State Route 57

Corridor System Management Plan

August 2010

CALTRANS DISTRICT 12

corridor system management plans

Corridor System Management Plan
State Route 57 (Orange County)

Executive Summary

Caltrans District 12

State Route 57

Corridor System Management Plan

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1. Introduction

This document represents the Executive Summary for the Orange County State Route 57 (SR-57) Corridor System Management Plan (CSMP) Final Report developed by the California Department of Transportation (Caltrans). 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). The ballot measure included a funding program deposited into a Corridor Mobility Improvement Account (CMIA). There are two CMIA funded projects on the SR-57 corridor:

- Lane addition on northbound SR-57 (from 0.4 mile north of SR-91 to 0.1 mile north of Lambert Road) - this project should be completed in 2014 at a total cost of approximately $182 million.
- Lane addition on northbound SR-57 (from 0.3 mile south of Katella Avenue to 0.3 mile north of Lincoln Avenue) - this project should be completed by 2018 or 2020 with a total cost of approximately $41 million.

To receive CMIA funds, the California Transportation Commission (CTC) guidelines required that project sponsors describe in a CSMP how mobility gains from CMIA funded corridor improvements would be maintained over time. A CSMP therefore aims to define how corridors will be managed over time, 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:

- 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 expand and maintain the infrastructure to keep up with growing demand. Caltrans therefore adopted a system management philosophy to address current and future transportation needs in a comprehensive manner. Exhibit ES-1 conceptually illustrates this philosophy as a "system management pyramid". The exhibit shows that the 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.

The SR-57 CSMP aims to define how Caltrans and its stakeholders will manage the corridor 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 2007 Base Year model for the SR-57 corridor. This model was calibrated using California and Federal Highway Administration (FHWA) guidelines. Following approval of a 2007 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 coordination with community goals, plans, and values. Caltrans seeks and tries 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 is more focused on reducing congestion and increasing mobility through capital and operational strategies. The 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-57 CSMP involved corridor stakeholders including representatives from cities bordering SR-57, 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, various 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
- Southern California Association of Governments (SCAG)
- City of Fullerton
- City of Anaheim
- City of Orange
- City of Placentia
- City of Brea

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-57 corridor and summarizes the results of the comprehensive corridor performance assessment conducted.

CORRIDOR DESCRIPTION

Exhibit ES-2 shows the Orange County SR-57 CSMP corridor. The study corridor extends approximately 12 miles and is a north-south route from the I-5/SR-22 Interchange (the "Orange Crush") at postmile 10.7 in the south to the Orange/Los Angeles County Line in the north at postmile 22.6.

As shown in Exhibit ES-2, the SR-57 corridor passes through the cities of Orange, Anaheim, Fullerton, Placentia, and Brea. It includes two major freeway-to-freeway interchanges at I-5 and SR-22 and at SR-91.

SR-57 is an eight to ten-lane freeway with a concrete median barrier that separates northbound and southbound traffic for most of the corridor. There are auxiliary lanes along many sections of the corridor, but they are not always available on both directions of the freeway in a given highway section. There is one HOV lane in each direction of the study corridor. The HOV facility operates as a 2+ facility, 24 hours a day. There is a direct HOV connector between the southbound SR-57 and westbound SR-91 and between the eastbound SR-91 and northbound SR-57. There is also a direct HOV connector (transitway) from the northbound I-5 to northbound SR-57. Between SR-57 to I-5, SR-57 has flat to rolling terrain with a long climbing grade in the northerly end of the corridor.

According to Caltrans traffic volumes reported for 2008, SR-57 in Orange County carries between 210,000 and 273,000 annual average daily traffic (AADT). The highest average daily traffic volume on the corridor occurs between SR-91 and Orangethorpe Avenue and the lowest volume occurs between Lambert Road and Tonner Canyon Road.

SR-57 is also a Surface Transportation Assistance Act (STAA) route that allows large trucks to operate on the mainline lanes. According to the 2008 truck volumes from Caltrans, trucks comprise over six percent of total daily traffic along the corridor.

Four major transit operators provide service on or near SR-57: Orange County Transportation Authority (OCTA), Foothill Transit, the Southern California Regional Rail Authority (SCRRA) commonly known as Metrolink, and Amtrak.

Established in 1991, OCTA provides fixed-route bus and paratransit services throughout Orange County. The following routes operate on or directly adjacent to SR-57: Routes 53, 57, 59, 757, and 758.

Foothill Transit has operated fixed-route bus public transit in the San Gabriel Valley since 1998. Route 286 operates directly on SR-57 providing service between Los Angeles County and Orange County.

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 weekday round trips on three lines. Along the SR-57 study corridor, Metrolink provides service at four stations: Fullerton, Anaheim Canyon, Anaheim, and Orange.

Exhibit ES-2: Orange County SR-57 CSMP Corridor Map

Amtrak provides interregional service throughout Southern California. The Pacific Surfliner and Southwest Chief trains provide service near SR-57 and share the same station locations as Metrolink.

Several major special event facilities generate significant trips along the SR-57 corridor including the Disneyland Resort and Theme Park; "Angels Stadium of Anaheim," home of the Los Angeles Angels professional baseball team; and the "Honda Center" arena, home to the Anaheim Ducks professional hockey team.

There are two major universities/colleges and four major medical facilities near SR-57 corridor. California State University Fullerton (CSUF) and Chapman University are located within close proximity to the study corridor. The Anaheim Memorial Medical Center, the University of California (UCI) Medical Center, the St. Joseph Hospital, and Children's Hospital of Orange County (CHOC) are all located within close proximity to SR-57. Finally, there are two major shopping malls located near SR-57. Brea Mall is directly west of SR-57, while the Block at Orange is located less than two miles away.

CORRIDOR PERFORMANCE ASSESSMENT

The SR-57 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.

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 models. The Performance Measurement System [1] (PeMS) provided 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 less the travel time during free flow conditions (assumed to be 60 miles per hour), and is reported as vehicle-hours of delay. Exhibit ES-3 shows the average weekday daily vehicle-hours of delay for each month between 2005 and 2009 for both mainline and high occupancy vehicle (HOV) lanes. These trends exclude weekends and holidays. This exhibit reveals the following:

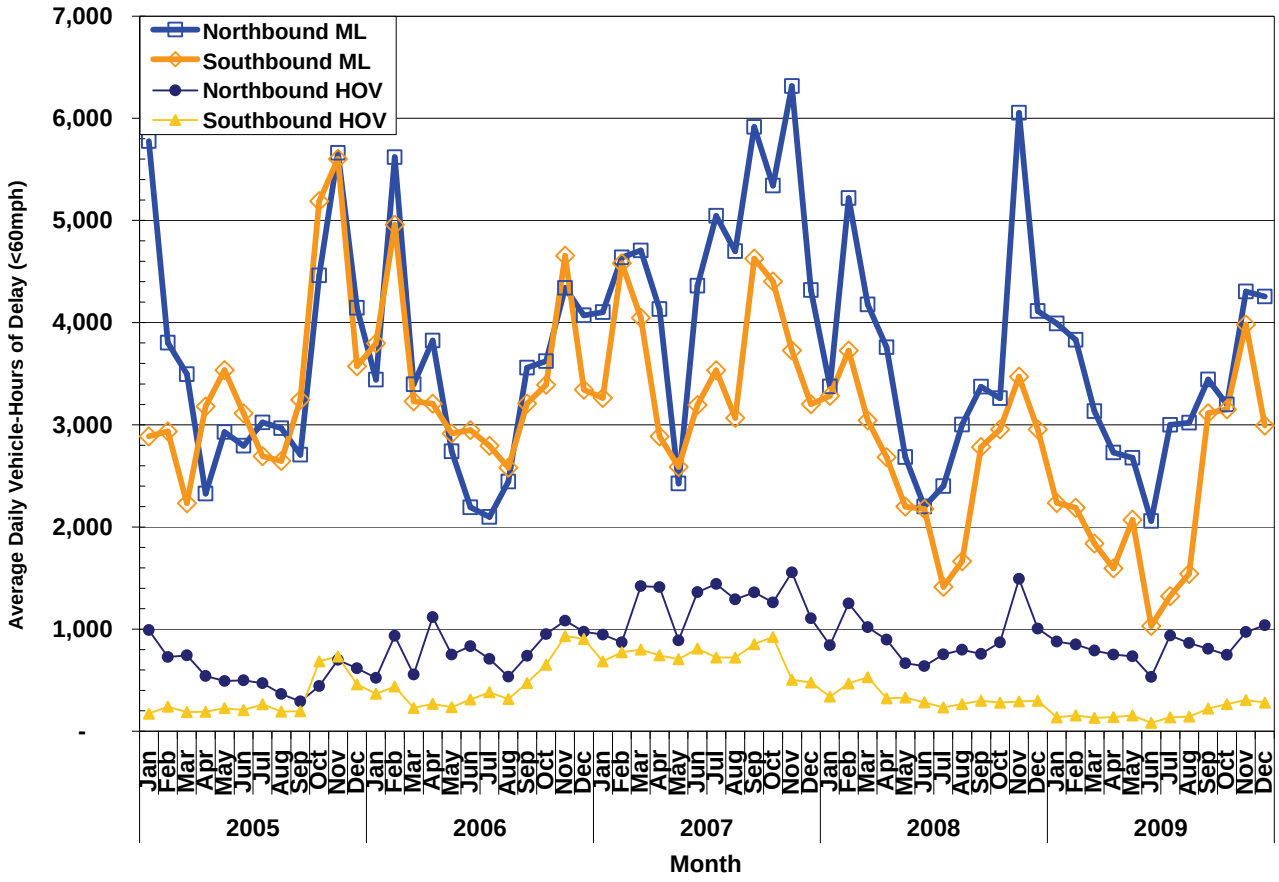
- As expected, the mainline (ML), or general purpose lanes, experience significantly more congestion than the HOV facility, and the northbound mainline lanes generally experience more delay than the southbound mainline lanes.
- HOV lanes do experience congestion, but more so in the northbound direction than in the southbound direction.
- Delay was highest in 2007 in the northbound direction with almost 6,300 vehicle-hours daily. Delay was highest in 2005 in the southbound direction with almost 6,400 vehicle-hours daily.
- After 2007, however, delay declined to 2006 levels and remains below 2007 peak levels.

Delay can be grouped into two components: severe delay and other delay. *Severe delay* is delay that occurs when speeds are below 35 mph and *other delay* occurs where 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. Other delays can be a leading indicator of future severe delay.

Exhibits ES-4 (Mainline lanes) and ES-5 (HOV lanes) show average severe and other daily vehicle-hours of delay by day of the week. A few notes related to ES-3 and ES-4:

- On the mainline lanes, severe delay makes up almost 90 percent of all weekday delay on the corridor in the northbound direction and more than 70 percent in the southbound direction (Exhibit ES-4). This reflects the extreme congestion that faces corridor travelers during peak periods. HOV severe delays (Exhibit ES-4) tend to average approximately 25 percent of the total delay for the northbound direction and approximately 15 percent of total delay for the southbound direction. This reflects relatively low but potentially growing congestion.
- In the northbound direction, the highest severe congestion generally occurred on Fridays, exceeding 4,000 vehicle-hours of delay in 2007 and 2009. In the southbound direction, severe congestion occurred more or less evenly for Tuesdays through Fridays, ranging from a high of 3,000 vehicle-hours of delay in 2007 to below 2,000 vehicle-hours of delay in 2009.
- Peak Friday congestion in the northbound direction reached similar levels as in 2007. However, congestion in the southbound direction remains well below 2007 levels.
- On the HOV facility, severe delay was highest on Fridays in the northbound direction and Thursdays in the southbound direction. In 2007, the northbound HOV facility experienced about 1,300 vehicle-hours of severe delay on Fridays, almost a third of the congestion experienced on the mainline. The southbound HOV facility experienced about 240 vehicle-hours of severe delay on Thursdays, less than one tenth of the mainline congestion. Clearly, northbound HOV congestion trends are more of a concern with future demand increases.

