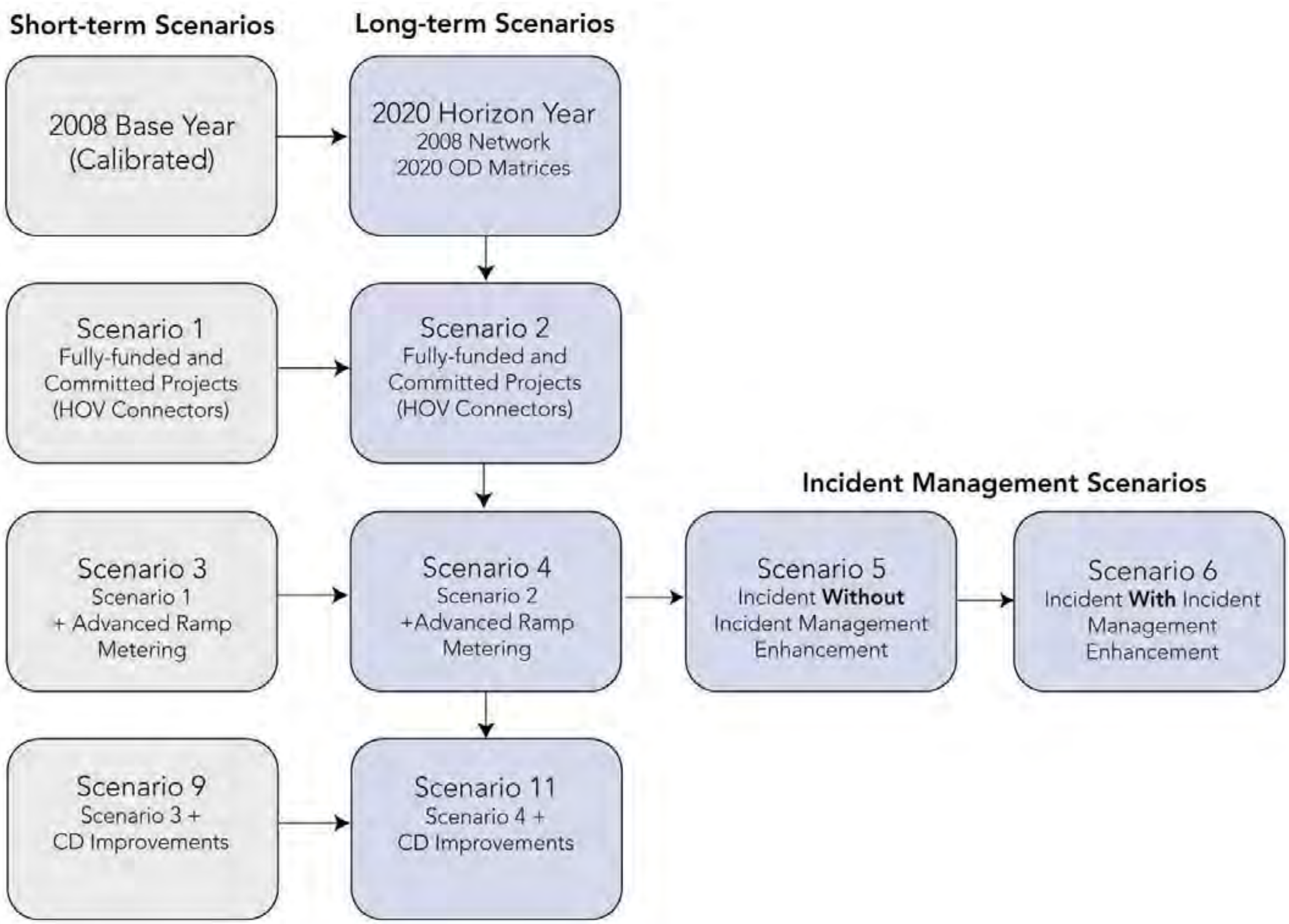
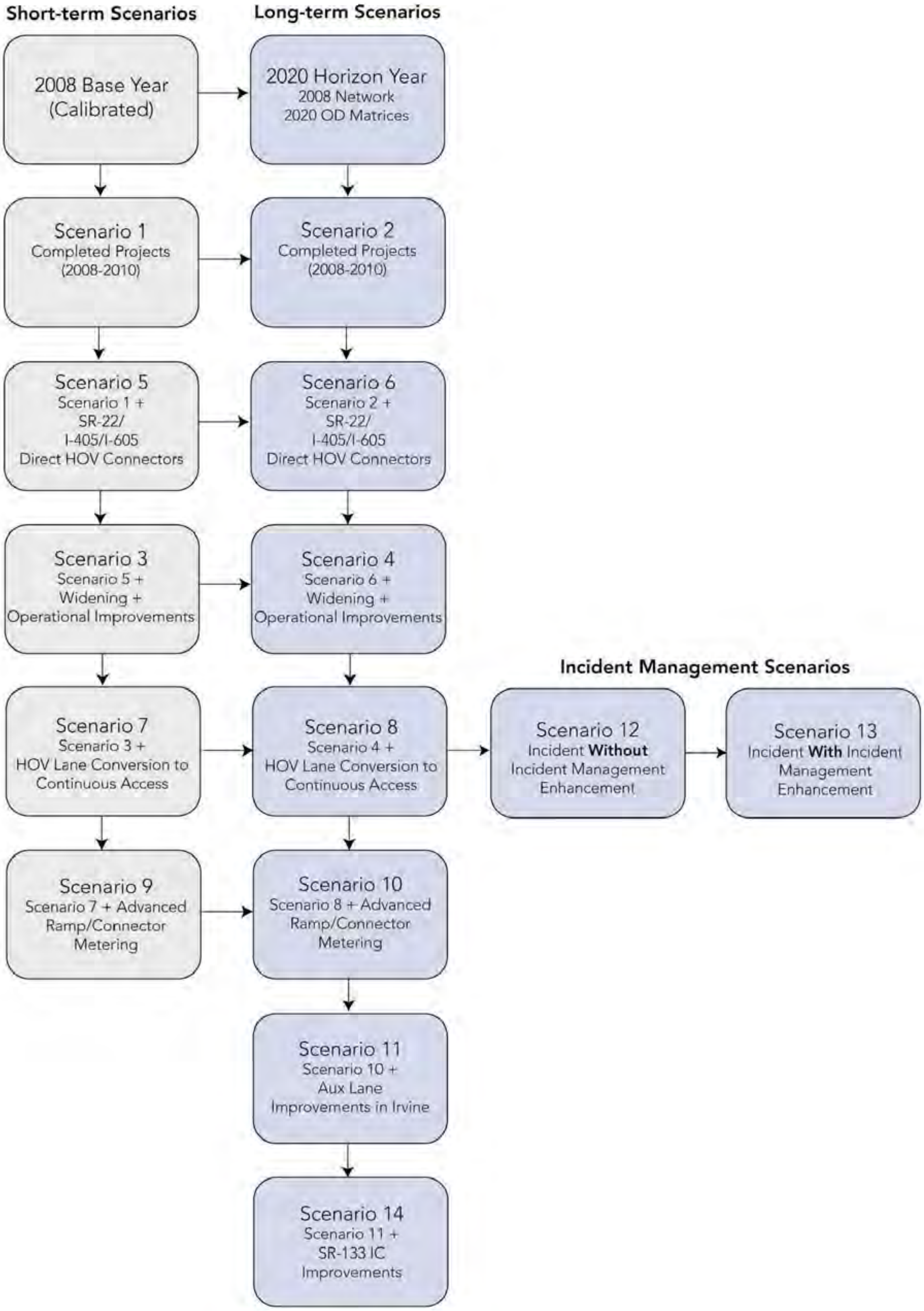


Exhibit ES-32: I-405 Micro-Simulation Modeling Approach



SCENARIO EVALUATION RESULTS

This section discusses the separate micro-simulation results for SR-22 and I-405 freeways.