Exhibit ES-3: Average Weekday Delay by Month (2005-2009)



[1] Developed and maintained by Caltrans and accessible at PeMS@dot.ca.gov

Exhibit ES-4: Mainline Lane Delay by Day of Week (2005-2009)

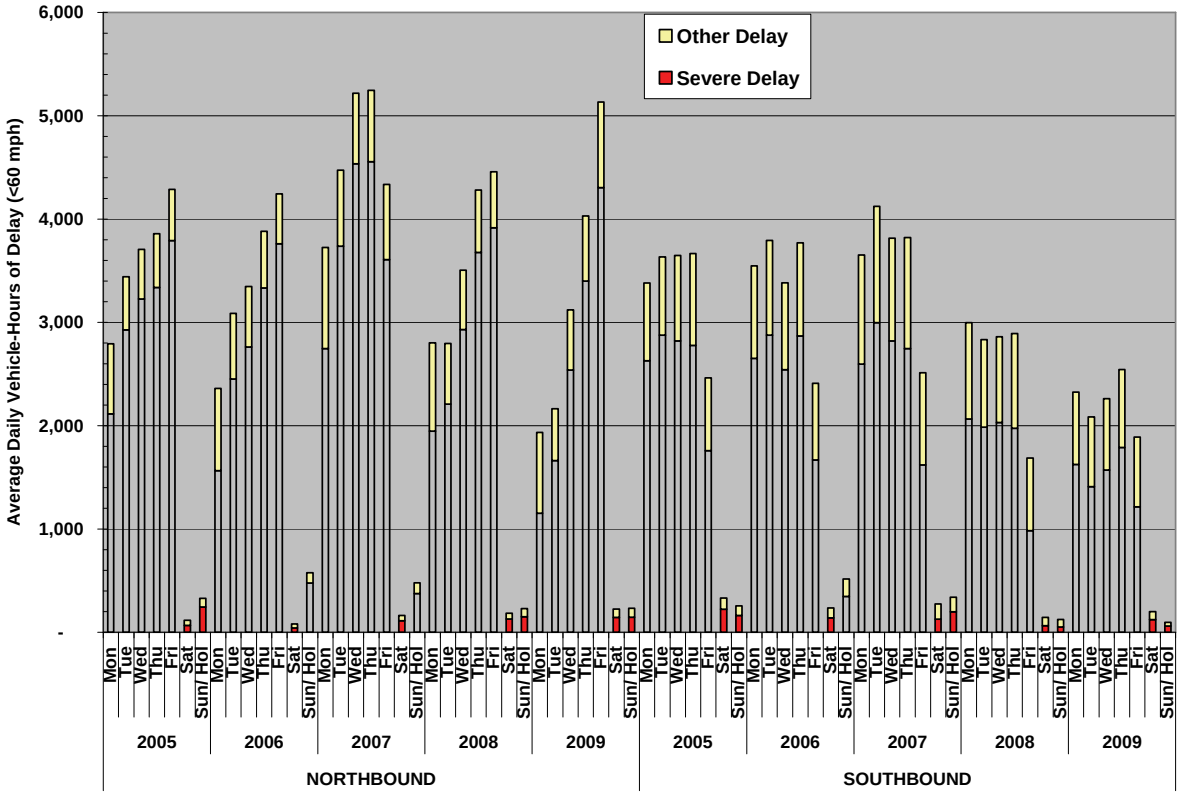
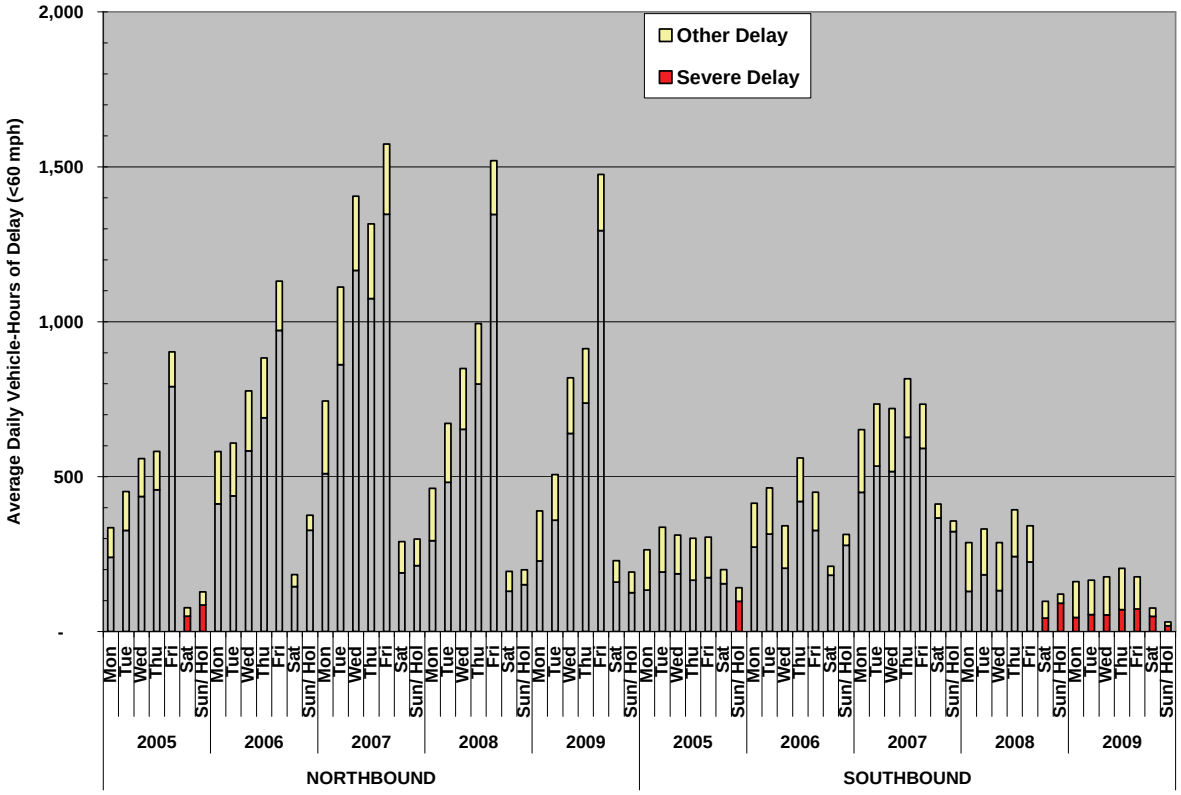


Exhibit ES-5: HOV Lane Delay by Day of Week (2005-2009)



Exhibits ES-6 and ES-7 summarize average annual weekday delay by hour of the day over the five-year period for the mainline northbound and southbound lanes, respectively. These exhibits allow planners and decision makers to understand the trend in peak period delay spiking (greater variance/differences) and peak period spreading (longer duration) by comparing the intensity and duration of the 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 main technical report contains the HOV delay by hour results). A few notes on these two exhibits:

- Northbound delay peaked in 2007, almost reaching 1,200 hours between 5:00 PM and 6:00 PM. During 2007, congestion started at 2:00 PM and lasted to 7:00 PM. By 2009, peak hour delay was around 900 hours (a 25 percent decrease from 2007) but started and ended about the same time. In other words, the intensity of congestion decreased, but its duration remained more or less constant. Northbound peak hour delays were the lowest in 2009 for the five years analyzed.
- Southbound delay peaked in 2006 at around 900 hours between 7:00 AM and 8:00 AM. During 2006, congestion started at 6:00 AM and lasted until 9:00 AM. By 2009, peak delay was around 500 hours (more than a 40 percent decrease from 2007). Congestion duration decreased slightly. Again, southbound 2009 peak delays were the lowest in 2009 for the five years analyzed.

Travel Time

The travel time performance measure represents the average time it takes for a vehicle to travel between the I-5/SR-22 Interchange to the Orange/Los Angeles County Line and vice versa (approximately 12 miles).

Exhibits ES-8 and ES-9 present the travel times results for the mainline facility of the SR-57 corridor for the years 2005 through 2009. Travel along the mainline takes about 10 minutes in the off-peak periods. During the peak period in 2007, travel times were roughly double the free-flow travel times. The northbound mainline had an average travel time of approximately 22 minutes during the PM peak hour (5:00 to 6:00 PM) while the southbound mainline had an average travel time of approximately 19 minutes during the AM peak hour (6:30-7:30 AM). By 2009, peak hour travel time had diminished to 18 and 16 minutes for the northbound and southbound directions respectively.

Travel times on the HOV facility are much lower than on the mainline. For instance, in 2009, it took about 16 minutes to travel the southbound mainline compared to only 13 minutes on the southbound HOV facility at 7:00 AM. The detailed HOV travel time charts are available in the technical CSMP.

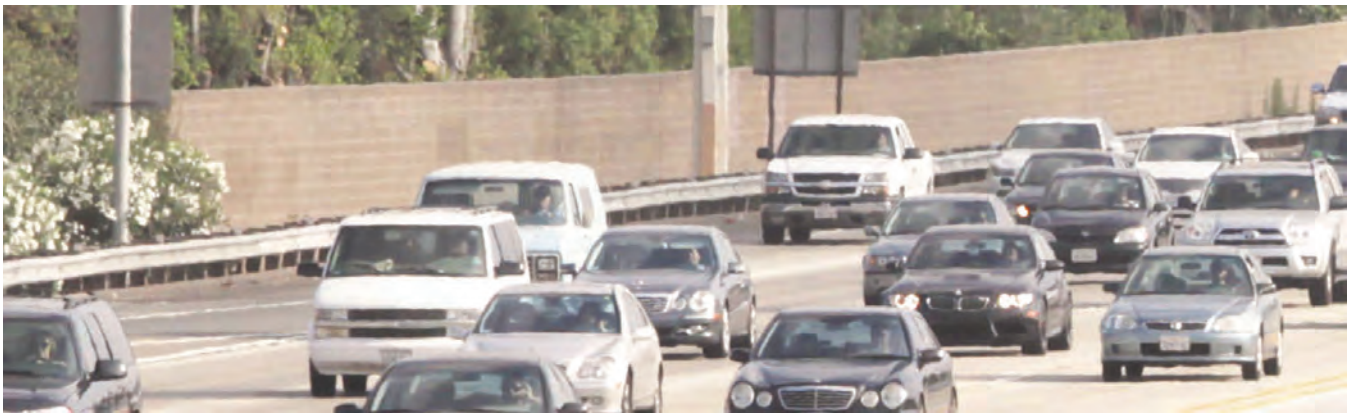


Exhibit ES-6: Northbound Mainline Lanes Hourly Delay (2005-2009)

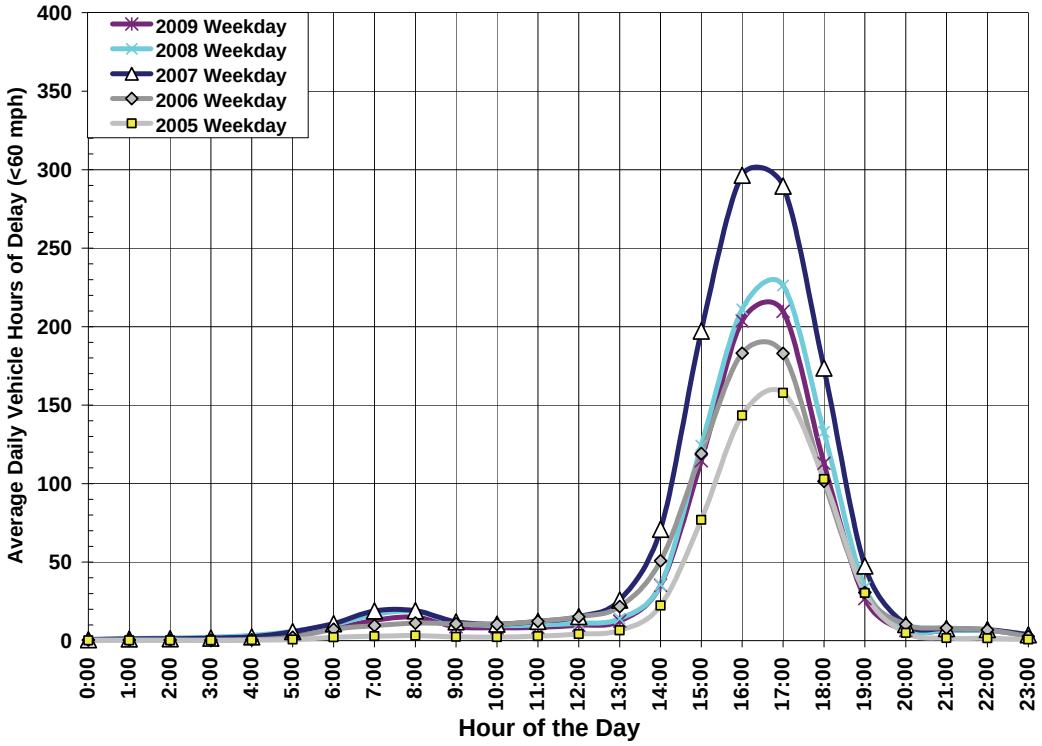


Exhibit ES-7: Southbound Mainline Lanes Hourly Delay (2005-2009)

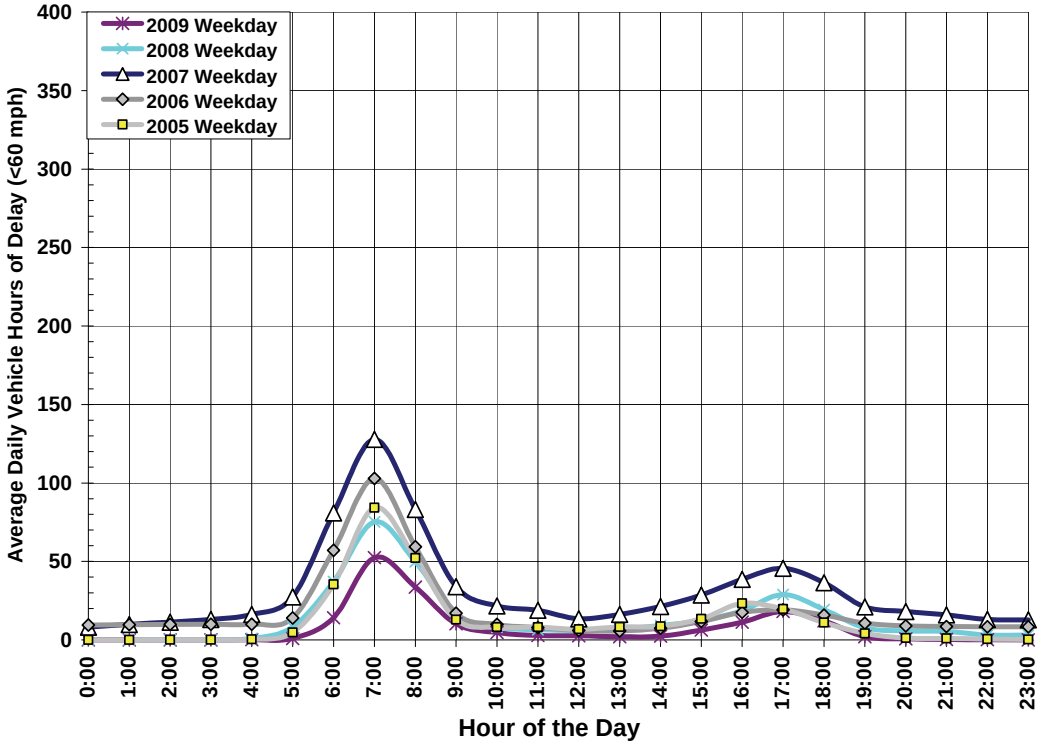


Exhibit ES-8: Northbound Mainline Lanes Travel Time by Hour (2005-2009)

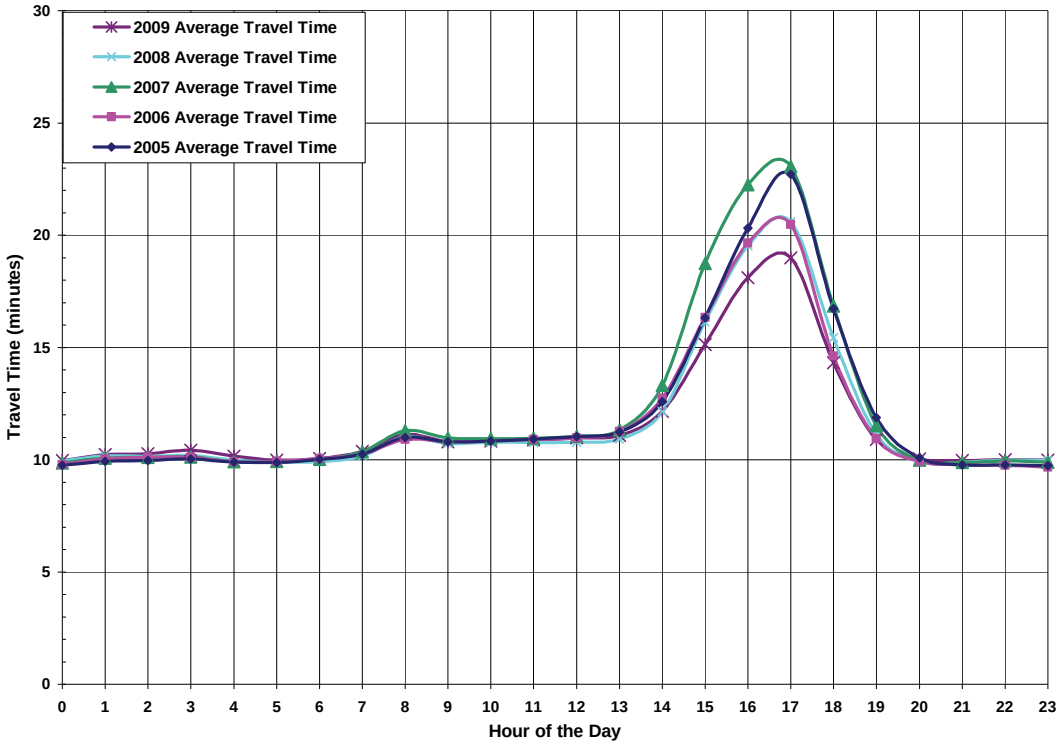
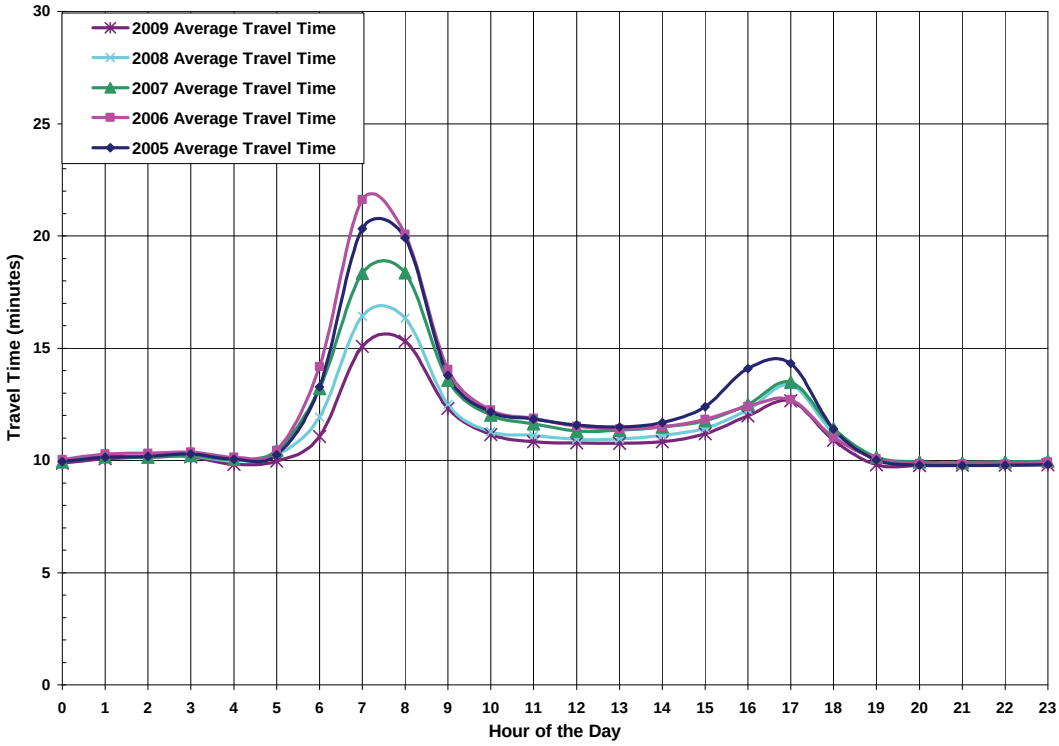


Exhibit ES-9: Southbound Mainline Lanes Travel Time by Hour (2005-2009)



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 used 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. The 95th percentile represents days with extreme events (e.g., major accidents) and other, more typical travel days.

Exhibits ES-10 and ES-11 illustrate the variability of travel time along the mainline lanes for non-holiday weekdays in 2007. The technical report shows the buffer index for the years 2005-2009 for both mainline and HOV lanes, but this Executive Summary reports only the data for the year 2007 for mainlines since the base year for modeling is 2007.

The following observations on the reliability results are worth noting:

- In 2007 in the northbound direction, 5:00 PM had the highest estimated average travel time at approximately 23 minutes and the highest estimated buffer index time of 13 minutes for a buffer index of 56 percent. In other words, to arrive on time 95 percent of the time, a commuter would need to leave 36 minutes before the start time to travel the entire length of the SR-57 study corridor.
- The southbound direction at 8:00 AM had an estimated average travel time of 19 minutes in 2007 with a buffer time of 8 minutes for a buffer index of 42 percent. A similar buffer time also existed at 5:00 PM.