SR-22 Corridor Model Results

Exhibits ES-33 and ES-34 show the SR-22 corridor delay results for all 2008 scenarios in the AM and PM peak periods, respectively. Exhibits ES-35 and ES-36 show results for all 2020 scenarios in the AM and PM peak periods, respectively. The percentages shown in the exhibits indicate the difference in delay between the current scenario and the previous scenario (e.g., "Percent Change = (Current Scenario – Previous Scenario)/Previous Scenario"). Impacts of strategies differ based on a number of factors such as traffic flow conditions, ramp storage, bottleneck locations, and levels of congestion.

For each scenario, the modeling team added the proposed improvements, conducted multiple model runs, and produced composite results by facility type (i.e., mainline, HOV, arterials, and ramps) and vehicle type (SOV, HOV, trucks) as well as speed contour diagrams. The study team reviewed incremental steps in detail of each modeling analysis to ensure that they were consistent with general traffic engineering principles.

Base Year and "Do Minimum" Horizon Year

Absent any physical improvements, the modeling team estimates that by 2020, total delay (mainline, HOV, ramps, and arterials) will nearly double compared to 2008 (from a total of around 21,000 vehicle-hours daily to just fewer than 40,000 vehicle-hours) in the combined AM and PM peak. Demand may continue to increase beyond 2020 and may require further study.

Scenarios 1 and 2 (SR-22/I-405/I-605 HOV Direct Connectors)

Scenarios 1 and 2 test the only fully funded project on SR-22. The project links HOV lanes on I-405 with HOV lanes on SR-22 and I-605 to create a seamless HOV connection. The eastern segment of the project directly connects the westbound SR-22 HOV lane at Valley View

Street to the HOV lane on northbound I-405, and reconstructs the southbound I-405 to eastbound SR-22 HOV direct connector.

The 2008 model shows that the new HOV connectors improve overall corridor delay in the AM peak period by 13 percent (1,200 vehicle-hours) and minimally effect the PM peak period. In the last segment of the westbound direction, from Valley View to I-405, the corridor experienced a 68-percent delay reduction (350 vehicle-hours) during the AM peak period and almost a 90-percent delay reduction (500 vehicle-hours) during the PM peak period with the proposed project.

The 2020 model results indicate more impressive gains with the HOV direct connectors as corridor delay is reduced by 16 percent in the AM peak and 22 percent in the PM peak. In total, this scenario estimates a reduction of around 7,800 vehicle-hours of daily delay. Most of the reduction occurred in the westbound direction from Valley View to the I-405 Interchange, near the location of the project. The mobility improvements are likely attributable to better access to other freeways and reduced weaving (i.e., between the HOV lanes and general purpose lanes).

Scenarios 3 and 4 (Advanced Ramp Metering, Connector Metering)

Scenarios 3 and 4 build on Scenarios 1 and 2 by adding an advanced ramp metering system, such as a dynamic or adaptive ramp metering system with connector metering and queue control (to ensure queuing does not exceed the capacity of the connector) at the northbound and southbound I-5/SR-57 connectors to SR-22. The scenarios also add an HOV direct connector from southbound SR-57/I-5 to westbound SR-22.

The 2008 model indicates that advanced ramp and connector metering modestly improves delay by one percent in the AM peak and by six percent in the PM peak, or a total of 600 vehicle-hours. The 2020 model results show a similar improvement of only one percent during each peak period, or a total of 400 vehicle-hours. Although the mainline facility experienced an improvement in delay during both the AM and PM peak hours, the ramps experienced an overall delay increase, thereby resulting in a modest improvement for the overall corridor. Overall, the two models estimate that advanced ramp and connector metering would reduce congestion along the corridor by more than 1,000 vehicle-hours of delay. It appears that advanced ramp metering and connector metering may not be very effective on this corridor, especially in the westbound direction where most congestion occurs in the upstream segments.

There are various types of advanced ramp metering systems deployed around the world, including the System-wide Adaptive Ramp Metering System (SWARM) tested on Los Angeles I-210 freeway corridor. For modeling on SR-22, the Asservissement Lineaire d'Entrée Autoroutiere (ALINEA) system was tested as a proxy for an advanced ramp metering system, since its algorithm was readily available. The study team is not necessarily recommending deployment of ALINEA. Rather, some type of advanced ramp metering system would produce similar, if not better results.

Scenarios 5 and 6 (Enhanced Incident Management)

Two incident scenarios were built upon on Scenario 4 to evaluate the non-recurrent delay reductions resulting from enhanced incident management strategies. In the first scenario, Scenario 5, a collision incident with the closure of one outside lane was simulated westbound in the AM peak period model and eastbound in the PM peak period model. The incident simulation location and duration were selected based on a review of actual 2010 incident data, at one of the highest incident frequency locations.

The following are the scenario details:

- Eastbound AM Peak starting at 8:00 AM, close mainline lane 3 for 50 minutes at post mile 9.48 (at the collector/distributor entrance)
- Westbound PM Peak starting at 5:00 PM, close mainline lane 4 for 80 minutes at post mile 9.49 (at Harbor).

This scenario represents a typical, moderate incident at one location during each peak direction period. Data suggest that incidents vary significantly in terms of impact and duration. Some incidents last hundreds of minutes, some close multiple lanes, and some occur at multiple locations simultaneously. Numerous minor incidents last only a few minutes without lane closures and still result in congestion. In addition, many incidents occur during off-peak hours.

An enhanced incident management system would entail upgrading or enhancing the current Caltrans incident management system that includes deployment of intelligent transportation system (ITS) field devices, central control/communications software, communications medium (i.e. fiber optic lines), advanced traveler information system, and/or freeway service patrol (FSP) program to reduce incident detection, verification, response, and clearance times.

In the second scenario, Scenario 6, the same collisions were simulated with a reduction in duration by 13 minutes in the eastbound direction and by 14 minutes in the westbound direction. Based on actual Caltrans incident management data, it is estimated at that an enhanced incident management system could reduce a 35-minute incident by about 10 minutes.

With the deployment of an enhanced incident management system, the 2020 model estimates that approximately 600 vehicle-hours delay are eliminated in the eastbound direction with minimal impact in the westbound direction. These results reflect benefits realized during the peak direction period. However, significant additional benefits may also be realized during the off-peak direction and hours.

Scenarios 9 and 11 (Collector-Distributor Improvements)

Scenario 9 and 11 build on Scenarios 3 and 4 by adding a proposed project to reconstruct the eastbound collector-distributor facility, and add new connectors to the I-5 and SR-57. The eastbound SR-22 collector distributor has significant congestion before the entrance and through the entire collector distributor facility. Traffic volumes exceed capacity resulting in queuing and delay to motorists accessing the local interchanges and freeway connectors to I-5, SR-57 and SR-22 freeways. Results indicate operational delay is directly attributed to traffic demand exceeding capacity, geometric and capacity constraints of the collector-distributor facility and freeway to freeway connectors. Significant weaving within the collector-distributor facility also contributes to the bottleneck severity.

The 2008 model estimates that the proposed project reduces delay by 11 percent in the AM peak and 27 percent in the PM peak, or a total of 4,000 vehicle-hours overall on the corridor. Delay at the eastbound segment from Fairview to I-5/City Drive decreases by over 85 percent from about 1,000 vehicle-hours without the project to 150 vehicle-hours with the interchange improvement. The 2020 model estimates a delay reduction of 27 percent in the AM peak and 34 percent in the PM peak. In total, this scenario estimates a reduction of over nearly 10,000 vehicle-hours of delay in 2020.