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-10: Northbound Mainline Lanes Travel Time Variability (2007)

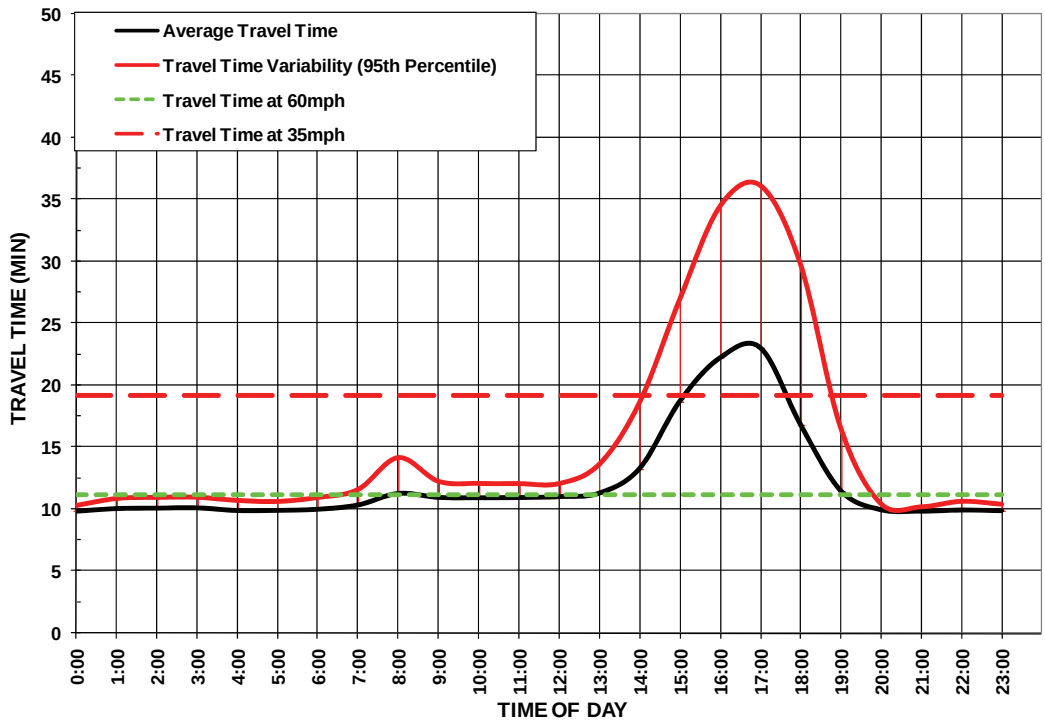
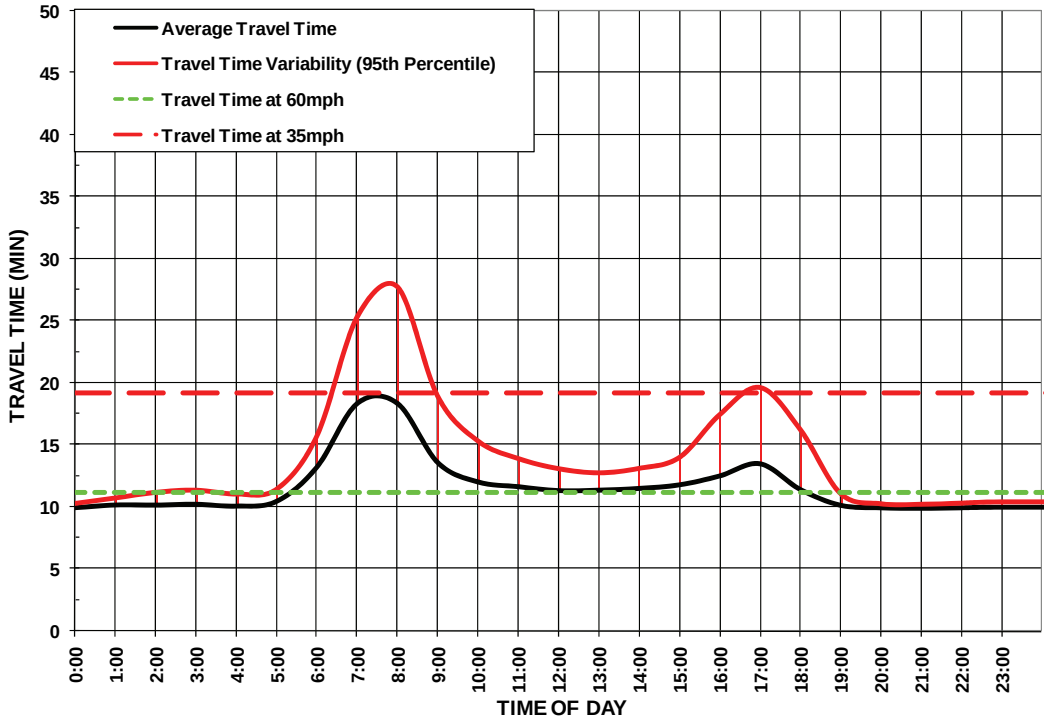


Exhibit ES-11: Southbound Mainline Lanes Travel Time Variability (2007)



Safety

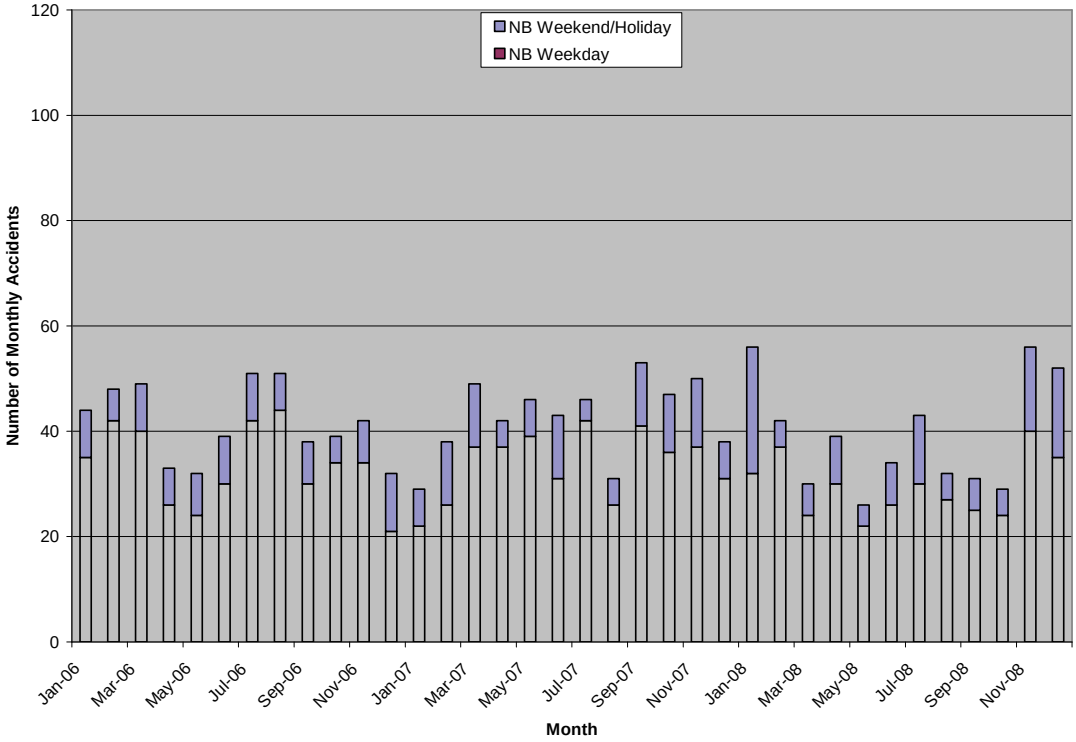
The adopted performance measures to assess safety involve the number of accidents and the accident rates computed from the Caltrans Traffic Accident Surveillance and Analysis System (TASAS). TASAS is a traffic records system containing an accident database linked to a highway database. The highway database 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, and to highlight notable accident concentration locations or patterns that are readily apparent. This report does not intend to supplant more detailed safety investigations routinely performed by Caltrans staff.

Exhibits ES-12 and ES-13 show the SR-57 total number of northbound and southbound accidents by month, respectively. Accidents are reported for the study corridor and not separated by mainline and HOV facility. The exhibits summarize the latest available three-year data from January 1, 2006 through December 31, 2008.

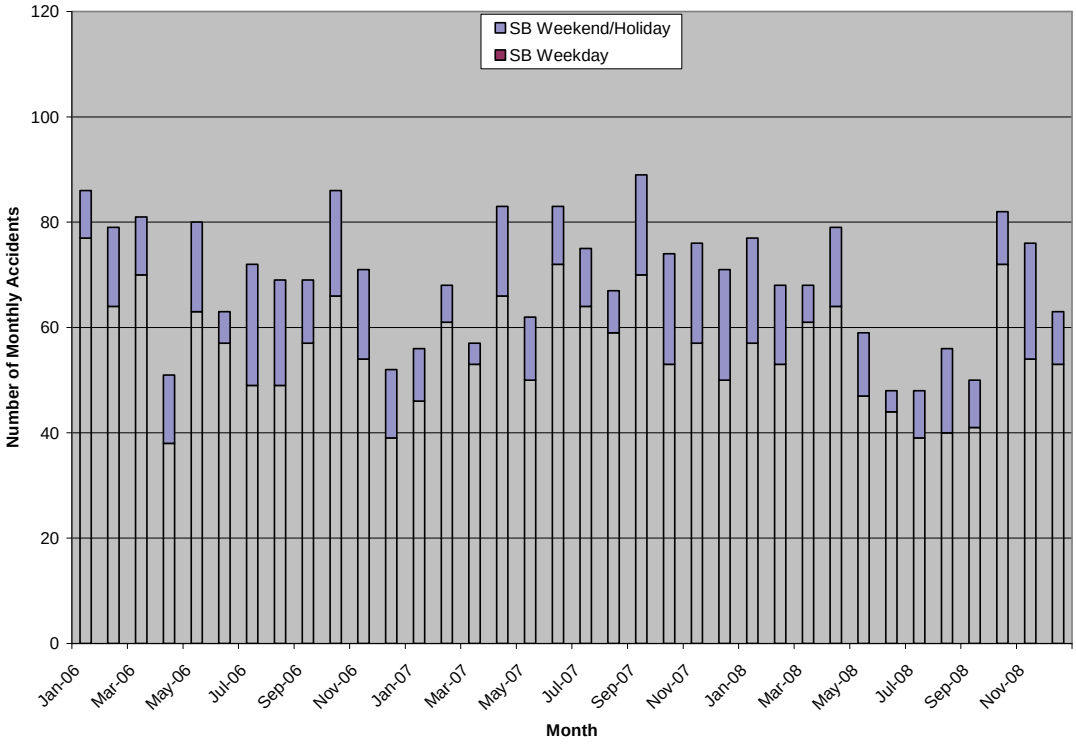
From 2006 to 2008, northbound SR-57 experienced up to 55 collisions per month (less than two per day), while the southbound direction had up to 90 monthly collisions (up to three per day). The total number of accidents for both the northbound and southbound directions decreased slightly in 2008. Many of the collisions were rear-end collisions, which can be indicative of congestion-related incidents.

Exhibit ES-12: Northbound Monthly Accidents (2006-2008)



Source: SMG analysis of Caltrans TASAS data

Exhibit ES-13: Southbound Monthly Accidents (2006-2008)



Source: SMG analysis of Caltrans TASAS data

Productivity

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

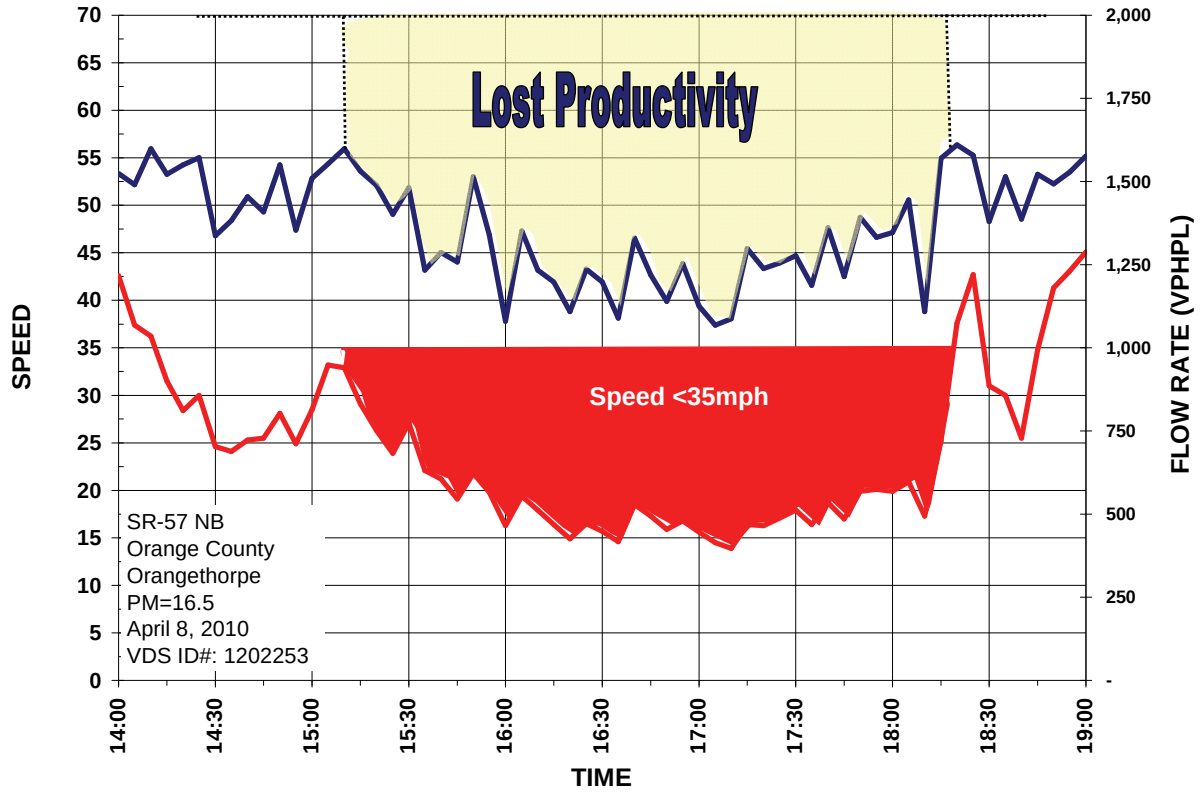
Exhibit ES-14 illustrates how congestion leads to lost productivity. The exhibit uses observed SR-57 data from sensors for a typical spring 2010 afternoon peak period (Tuesday, April 8, 2010). It shows speeds (in red) and flow rates (in blue) on northbound SR-57 at Orangethorpe Avenue, one of the most congested locations on the corridor.

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

Once volumes approach this maximum rate, traffic becomes unstable. 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 the capacity, these merges lead to queues. Moreover, 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-14, throughput drops by nearly 25 percent on average during the peak period (from over 1,600 to around 1,200 vphpl). This five-lane road 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-14: Lost Productivity Illustrated



The estimated average non-holiday, weekday equivalent lost lane-miles by period and year on SR-57 are shown Exhibits ES-15 (mainline) and ES-16 (HOV). A few notes on these two exhibits:

- The largest productivity losses occurred in the northbound direction during the PM peak hours, which is the direction and period that experiences the most congestion. In 2007, mainline lost productivity reached seven equivalent lane-miles. By 2009, that loss diminished to five equivalent lane-miles.
- In 2007, HOV lost productivity reached 1.5 equivalent lane-miles. By 2009, that loss diminished to less than one equivalent lane mile.

Operational strategies are critical to recovering such productivity losses. These strategies include building new or extending auxiliary lanes, developing more aggressive ramp metering strategies without negatively influencing the arterial network, and improving incident management.

Exhibit ES-15: Mainline Daily Equivalent Lost Lane-Miles by Direction and Period (2005-2009)

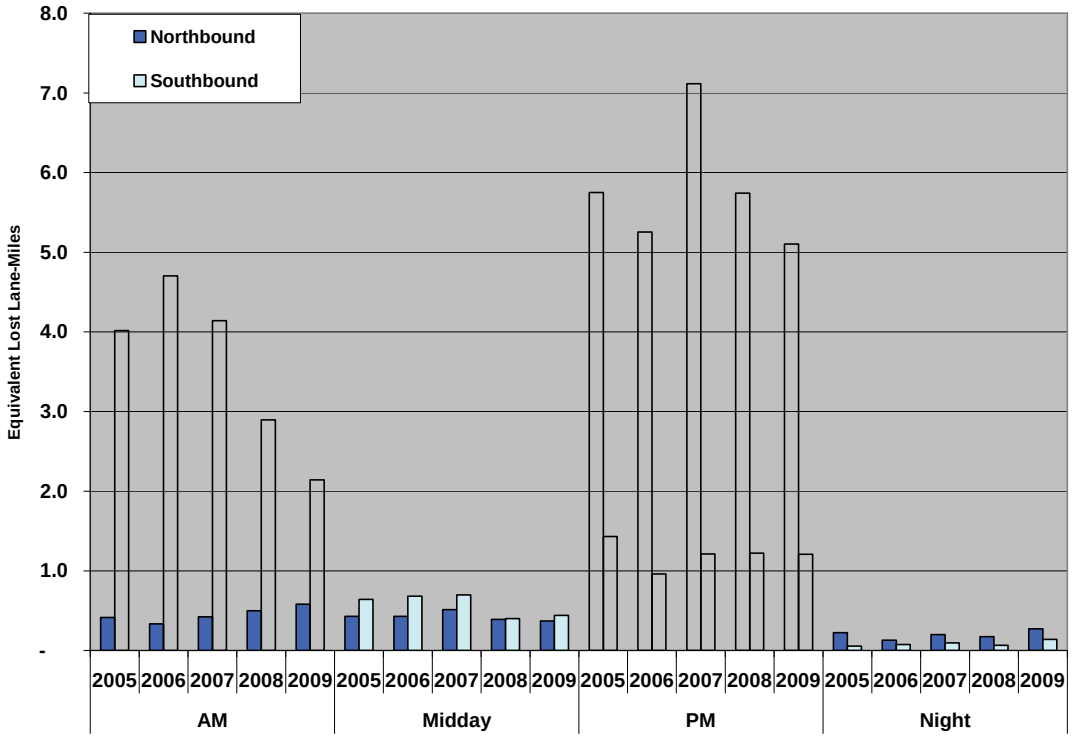
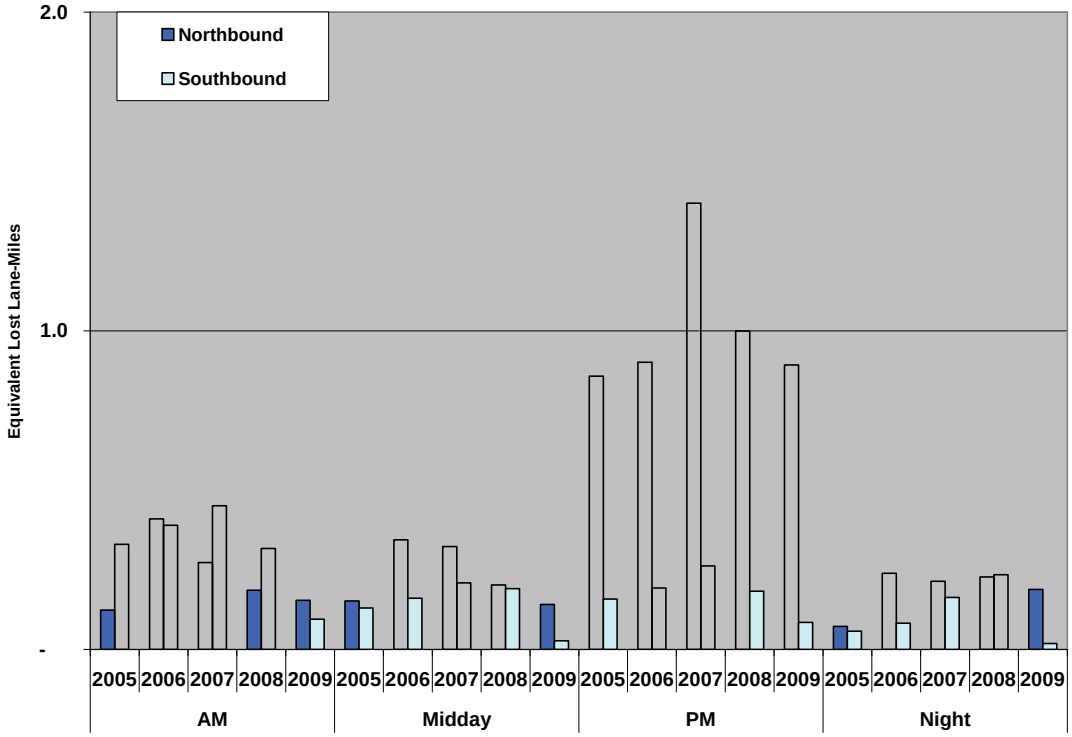


Exhibit ES-16: HOV Daily Equivalent Lost Lane-Miles by Direction and Period (2005-2009)



5. Bottleneck Identification and Causality Analysis

Exhibit ES-17 summarizes the northbound and southbound bottleneck locations, the period these bottlenecks are active, and the causes of the bottlenecks. Exhibits ES-18 and ES-19 are maps of the corridor showing these bottleneck locations 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 condition 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-57 bottleneck was 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 details the process and results of the bottleneck identification and causality analysis.

Exhibit ES-17: Orange County SR-57 Bottleneck Areas

Dir	Bottleneck Location	Causality	Active Period		Location
			AM	PM	Postmile
Northbound	Tonner Canyon Rd	Climbing grades		✓	21.10
	Lambert Rd On	Heavy ramp merge; steep grades		✓	19.80
	Imperial Hwy On	Consecutive ramp merge; rolling terrain; curves		✓	16.56
	Orangethorpe Ave On	Heavy ramp merge; weaving	✓	✓	10.70
Dir	**Bottleneck Location**	**Causality**	**Active Period**		**Location**
			AM	**PM**	**Postmile**
Southbound	Imperial Hwy On	Heavy consecutive ramp merge; rolling terrain; curves	✓		22.06
	Chapman Ave On	Heavy consecutive ramp merge	✓	✓	19.95
	Ball Rd On	Heavy consecutive ramp merge	✓	✓	17.18
	I-5 Off / SR-57 Terminus	Heavy I-5 mainline merge	✓	✓	13.27