Benefits would result from widening the collector-distributor, widening of the I-5/SR-22 separation structure (horseshoe) and the braiding of SR-22 connectors to both I-5 and SR-57. The CSMP model results for 2020 traffic shows that short term operational benefits for collector-distributor facility improvements may be achieved in a Minimum Operating Segment (MOS) by phasing construction. Outside the scope of the CSMP, Caltrans has analyzed future traffic conditions beyond the 2020 model year used in this study. This analysis estimates that year 2035 traffic volumes show that both braiding the connectors and modifications to the collector distributor facilities will be required to accommodate the future traffic demand and provide long-term benefits. Further study of the developing MOS strategies is recommended during the project report phase.

Exhibit ES-33: SR-22 AM Peak Micro-Simulation Delay Results by Scenario (2008)

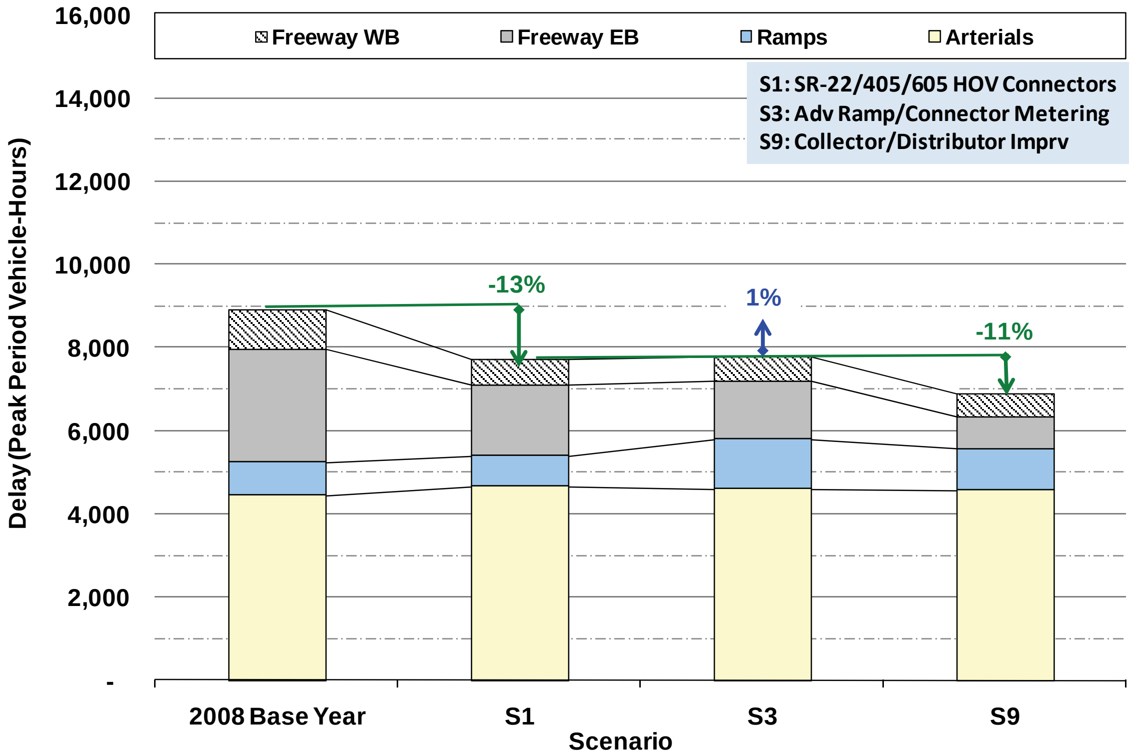


Exhibit ES-34: SR-22 PM Peak Micro-Simulation Delay Results by Scenario (2008)

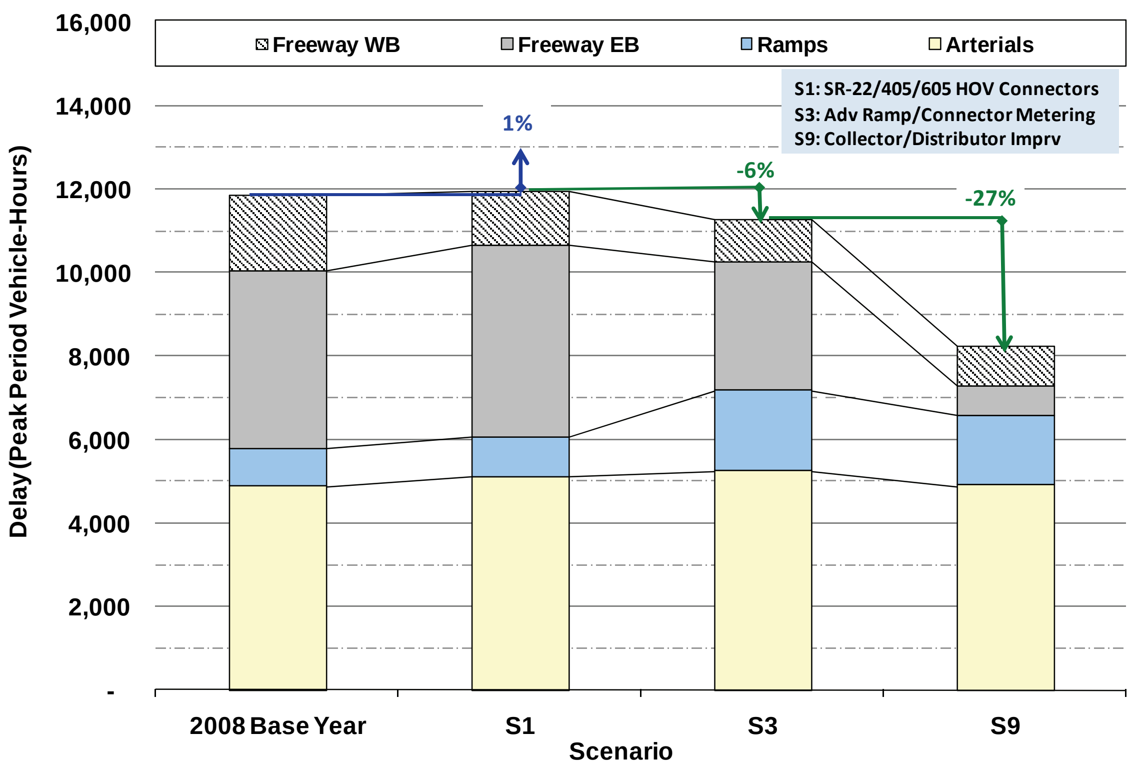


Exhibit ES-35: SR-22 AM Peak Micro-Simulation Delay by Scenario (2020)