Exhibit ES-18: Map of Major SR-57 AM Existing Bottlenecks

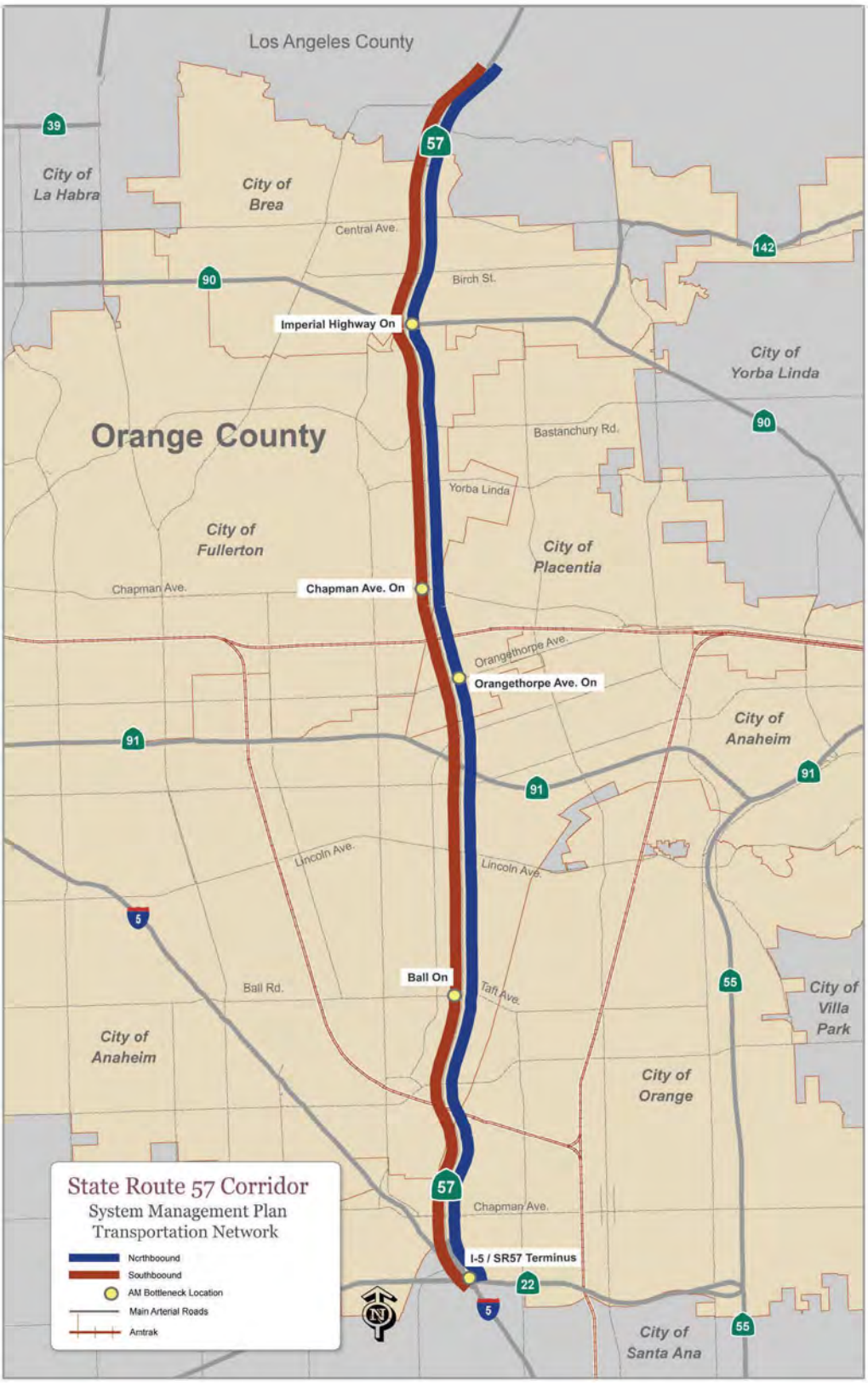


Exhibit ES-19: Map of Existing SR-57 PM Bottlenecks

6. Scenario Development and Analysis

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

- Developing traffic models for 2007 base year and 2020 long-term demand
- Combining projects in a logical manner for modeling and testing
- Evaluating model outputs and summarizing results
- Conducting a benefit-cost assessment of scenarios.

TRAFFIC MODEL DEVELOPMENT

The Study Team developed a traffic model using the 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, it is one of the only 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-20 depicts the network included in the model. All freeway interchanges were included as well as on and off-ramps. The Study Team calibrated the base year model against 2007 conditions presented earlier. This was a resource intensive effort, requiring several iterations of submittals and review cycles until the model reasonably matched bottleneck locations and relative severity. 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 two 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.

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 that were fully programmed and funded were combined separately from projects that were not
- Short-term projects (delivered typically by 2014) were used to develop scenarios to be tested with the both the 2007 and 2020 models
- Long-term projects (delivered after 2014, 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 2014 could reasonably be evaluated using the 2007 base year model. The 2020 forecast year for the SR -57 corridor was consistent with the OCTA regional travel demand model origin-destination matrices.

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

Project lists used to develop scenarios were part from the Regional Transportation Improvement Program (RTIP), the Regional Transportation Plan (RTP), Measure M2, SR-91 Implementation Plan, Transportation Corridor Agencies (TCA) improvements, and Riverside County Transportation Commission (RCTC) improvements, and other sources (e.g., 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 since micro-simulation models cannot evaluate them.

Exhibit ES-20: Micro-Simulation Model Network

Scenario testing performed for the SR-57 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-57 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 showed an acceptable level of performance improvement. This incremental scenario evaluation approach is important because CSMPs are new and often compared with alternatives studies.

Exhibit ES-21 summarizes the approach used and scenarios tested. It also provides a general description of the projects included in the 2007 and 2020 micro-simulation runs.

SCENARIO EVALUATION RESULTS

Exhibits ES-22 and ES-23 show the delay results for all the 2007 scenarios evaluated for the AM and PM peak periods, respectively. Exhibits ES-24 and ES-25 show the delay results for all the 2020 scenarios evaluated for 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.

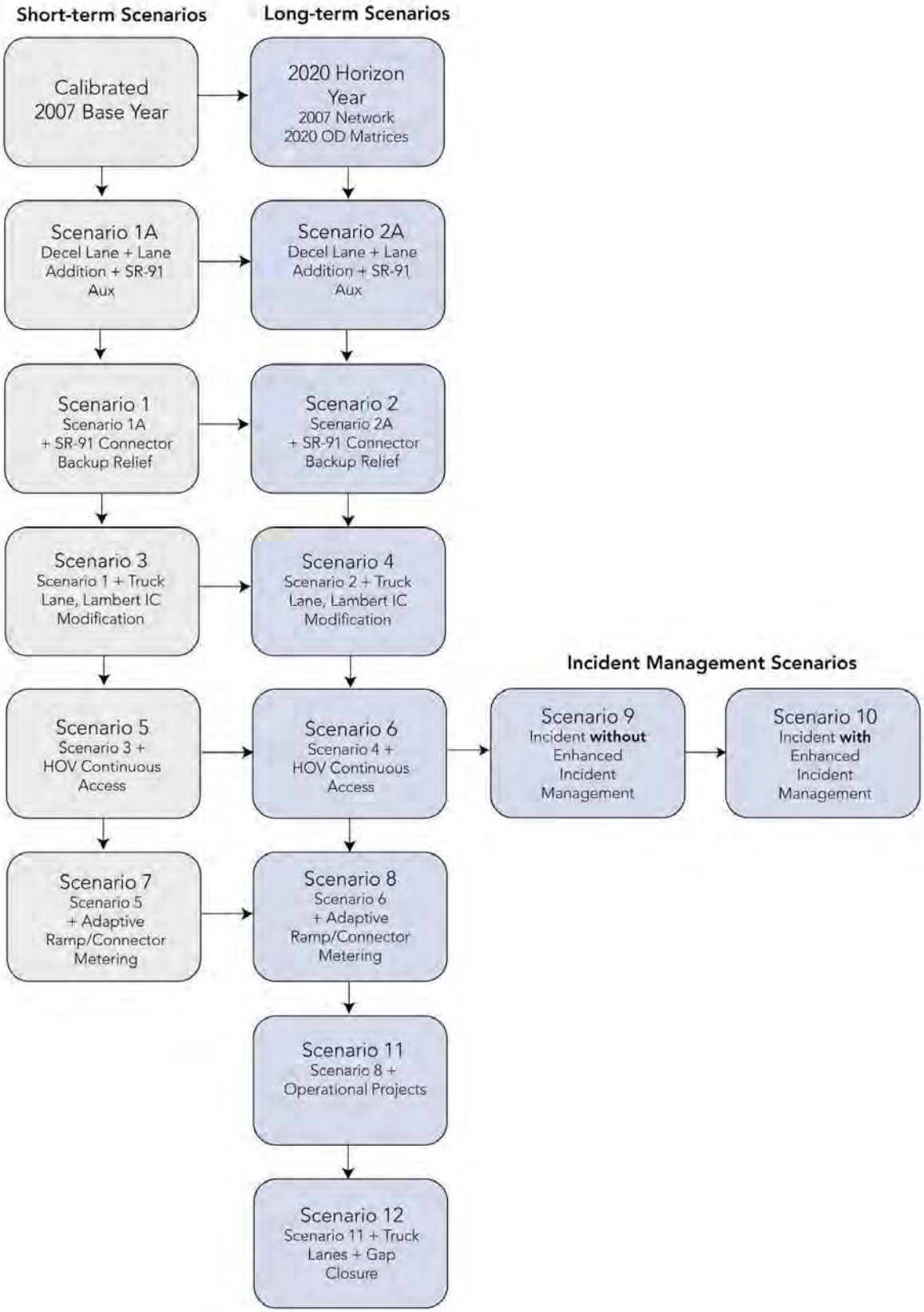
For each scenario, the modeling team produced results by facility type (i.e., mainline, HOV, Arterials, and ramps) and vehicle type (SOV, HOV, trucks) as well as speed contour diagrams (discussed in more detail in the full technical CSMP). The Study Team scrutinized to ensure that they were consistent with general traffic engineering principles.

The following describes the findings for each scenario tested and reviewed by the study team:

Base Year and “Do Minimum” Horizon Year

Absent any improvements, the modeling team estimates that total delay (mainline, HOV, ramps, and arterials) will increase by more than 60 percent compared to 2007 (from a total of around 20,000 hours daily to more than 34,000 hours). Demand may continue to increase beyond 2020 and may require further study. As described below, the short term programmed projects lead to significant decreases and improved mobility on the corridor.

Exhibit ES-21: Paramics Micro-Simulation Modeling Approach



Scenarios 1A/1 and 2A/2 – (Deceleration Lane, Lane Additions, SR-91 Aux Lane)

The first four scenarios include both expansion and operations-related, fully funded programmed projects slated for completion by 2014, except for the Katella Avenue to Lincoln Avenue widening project, which is slated for competition by 2018 or 2020. These projects include:

- A southbound deceleration lane from Lambert Road to Imperial Highway (SR-90)
- Widening the northbound SR-57 by adding one lane from 0.4 miles north of SR-91 to 0.1 mile north of Lambert Road
- Widening the northbound SR-57 by adding one lane from 0.3 miles south of Katella Avenue to Lincoln Avenue
- Connect existing auxiliary lanes on westbound SR-91 from SR-57 to I-5. This would provide additional capacity to SR-57.

During the early stages of testing, the Study Team realized that improvements on SR-57 led to mobility benefits on SR-91 and vice versa. The team needed to isolate such benefits and assign them to the correct projects.

For instance, improvements on SR-91 will reduce backups on the connector from southbound SR-57 to westbound SR-91. These delay benefits do not relate to improvements on SR-57. Conversely, improvements on SR-57 also lead to delay reductions on SR-91.

In order to correctly assign benefits to the associated projects, the team evaluated two sets of scenarios related to the short term projects listed above. The first set relieved the backups on the connectors from southbound SR-57 to westbound SR-91. The second set maintained these backups. The difference between the two benefits belongs to SR-91 projects. The team used the same approach on the SR-91 model (developed for the SR-91 CSMP) to delineate the benefits associated with the improvements on SR-57.

The 2007 model estimates that the projects included in the first scenario (S1A) will reduce delay on the corridor by approximately 11 percent in the AM peak period and by 30 percent in the PM peak period. In total, this scenario estimates a reduction of around 5,000 hours of daily delay. The majority of the delay reduction occurs in the northbound direction during the PM peak period where the corridor experiences the highest amount of congestion. There is a slight increase in delay from S1A to S1 as the congestion at the SR-91 connector clears up traffic throughout and speed from upstream increases causing slight additional delays further downstream.

The 2020 model estimates that the same set of projects will reduce delay on the corridor by approximately 20 percent in the AM peak period but increase delay by slightly (by 3 percent) in the PM peak period, primarily on the HOV facility. When demand increases in 2020, the lane drop at Lambert (at the end of the lane addition) intensifies the Lambert bottleneck and leads to very long queues. This in turn makes it harder for HOV vehicles to enter and exit the HOV facility at the current egress and ingress access points, and leads to delay increases. A similar increase in delay also occurs from S2A to S2 as the congestion at the SR-91 connector clears up, traffic throughput and speed from upstream increases causing slight additional delays further downstream.

In summary, the first set of projects significantly reduces 2007 congestion by 5,000 hours. By 2020, the same projects reduce 2020 congestion by less than 2,000 hours. The diminishing benefits suggest that complementary improvements to address the Lambert bottleneck are needed.

Scenarios 3 and 4 – Truck Climbing Lane and Lambert Interchange Improvement

Scenarios 3 and 4 build on Scenarios 1 and 2 by adding operations-related projects in the northerly section of the corridor. One project would add a truck climbing/auxiliary lane from Lambert Road to the Orange/Los Angeles County Line and the other project would reconfigure the Lambert Road interchange to provide additional storage capacity at the ramps. The two projects are programmed in the 2008 Regional Transportation Improvement Program (RTIP).