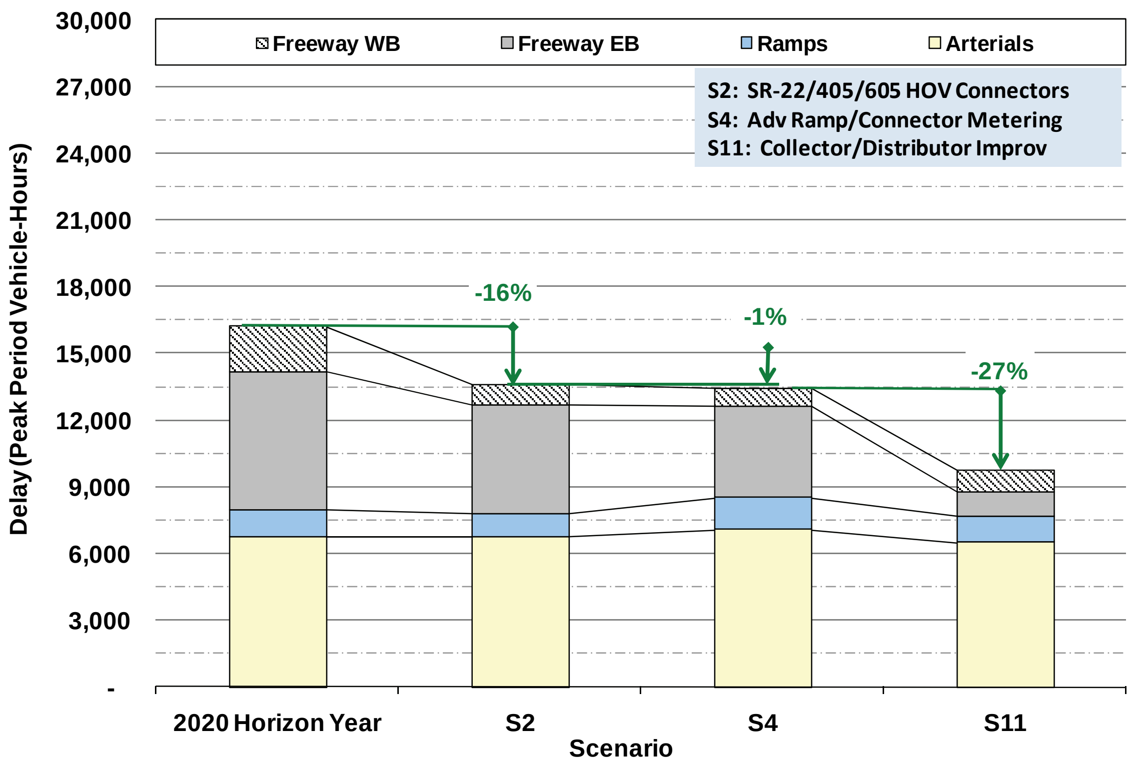
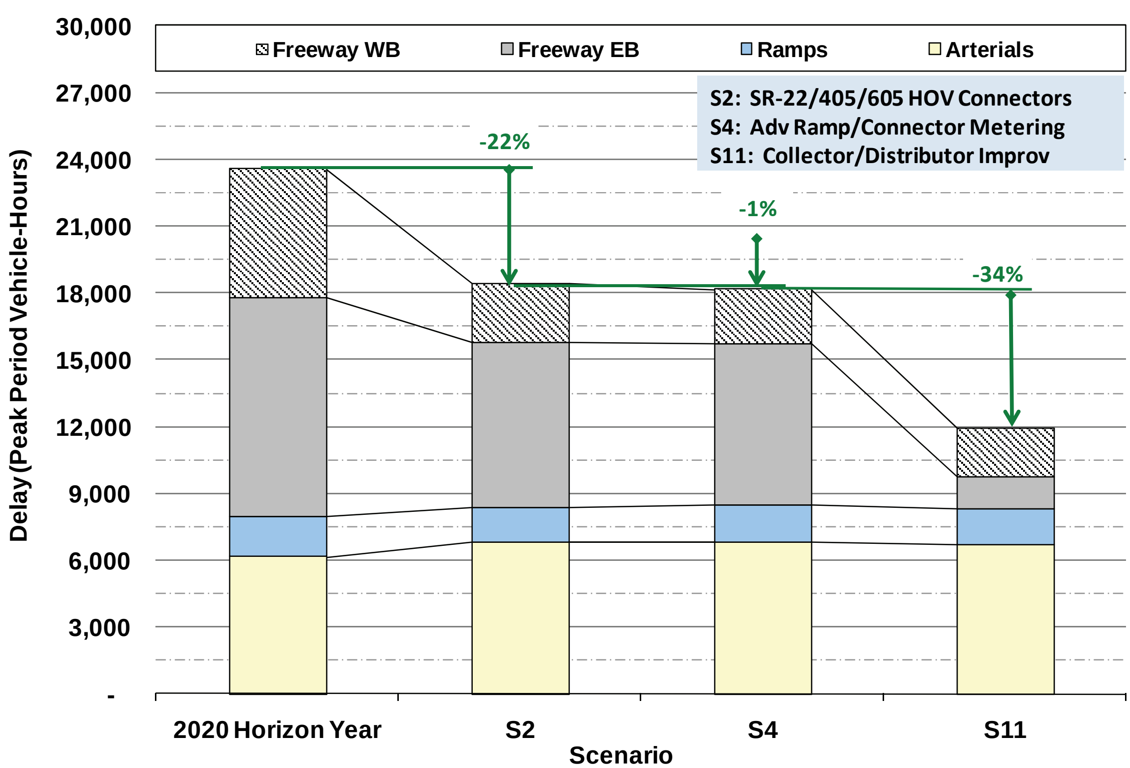


Exhibit ES-36: SR-22 PM Peak Micro-Simulation Delay by Scenario (2020)



I-405 Corridor Model Results

This section presents the modeling results for the I-405 freeway.

Exhibits ES-37 and ES-38 show the delay results by facility type and peak period for all scenarios evaluated using the 2008 base year model. Exhibits ES-39 and ES-40 show similar results for scenarios evaluated using 2020 horizon year model. The percentages shown in the exhibits indicate the difference in delay between the current scenario and the previous scenario (e.g., "Percent Change = (Current Scenario – Previous Scenario)/Previous Scenario"). Impacts of strategies differ based on a number of factors such as traffic flow conditions, ramp storage, bottleneck locations, and levels of congestion.

For each scenario, the modeling team added the proposed improvements, conducted multiple model runs, and produced composite results by facility type (i.e., mainline, HOV, arterials, and ramps) and vehicle type (SOV, HOV, trucks) as well as speed contour diagrams. The study team reviewed incremental steps in detail of each modeling analysis to ensure that they were consistent with general traffic engineering principles.

Base Year and "Do Minimum" Horizon Year

Absent any physical improvements, the model estimates that total delay on I-405 (mainline, HOV, ramps, and arterials) double in 2020 compared to 2008 (from a total of around 38,000 hours daily to just less than 75,000 hours). Demand may continue to increase beyond 2020 and may require further study.

Scenarios 1 and 2 (Completed Projects from 2008 to 2010)

Scenarios 1 and 2 consist of projects completed from the model base year to 2010. These projects include:

- Adding a northbound and southbound auxiliary lane from Magnolia to Beach
- Adding a third southbound left-turn lane and third southbound I-405 on-ramp lane at Fairview Road
- Adding a direct on-ramp at northbound Sand Canyon Avenue and converting the HOV preferential lane to a second metered general purpose lane
- Widening northbound Harbor Boulevard from three lanes to four lanes between the southbound I-405 off-ramp and the northbound I-405 on-ramp and modifying the northbound I-405 on-ramp.

The 2008 model results show modest mobility improvements with the implementation of these projects. Delay improves by four percent in the AM peak period (650 vehicle-hours) and six percent in the PM peak period(1,200 vehicle-hours). The majority of the delay reduction occurs in the southbound direction (eight percent in the AM peak and 19 percent in the PM peak). During the AM peak in the southbound direction, the segment from SR-39 (Beach Boulevard) to Warner experiences a 25-percent improvement in delay (reduction from 1,100 to 800 vehicle-hours of delay). This is likely attributable to the auxiliary lane constructed between Beach and Magnolia.

The 2020 model results show that these projects are expected to provide a marginal reduction in delay (three percent in AM peak and one percent in the PM peak) when travel volumes increase. This scenario is expected to reduce overall corridor delay by over 1,300 vehicle-hours. The southbound section from SR-39 (Beach Boulevard) to Warner experiences a notable decrease in delay, particularly in the AM, from 2,400 to 1,300 vehicle-hours, a decline of about 40 percent.

Scenarios 5 and 6 (SR-22/I-405/I-605 HOV Direct Connectors)

Note that Scenarios 5 and 6 come before Scenarios 3 and 4. Scenarios 5 and 6 build on Scenarios 1 and 2 and test the SR-22/I-405/I-605 HOV direct connectors partially funded by the CMIA. The project links HOV lanes on I-405 with those on SR-22 and I-605 to create a seamless HOV connection among the three freeways.