These improvements target the aforementioned Lambert bottleneck. Providing a separate lane for trucks relieves the other lanes significantly. The 2007 model estimates that S3 will reduce delay on the corridor by approximately 13 percent in the AM peak period and by around 51 percent in the PM peak period. Much of the delay reduction occurs at the Imperial Highway and Lambert Road bottleneck areas. In total, S3 reduces daily vehicle-hours of delay by more than 5,000 hours in addition to the benefits from S1. Together, the models estimate that the first two sets of projects combined reduce congestion by more than 50 percent.

The 2020 model estimates that S4 will decrease delay by approximately 54 percent in the PM peak period or almost 13,000 hours of daily delay. The largest delay reduction in the PM peak period occurs in the northbound direction. As the bottleneck at Lambert Road clears up, traffic throughput and speed increases upstream of the bottleneck, thereby reducing delay significantly. Together, the models project that the first two sets of projects will have a reduction of more than 14,000 of daily vehicle-hours of delay. Caltrans has noted that prior studies have shown that extending the truck climbing lane even further beyond the Orange/Los Angeles County Line to SR-60 would reduce delay even further.

Scenarios 5 and 6 – Continuous Access HOV

Scenarios 5 and 6 test the conversion of the existing buffer-separated HOV and limited access HOV to a full-time continuous access HOV facility with both 2007 and 2020 demand, respectively. Caltrans may revisit the modeling once the full details of the continuous access design are finalized.

The 2007 model estimates that S5 will produce a delay reduction of 9 percent in the AM peak period and 11 percent in the PM peak period over and beyond S4 benefits. This translates into a bit less than 1,000 hours of daily delay.

The 2020 model estimates that S6 will produce an even higher delay reduction of 14 percent in the AM peak period and 42 percent in the PM peak period. Standard HOV continuous access conversion would not normally produce such high reduction in delays. However, for SR-57, much of the delay reduction occurs at the HOV access location near the SR-91 interchange. Currently, HOV traffic must exit just south of SR-91 to exit to Orangethorpe Avenue, Chapman Avenue, and Nutwood Avenue. With continuous access, HOV traffic desiring to exit off Chapman Avenue and Nutwood Avenue can continue using the HOV lane until further downstream. This allows the HOV lane to have a higher throughput/capacity, and it reduces the weaving at the Orangethorpe Avenue bottleneck area.

In summary, the model estimates that the first three sets of projects provide compelling mobility benefits to the corridor. Delivery of these projects would reduce congestion on the corridor by around 11,000 hours or 55 percent of total congestion in the near term, and by almost 22,000 hours by 2020 representing more than 60 percent of total projected congestion.

Scenarios 7 and 8 (Advanced Ramp Metering, Connector Metering)

Scenarios 7 and 8 show the impacts of the following projects proposed by the study team:

- Implementing an advanced ramp metering with queue control
- Metering the eastbound SR-57 to northbound SR-57 connector ramp and metering the westbound SR-91 to southbound SR-57 connector ramp.
- Metering and widening the eastbound SR-91 to southbound SR-57 connector ramp and metering and widening the eastbound SR-57 connector ramp to northbound SR-57 connector ramp.

Note that there are several advanced ramp metering systems deployed around the world and for modeling purposes, we used one called Asservissement Lineaire d'Entrée Autoroutiere (ALINEA). This algorithm has been deployed in Europe and Asia and the software was readily available for modeling. However, it is used as a proxy and is not specifically recommended. Caltrans should evaluate different algorithms and implement the one it deems to provide the best benefits.

The 2007 model indicates that the projects will improve delay slightly in the AM peak by two percent and PM peak by one percent. The 2020 model shows that the projects will improve delays modestly in both the AM and PM peaks by three percent. Although the mainline facility experienced an improvement in delay during both the AM and PM peak hours, the ramps and connector ramps experienced an overall delay increase, thereby resulting in only a small improvement for the overall corridor. and connector metering would reduce congestion along the corridor by more than 650 vehicle-hours of delay.

Overall, the two models estimate that advanced ramp and connector metering would reduce congestion along the corridor by more than 650 vehicle-hours of delay.

Scenarios 9 and 10 (Enhanced Incident Management)

Two incident scenarios were tested upon Scenario 6 to evaluate the non-recurrent delay reductions resulting from enhanced incident management strategies. In the first scenario, Scenario 9, one collision incident with one outside lane closure was simulated in the southbound direction in the AM peak period model and in the northbound direction in the PM peak period model. The incident simulation location and duration was selected based on review of the 2010 actual incident data, at one of the high frequency locations. The following are the Scenario details:

- Southbound AM peak period starting at 8:00 AM, close outermost mainline lane for 40 minutes at postmile 15.38 (at westbound SR-91 on-ramp)
- Northbound PM peak period starting at 5:00 PM, close outermost mainline lane for 30 minutes at postmile 19.45 (at Imperial Highway)

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. There are also numerous minor incidents lasting only a few minutes without lane closures, yet still resulting in congestion. In addition, there are many incidents occurring during off-peak hours.

Based on actual Caltrans incident management data, it is estimated that an enhanced incident management system could reduce a 35-minute incident by about 10 minutes. 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 10, the same collision incident was simulated with a reduction in duration by 10 minutes in the southbound direction and 8 minutes in the northbound direction to determine the benefits of an enhanced incident management system.

The model results indicate that deployment of such a system could eliminate approximately 85 vehicle-hours of delay in the southbound direction and 50 vehicle-hours of delay in the northbound direction using 2020 demand. These results reflect benefits realized during the peak direction period. Additional benefits would be realized during off-peak hours and in the off-peak direction.

Scenarios 11 (Operational Projects)

Scenario 11 tests the following projects proposed by the study team and Caltrans on the 2020 model:

- Extend eastbound Imperial Highway on-ramp merge further downstream with an acceleration lane on southbound SR-57
- Add an acceleration lane from Nutwood to downstream of Placentia Avenue on southbound SR-57
- Merge Ball loop on-ramp with slip on-ramp further downstream with an acceleration lane on southbound SR-57
- Merge Katella loop on-ramp with slip on-ramp further downstream and merge with auxiliary lane to Orangewood Ave on southbound SR-57
- Add northbound lane from Orangewood to Katella.

The 2020 model shows that the combination of these projects will produce a seven percent reduction in delay in the AM peak period and a four percent reduction in delay in the PM peak period. While the first two projects improved congestion, this allowed more traffic to build up on the downstream end of the corridor. Without the Ball and Katella on-ramp projects, delay might increase further. Total congestion on the corridor decreased by almost 650 vehicle-hours incrementally.

Scenarios 12 (Truck Climbing Lanes, Gap Closure)

Scenario 12 tests the following long-term projects proposed by Caltrans on the 2020 model:

- Add a second northbound truck climbing lane from Lambert Road to Orange/Los Angeles County Line
- Add a truck southbound truck climbing lane from north of the Orange/Los Angeles County Line to Lambert Road
- Construct northbound gap closure between north of Lincoln and north of SR-91 (add one lane and modify interchanges).

The 2020 model shows that these three projects will produce a 16 percent reduction in delay in the AM and 17 percent reduction in delay in the PM peak periods. These delay improvements are mostly due to the addition of the southbound truck lane and the gap closure project as addition of the second northbound truck climbing lane does not seem to improve conditions. With these three projects, the corridor is expected to experience a 16 percent delay reduction of over 1,800 vehicle-hours incrementally.