The 2008 model results suggest that the project improves delay by an additional 12 percent in the AM peak and 10 percent in the PM peak over the previous scenario. This scenario is estimated to reduce overall corridor delay by nearly 3,800 vehicle-hours. The northbound segment from SR-22 to the LA County Line has a notable reduction in delay of over 650 vehicle-hours in the AM peak and 920 vehicle-hours in the PM peak, which is at least a 35 percent reduction over the previous scenario.

The 2020 model estimates a greater reduction in delay from the project. Delay is estimated to decrease by 18 percent in both peak periods, or a total of 13,000 daily vehicle-hours. With the project, delay in the two southbound segments from the LA County Line to SR-39 (Beach Boulevard) is reduced to minimal levels.

These significant mobility improvements are likely due to better access to the other freeways and reduced weaving between the HOV lanes and the general purpose lanes.

Scenarios 3 and 4 (Widening from SR-73 to LA County Line)

Scenarios 3 and 4 build on Scenarios 5 and 6 and test a project to add new lanes and incorporate operational improvements. These scenarios were tested out of sequence; hence, Scenarios 3 and 4 follow Scenarios 5 and 6 instead of preceding them. These projects include:

- Adding a general purpose lane in each direction from SR-73 to the LA County Line and adding operational improvements and auxiliary lanes
- Widening Bolsa Avenue interchange bridge from four to six lanes from Chestnut to Golden West)
- Constructing a fourth northbound through lane on Beach Boulevard at the I-405 interchange.

The 2008 model results indicate that mobility improves with the implementation of these projects. Delay drops 13 percent (or 2,000 vehicle-hours) in the AM peak period and 24 percent (4,000 vehicle-hours) in the PM peak period. The 2020 model results show that these projects reduce delay by 15 percent in AM peak (4,000 vehicle-hours) and 18 percent in the PM peak (6,000 vehicle-hours).

As expected, the largest reductions in delay occur in the lane-widening segments, most notably in the northbound direction from SR-73 to Brookhurst Street and Beach Boulevard to SR-22 during the PM peak period, and in the southbound direction from Beach Boulevard to Warner Avenue during the AM peak period. According to the model results, this project eliminates the southbound Warner Avenue bottleneck.

Scenarios 7 and 8 (HOV Lane Conversion to Continuous Access)

Scenarios 7 and 8 build on the previous scenarios (Scenarios 3 and 4) and include a planned project to convert the existing buffer-separated HOV facility to a continuous access HOV facility. Caltrans may revisit the modeling once the full details of the continuous access design are finalized .

The 2008 model shows that converting the HOV lane to continuous access reduces delay on the corridor by about three percent during each peak period. Similarly, the 2020 model estimates that the continuous HOV lane reduces delay on the corridor by three percent in the AM peak and two percent in the PM peak. In total, the project reduces daily delay by 750 vehicle-hours in the 2008 model and about 1,400 vehicle-hours in the 2020 model.

Scenarios 9 and 10 (Advanced Ramp Metering and Connector Metering)

Scenarios 9 and 10 build on Scenarios 7 and 8 and include implementation of advanced ramp metering and connector metering on the SR-73, SR-133, and SR-55 connectors to I-405.

The 2008 model estimates that advanced ramp metering and connector metering reduce delay modestly by four percent in the AM peak and two percent in the PM peak, or a total of 800 vehicle-hours. The southbound direction experienced a greater reduction in delay ((690 vehicle-hours compared to 80 vehicle-hours in the northbound direction).

The northbound direction has minimal reductions. The 2020 model estimates that this strategy reduces delay by two percent in both peak periods, or a total of 950 vehicle-hours.

For modeling purposes, the Asservissement Lineaire d'Entrée Autoroutiere (ALINEA) system was tested as a proxy for any advanced ramp metering system since its algorithm for the model was readily available. However, it is not necessarily recommended that ALINEA be deployed, but rather, some type of advanced ramp metering system that produces similar, if not better results.

Scenario 11 (Auxiliary Lane Improvements in Irvine)

Scenario 11 consists of seven operational projects tested using the 2020 horizon year model. These projects build on Scenario 10 and include the following:

- At southbound Irvine Center Drive off-ramp, adding a second auxiliary lane from I-405 to the off-ramp
- At southbound Sand Canyon Avenue, adding a second drop lane from I-405 to the off-ramp
- Constructing southbound auxiliary lanes from SR-133 to Sand Canyon Road
- Adding a 400-meter southbound auxiliary lane and widening the off-ramp to provide a two lane exit at Jeffrey/University
- Adding a second southbound auxiliary lane from SR-133 to Irvine Center Drive
- Adding a northbound auxiliary lane from Jeffrey to Culver
- Adding a northbound auxiliary lane at Culver Drive off-ramp.

The 2020 model estimates that the auxiliary lane improvements reduce delay by 11 percent in both peak periods. This totals to a reduction of over 5,000 vehicle-hours. Most notably, the reductions occur in the southbound direction in both the AM and PM peak period, from McArthur Boulevard to Jeffrey Road.

Scenarios 12 and 13 (Enhanced Incident Management)

Two incident scenarios were built upon on Scenario 8 to evaluate enhanced incident management strategies. In the first scenario, Scenario 12, a collision incident with one outside lane closure was simulated in the northbound direction in the PM peak model and in the southbound direction in the AM peak model. The incident simulation location and duration were selected based on a review of the 2010 actual incident data, at one of the high-incident frequency locations. The following are the scenario details:

- Northbound PM Peak starting at 5:00 PM, close mainline outermost lane for 35 minutes at post mile 9.3 (north of Bristol)
- Southbound AM Peak starting at 7:30 AM, close mainline outermost lane for 35 minutes at post mile 8.1 (at Bristol)

In the second scenario, Scenario 13, the same incidents were simulated with the duration reduced by 10 minutes for both. Based on Caltrans incident management data, the study team estimated that an enhanced incident management system could reduce a 35-minute incident by about 10 minutes. This scenario represents a typical, moderate-level incident at one location on the peak period direction.

An enhanced incident management system would entail upgrading or enhancing the current Caltrans incident management system that includes deployment of intelligent transportation system (ITS) field devices, central control/communications software, communications medium (i.e. fiber optic lines), advanced traveler information system, and/or freeway service patrol (FSP) program to reduce incident detection, verification, response, and clearance times.

The 2020 model results indicate that non-recurrent delay is reduced by two percent (approximately 1,000 vehicle-hours delay) for both directions with deployment of enhanced incident management. Similar to the SR-22 incident management results, these results reflect benefits that can be realized during the peak direction period. Additional benefits could be realized during off-peak hours and in the off-peak direction.

Scenario 14 (SR-133 Interchange Improvements)

Scenario 14 builds on Scenario 11 to test interchange improvements at SR-133 proposed by the South Orange County Major Investment Study (SOCMIS) using the 2020 model. This project involves the construction of connectors from southbound I-405 to northbound and southbound SR-133. It also involves a new southbound I-405 off-ramp to the vicinity of Alton Parkway.

The 2020 model estimates that the project reduces delay by three percent in the AM peak period with minimal impact during the PM peak period. The new southbound connector to SR-133 contributes to the delay reduction of over 650 vehicle-hours in the AM peak. The northbound direction experiences slightly heavier congestion (of about 280 vehicle-hours) as the connector allows SR-133 vehicles to reach northbound I-405 more quickly. However, model does not capture the additional benefits that may occur on the SR-133 corridor. The nominal impact of the project on I-405 is due to the limited, spot improvements rather than improvements across longer segments of the corridor.

Demand at this location may continue to increase beyond 2020 such that long-term operational benefits could be anticipated well into 2035 and beyond. Further study may be required to quantify the long-term benefits beyond 2020.

Exhibit ES-37: I-405 AM Peak Micro-Simulation Delay Results by Scenario (2008)

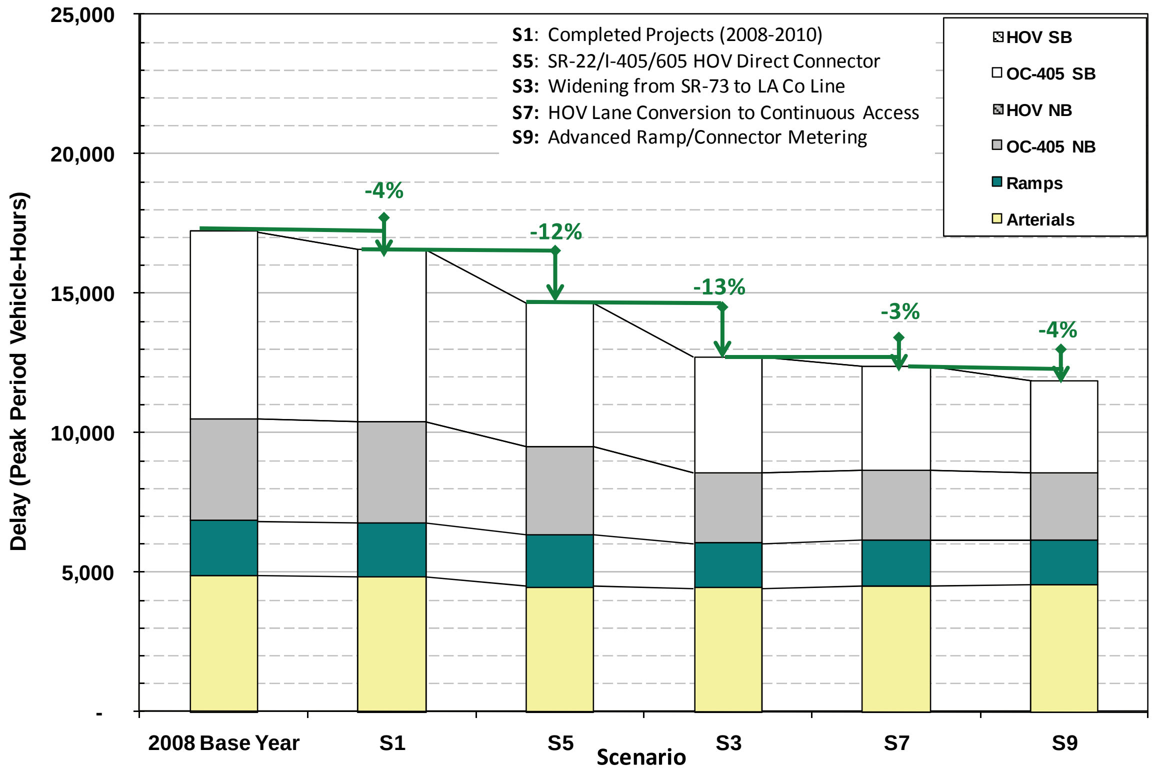


Exhibit ES-38: I-405 PM Peak Micro-Simulation Delay Results by Scenario (2008)

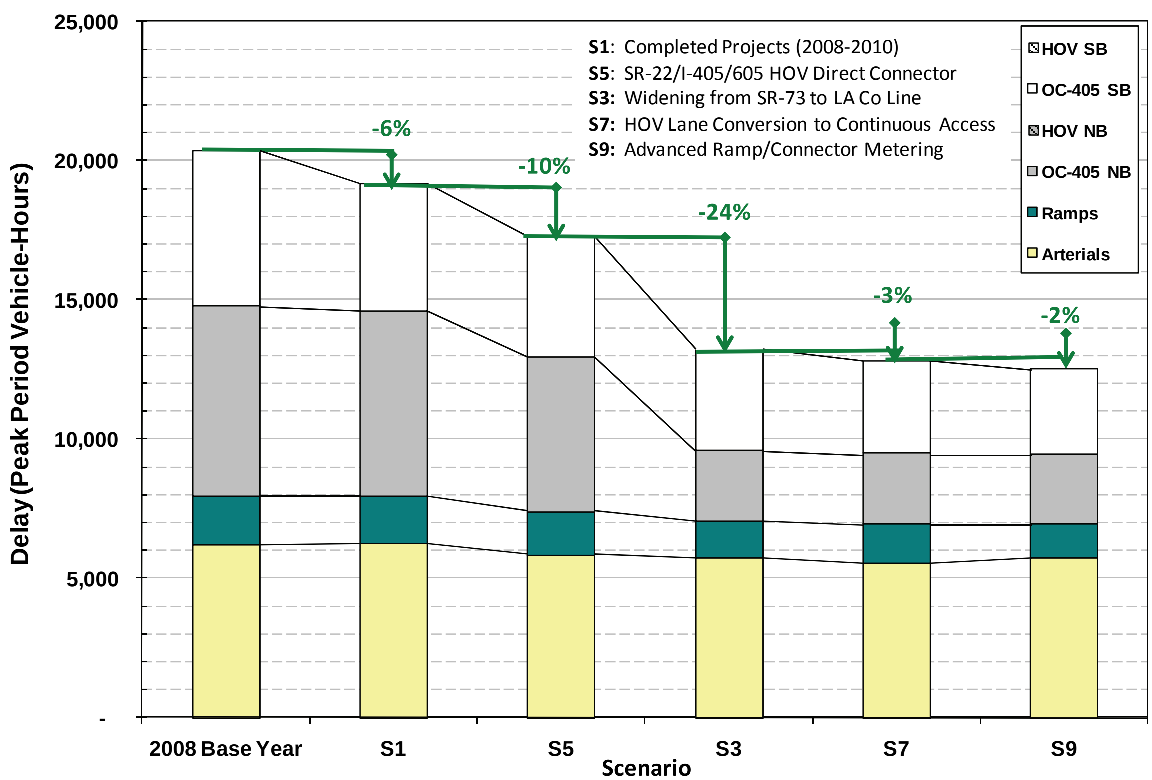


Exhibit ES-39: I-405 AM Peak Micro-Simulation Delay by Scenario (2020)

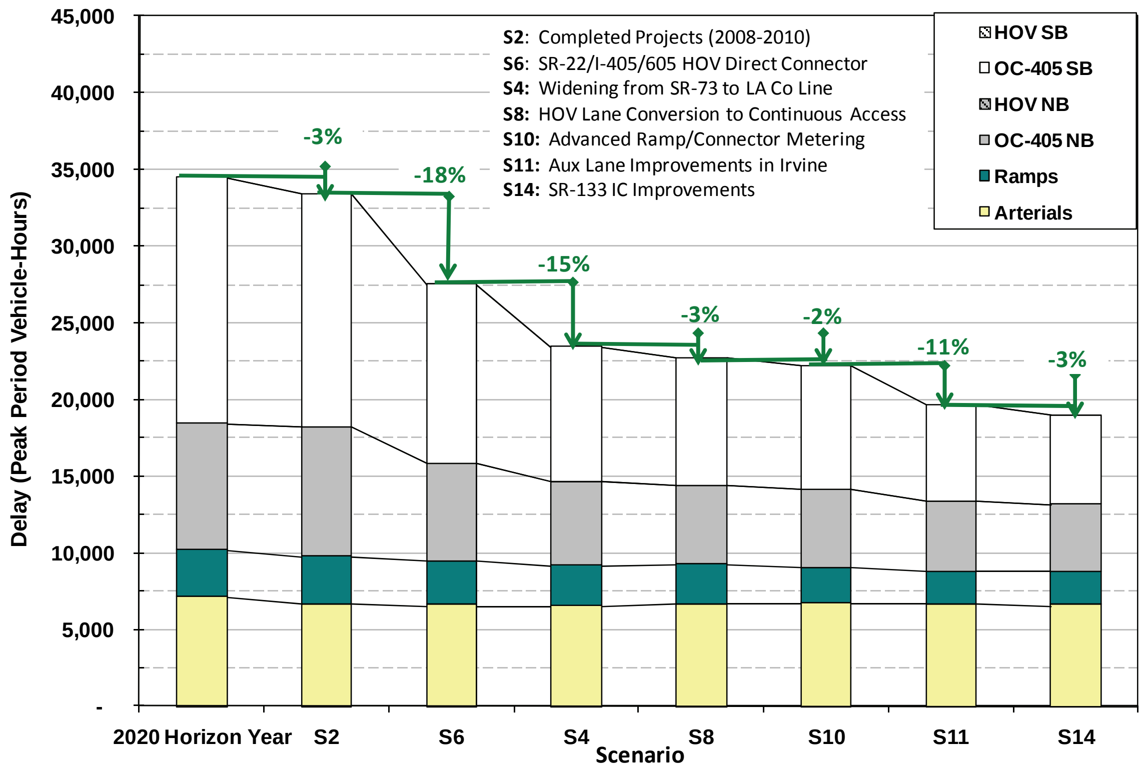
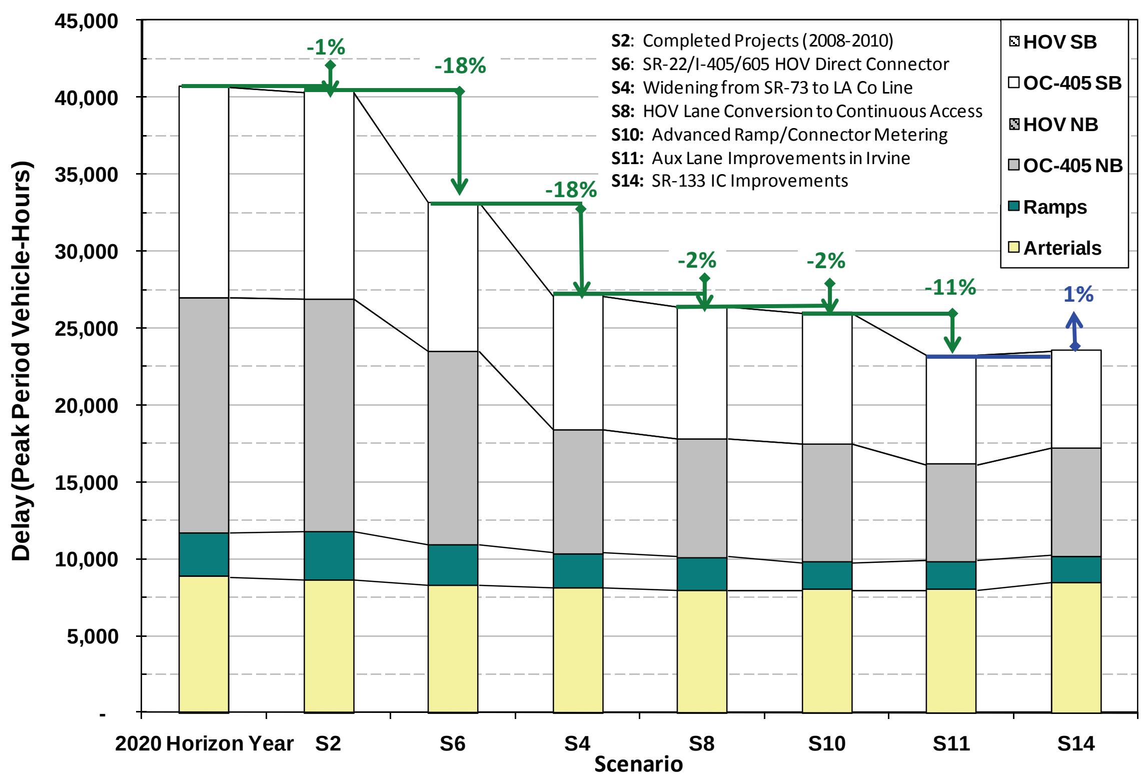


Exhibit ES-40: I-405 PM Peak Micro-Simulation Delay by Scenario (2020)



BENEFIT-COST ANALYSIS

Following an in-depth review of model results, the study team performed a benefit-cost analysis for each scenario. The benefit-cost results represent the incremental benefits over the incremental costs of a given scenario.

The study team used the California Benefit-Cost Model (Cal-B/C) developed by Caltrans to estimate benefits in three key areas: travel time savings, vehicle operating cost savings, and emission reduction savings. The results are conservative since this analysis does not capture the benefits after the 20-year lifecycle or other benefits, such as the reduction of congestion beyond the peak periods and improvement in transit travel times.

Project costs were obtained from various sources, including the RTIP, OCTA's Long Range Plan (LRP), and Caltrans project planning. Costs for the advanced ramp and connector ramp metering include widening to accommodate the connector meters within the State's right-of-way, but not the acquisition of new right-of-way. A benefit-cost ratio (B/C) greater than one means that a scenario's projects return benefits greater than they cost to construct or implement. It is important to consider the total benefits that a project brings. For example, a large capital expansion project, such as adding major lane additions, can have a high cost and a low B/C ratio, but it would bring much higher absolute benefits to users.

SR-22 Benefit-Cost Results

The benefit-cost results for the SR-22 scenarios are shown in Exhibit ES-41.

The benefit-cost findings for each scenario are as follows:

- Scenarios 1 and 2 (programmed SR-22/I-405/I-605 HOV direct connectors) produce a benefit-cost ratio of over 2:1. This result is consistent with typical operational projects with high costs – the cost of this improvement exceeds $300 million. The benefits are substantial at over $670 million.
- Scenarios 3 and 4 (advanced ramp metering with connector metering) produce a benefit-cost ratio below one due to the limited effect of advanced ramp and connector metering on corridor mobility. The benefit-cost ratio is likely to be higher with minimal connector metering implementation (i.e. no widening). In addition, advanced ramp metering can be optimized further to provide additional benefits. The model can be used to test different variable setting to optimize flow and minimize delay further.
- Scenarios 9 and 11 (eastbound collector-distributor facility improvement) produce a relatively high benefit-cost ratio of over 9:1 because of high expected mobility improvements. Reconstruction of the eastbound collector-distributor facility (with braided access improvements to the I-5 and SR-57 freeways) would be cost effective and produce a significant benefit. Staged improvement could be considered to capture mobility benefits earlier if there is a significant funding constraint. Additional analysis is recommended to evaluate MOS strategies.

Exhibit ES-41: SR-22 Scenario Benefit/Cost (B/C) Results

Scenario	Scenario Description	Benefit/Cost Ranges				
		Low	Medium	Medium-High	High	Very High
		<1	1 to 2	2 to 5	5 to 10	>10
1/2	SR-22/I-405/I-605 HOV Direct Connectors		★★			
3/4	Advanced Ramp/Connector Metering	★				
9/11	Collector/Distributor Improvements				★★★★	

- The benefit-cost ratio of all scenarios combined is about 3.5 to 1. If all projects were delivered at current cost estimates, the public would get over three dollars of benefits for each dollar expended. In current dollars, costs total to around $450 million whereas the benefits are estimated to be almost $1.6 billion.

- The projects also alleviate greenhouse gas (GHG) emissions by over 1.1 million tons over 20 years, averaging nearly a 55,000-ton reduction per year. The emissions are estimated using data from the California Air Resources Board (CARB) EMFAC model.

I-405 Benefit-Cost Results

Exhibit ES-42 summarizes the benefit-cost results for the I-405 scenarios. The benefit-cost findings for each scenario are as follows:

- Scenarios 1 and 2 (completed projects from 2008 base year to current year 2010) produce a relatively high benefit-cost ratio of over 12:1. This is primarily the result of beneficial improvements costing only $11.2 million. This result is consistent with other effective operational improvement projects.

- Scenarios 5 and 6 (CMIA project – SR-22/I-405/I-605 HOV direct connectors) produce a benefit-cost ratio above 3:1. This is consistent with other typical capital improvement projects.

- Scenarios 3 and 4 (mainline widening, auxiliary lanes, and operational improvements) produce a benefit-cost ratio below one. This relatively modest B/C is due to the high cost of widening at over $1.07 billion. However, the benefits are substantial at over $830 million.

- Scenarios 7 and 8 (HOV conversion to continuous access) produce a benefit-cost ratio of over 26:1. Although the benefits are relatively modest at $130 million, the low cost makes this project a cost-effective investment.

- Scenarios 9 and 10 (advanced ramp metering and connector metering) produces a benefit-cost ratio above 3:1, which is in an appropriate range considering the added cost of connector metering.

- Scenario 11 (operational improvements at south end of corridor) produces a relatively high B/C of over 10:1, again due to the relatively low cost of construction. The high benefit-cost ratio is consistent with other effective operational improvement projects.

- Scenario 14 (capital improvement with SR-133 interchange modification) produces a benefit-cost ratio below one, due to the high cost of construction and nominal benefits to the corridor. However, the model may not capture all of the benefits, since SR-133 may also experience improvements.

- The benefit-cost ratio of all scenarios combined is about 2:1. If all projects were delivered at current costs, the public would get two dollars of benefits for each dollar expended. In current dollars, costs add up to around $1.6 billion whereas the benefits are estimated to be almost $2.8 billion.

- The projects also alleviate greenhouse gas (GHG) emissions by about 1.7 million tons over 20 years. This reduction averages nearly 85,000 tons per year. The emissions are estimated using data from the California Air Resources Board (CARB) EMFAC model.

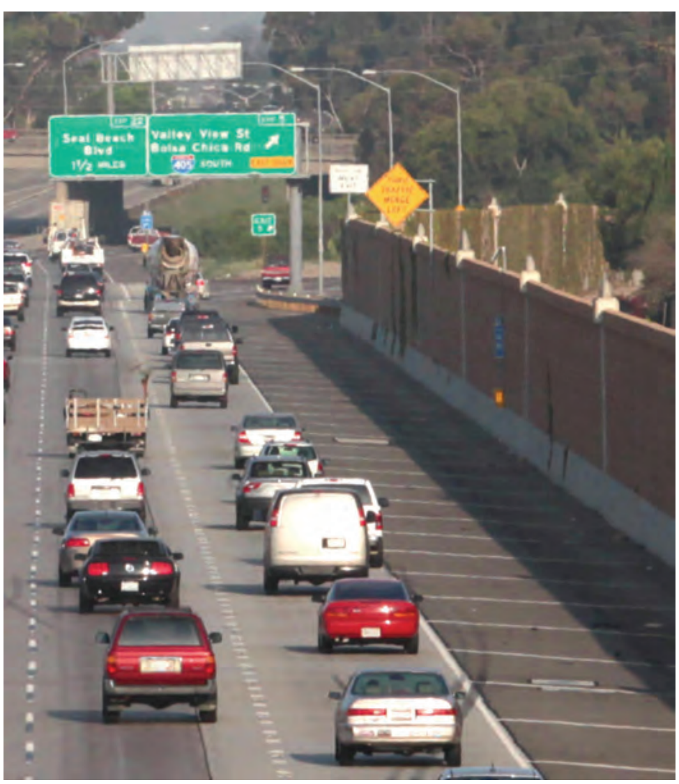
Exhibit ES-42: I-405 Scenario Benefit/Cost (B/C) Results

Scenario	Scenario Description	Benefit/Cost Ranges				
		Low	Medium	Medium-High	High	Very High
		<1	1 to 2	2 to 5	5 to 10	>10
1/2	Projects Completed (2008-2010)					★★★★★
5/6	SR-22/I-405/I-605 HOV Direct Connectors			★★★		
3/4	Widening (SR-73 to LA County Line)	★				
7/8	HOV Lane Conversion to Continuous Access					★★★★★
9/10	Advanced Ramp Metering			★★★		
11	Operational Improvements in Irvine					★★★★★
14	SR-133 Interchange Improvements	★				

7. Conclusions and Recommendations

This section summarizes the conclusions and recommendations based on the analysis presented. Many of these conclusions are based on the micro-simulation model results. The model was developed based on the best data available at the time. After a thorough and careful review of each incremental step and analysis, the study team believes that both the calibration and the scenario results are reasonable and allow for more informed decision-making.

However, caution should always be used when making decisions based on modeling alone. There are engineering and professional judgment and experience, among other technical factors to take into consideration in making the most effective project decisions that affect millions, if not billions, of dollars in investment. Project decisions are based on a combination of regional and inter-regional plans and needs, regional and local acceptance for the project, availability of funding, planning and engineering requirements.



SR-22 Corridor Improvements

- The programmed CMIA project, which constructs the SR-22/I-405/I-605 HOV direct connectors, is expected to produce a benefit-cost ratio of over 2:1. This result is consistent with typical capital expansion projects. Benefits are substantial at over $670 million.

- Advanced ramp metering with connector metering results in only modest mobility improvements on this corridor. This result should be revisited with additional analyses in the future.

- Reconstruction of the eastbound collector-distributor facility (with access improvements to the I-5 and SR-57 freeways) would be very cost effective (producing a benefit-cost ratio of over 9:1). The CSMP model results for 2020 traffic shows that short term operational benefits for collector-distributor facility improvements may be achieved in a Minimum Operating Segment (MOS) by phasing construction. The study team recommends additional analysis to evaluate such staging properly.

- Finally, improved incident management shows promise. The SR-22 corridor experienced up to 750 accidents in 2008. With an average delay savings of nearly 300 vehicle-hours per incident, that would amount to a total annual delay savings of over 225,000 vehicle-hours for the corridor.

I-405 Corridor Improvements

- The analysis results indicate that the operational projects completed in the last two years have produced immediate results and are very cost effective (benefit-cost ratio of 12 to 1). The benefits of these projects may decline somewhat in future years.

- The CMIA project (SR-22/I-405/I-605 HOV direct connectors) is expected to produce benefit-cost ratio of 3.5 to 1 on I-405. This project produces large benefits for a low cost.

- An HOV conversion to continuous access (Scenarios 7 and 8) would produce large benefits for a low cost on I-405.

- Auxiliary lane improvements at the south end of the corridor (Scenario 11) are also very cost-effective (B/C ratio of over 10:1). In 2020, these improvements may reduce delay by over 5,000 vehicle-hours.

- Other scenarios range from low to moderate cost-effectiveness. Low-cost improvements, such as advanced ramp metering with connector metering, seem to show relatively reasonable investment. Caltrans needs to consider other factors, for high-cost investments.

- Enhanced incident management shows promise. The I-405 study corridor experienced around 1,200 accidents in 2008. With an average delay savings of nearly 500 vehicle-hours per incident, that would amount to a total annual delay savings of over 600,000 vehicle-hours for the corridor.

This is the first-generation CSMP for the SR-22/I-405/I-605 CSMP Corridor. It is important to emphasize that CSMPs should be updated, on a regular basis, if possible. This is particularly important since traffic conditions and patterns can differ from current projections. After projects are delivered, it is also useful to compare actual results with estimated ones in this document so that models can be further improved as appropriate.

CSMPs, or some variation, should become the normal course of business that includes detailed performance assessments, an in-depth understanding of the reasons for performance deterioration, and an analytical framework that allows for evaluating complementary operational strategies that maximize system productivity.

Exhibit ES-43: District 12 CSMP Team Organization Chart