Exhibit ES-22: 2007 AM Peak Micro-Sim Delay Results by Scenario

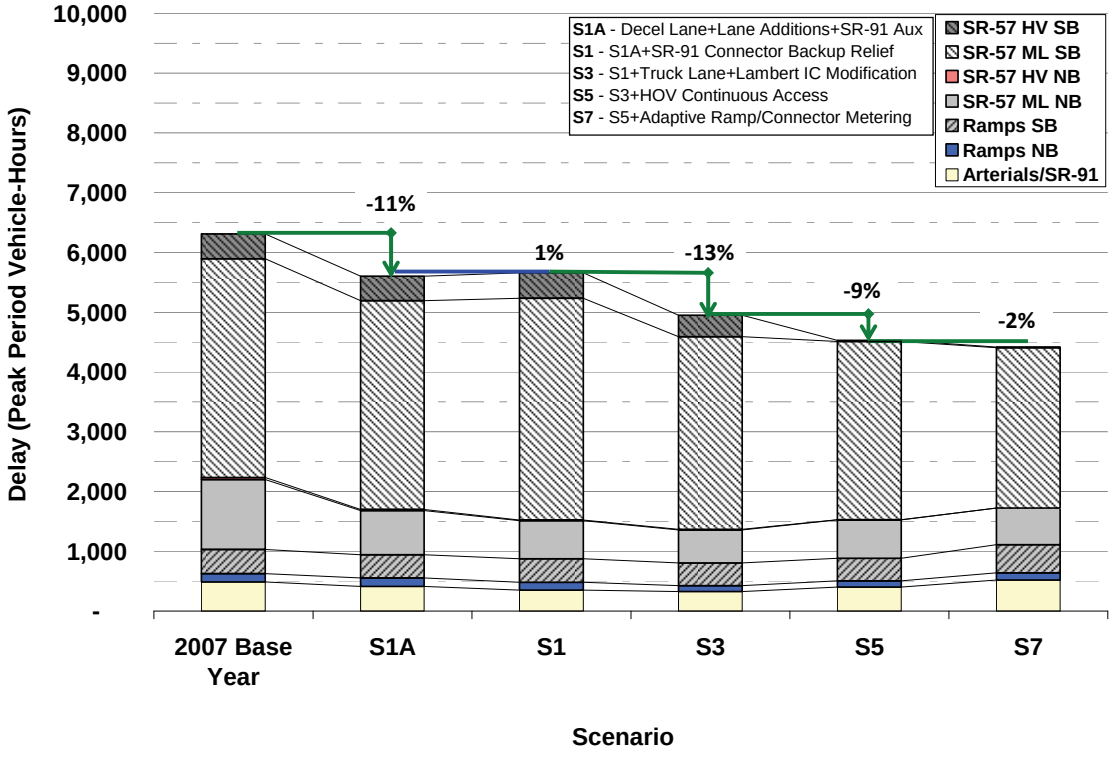


Exhibit ES-23: 2007 PM Peak Micro-Sim Delay Results by Scenario

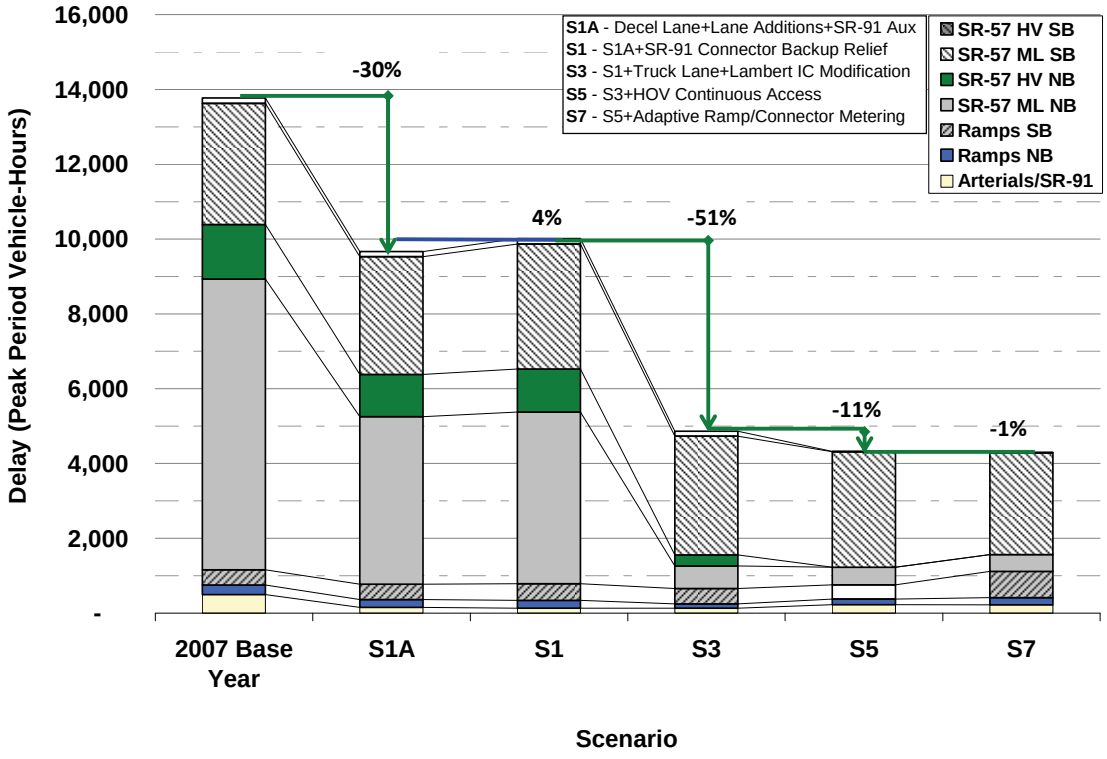


Exhibit ES-24: 2020 AM Peak Micro-Simulation Delay by Scenario

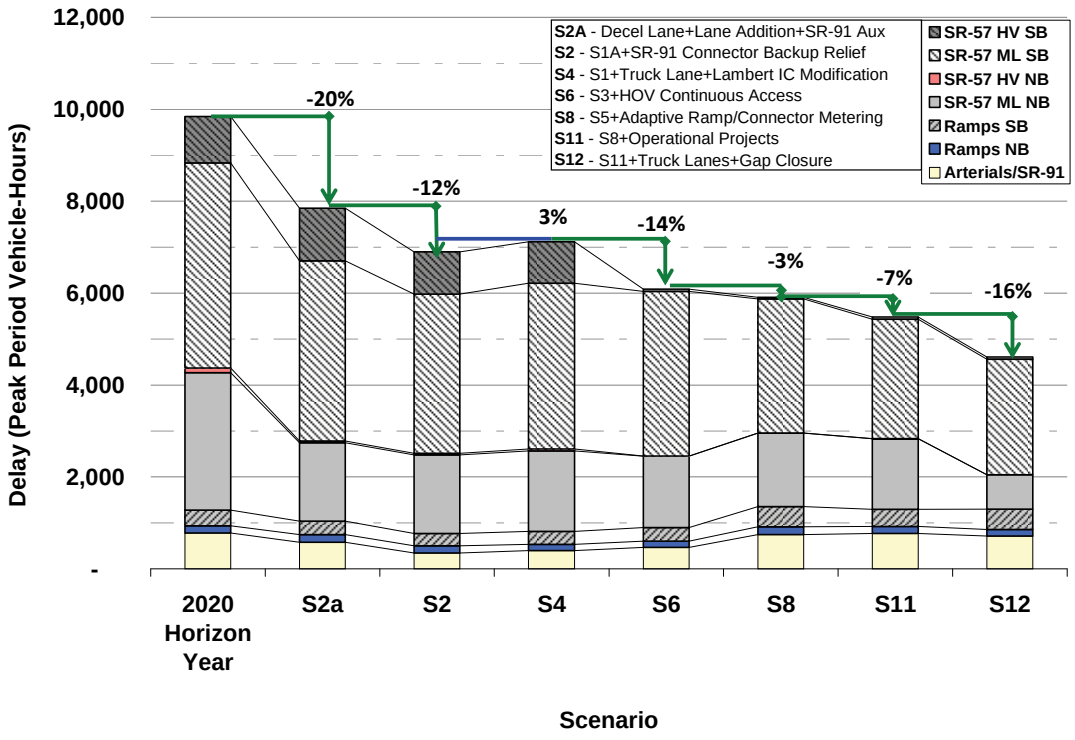
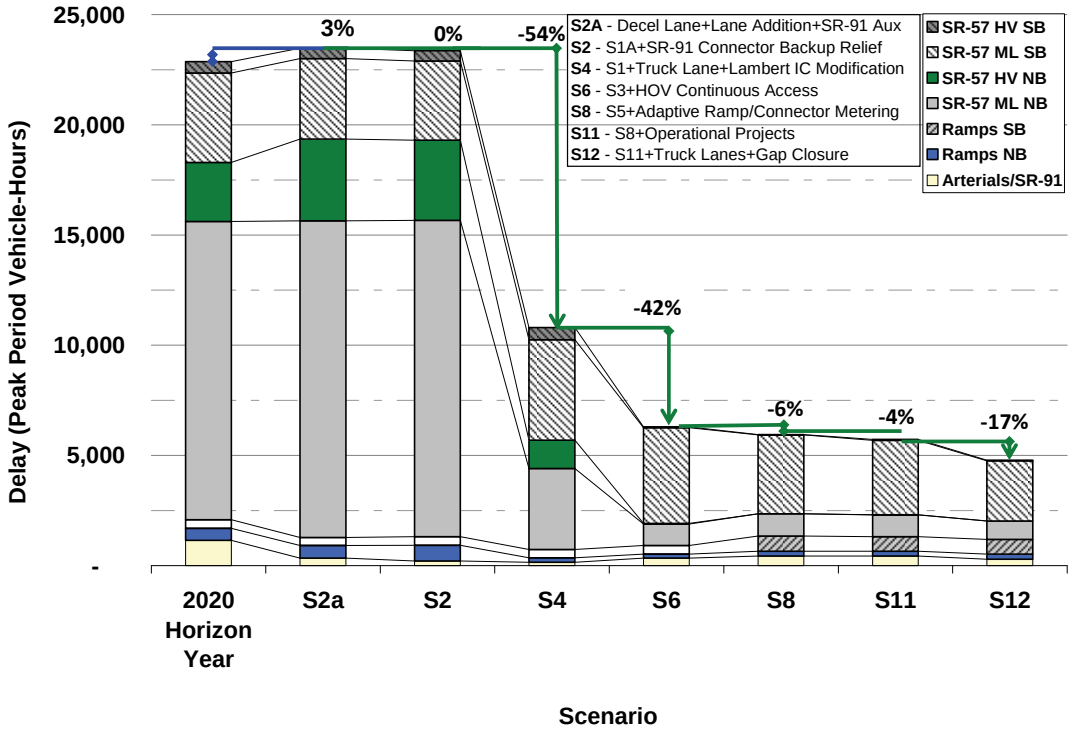


Exhibit ES-25: 2020 PM Peak Micro-Simulation Delay by Scenario



BENEFIT-COST ANALYSIS

Following an in-depth review of model results, the study team performed a benefit-cost analysis (BCA) 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, which estimates 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 B/C greater than 1.0 means that a scenario's projects return greater benefits than it costs 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 a northbound lane from Katella to Lincoln has a high capital construction cost, which reduces the B/C ratio, but brings much higher absolute benefits to SR-57 users. Exhibit ES-26 summarizes the results of the analysis as follows:

- Scenario 1A and Scenario 2A (Deceleration Lane, Lane Additions, SR-91 Aux Lane) produces a medium BC ratio of less than 2:1. This ratio takes into account SR-91 benefits (computed with the SR-91 model).
- Scenario 3 and Scenario 4 (truck climbing lane and Lambert Road interchange modification) produce a high benefit-cost ratio of over 5:1, reflecting the significant delay reductions.
- Scenarios 5 and 6 (continuous access for HOV) produce a very high benefit-cost ratio of over 10.
- Scenarios 7 and 8 (Advanced ramp metering and connector metering) produce a medium to high ratio of over 2:1.
- Scenario 11 (operational projects) produces a ratio of medium to high ratio of over 2:1.
- Scenario 12 (Truck climbing lane, gap closure) produced a medium BC ratio of less than 2:1. While the southbound truck climbing lane produced some delay reductions, the northbound gap closure project produced the biggest benefits. The addition of the second northbound truck climbing lane does not seem to make a significant difference.
- The benefit-cost ratio of the all the scenarios combined is almost 4:1 which is compelling. If all the projects are delivered at current cost estimates, the public will get four dollars of benefits for each dollar expended. In current dollars, costs add up to around $630 million whereas the benefits are estimated to be almost $2.4 billion.
- Finally, the projects also alleviate green house gas (GHG) emissions by over 1.1 million over 20 years, averaging more than 50,000 tons or reductions per year. The emissions are estimated using data from the California Air Resources Board (CARB) EMFAC model.

Exhibit ES-26: 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
1A/2A	Decel Lane + Lane Addition + SR-91 Aux		★★			
3/4	S1/S2 + Truck Lane + Lambert IC Modification				★★★★	
5/6	S3/S4 + HOV Continuous Access					★★★★★
7/8	S5/S6 + Adaptive Ramp/Connector Metering			★★★		
11	S8 + Operational Projects			★★★		
12	S11 + Truck Lanes + Gap Closure		★★			

7. Conclusions and Recommendations

This section summarizes the conclusions and recommendations based on the analysis discussed so far. It is important to note that many of these conclusions are based primarily on the micro-simulation model results. The model was developed based on the best data available at the time. The study team believes that both the calibration and the scenario results are reasonable. However, caution should always be used when making decisions based on modeling alone, especially complex models such as this one. 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.

Based on the results, the study team offers the following conclusions and recommendations:

- Due to the high capital cost of the two expansion projects in Scenarios 1A/1 and 2A/2, the overall benefit-cost is a modest 1.7. However, the long term relief in congestion provided by the combination of all four projects, particularly in the most heavily congested location in the corridor, is needed to improve both the short-term and long-term mobility of the mainline, ramps, and arterials.
- The addition of a northbound truck climbing lane from Lambert Road to the Orange/Los Angeles County Line and the Lambert Road interchange modification project provides significant operational benefits to the mainline by removing heavy truck traffic from the mainline. It complements the aforementioned expansion projects and significantly reduces overall congestion further. These projects are critical for improving the mobility of the corridor. In fact, without them, the Lambert bottleneck will worsen over time and its queue will extend to several miles south of Lambert.
- Operational projects such as adaptive ramp metering with queue control and construction of acceleration lanes, auxiliary lanes, and ramp reconfigurations in the southbound corridor should be considered and evaluated further.
- The addition of a second northbound truck climbing lane does not seem to make a significant improvement in operations of the corridor. However, Caltrans should consider extending the truck climbing lane further north beyond the Orange/Los Angeles County Line to provide for continuous flow into and within the Los Angeles section of the freeway, which also experiences high levels of congestion.
- The benefits of the HOV conversion to a continuous access facility are compelling. Even if the model is overestimating them, this project will improve mobility on the corridor.
- The northbound auxiliary lane from Orangewood to Katella however may not be worth funding as its cost is over $13 million, and it does not lead to any noticeable change in congestion in the project area within the model year 2020. Longer term 2030 and beyond may yield different results.

- The addition of the southbound truck climbing lane and the northbound gap closure (lane addition and interchange modifications from north of Lincoln Avenue to SR-91) would provide congestion relief in the areas that have not previously been addressed. The two northbound expansion projects tested in Scenarios 1A/1 and 2A/2 provided much needed congestion relief in the northbound direction, however, it left a gap between Lincoln and SR-91. It may be worth considering funding the gap closure project closer to the same time as the other two expansion projects so that it would provide better continuity for construction as well as improved operations.

- Finally, enhanced incident management shows promise. The SR-57 experiences up to 1,600 collisions per year. With an average delay savings of nearly 70 vehicle-hours per incident, that would amount to a total annual delay savings of over 110,000 vehicle-hours for the corridor.

This is the first generation CSMP for the SR-57 corridor. It is important to stress that CSMPs should be updated on a regular basis. 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 results in this document so models can be further improved.

CSMPs, or a variation thereof, should become the normal course of business that is based on 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 the productivity of the current system.

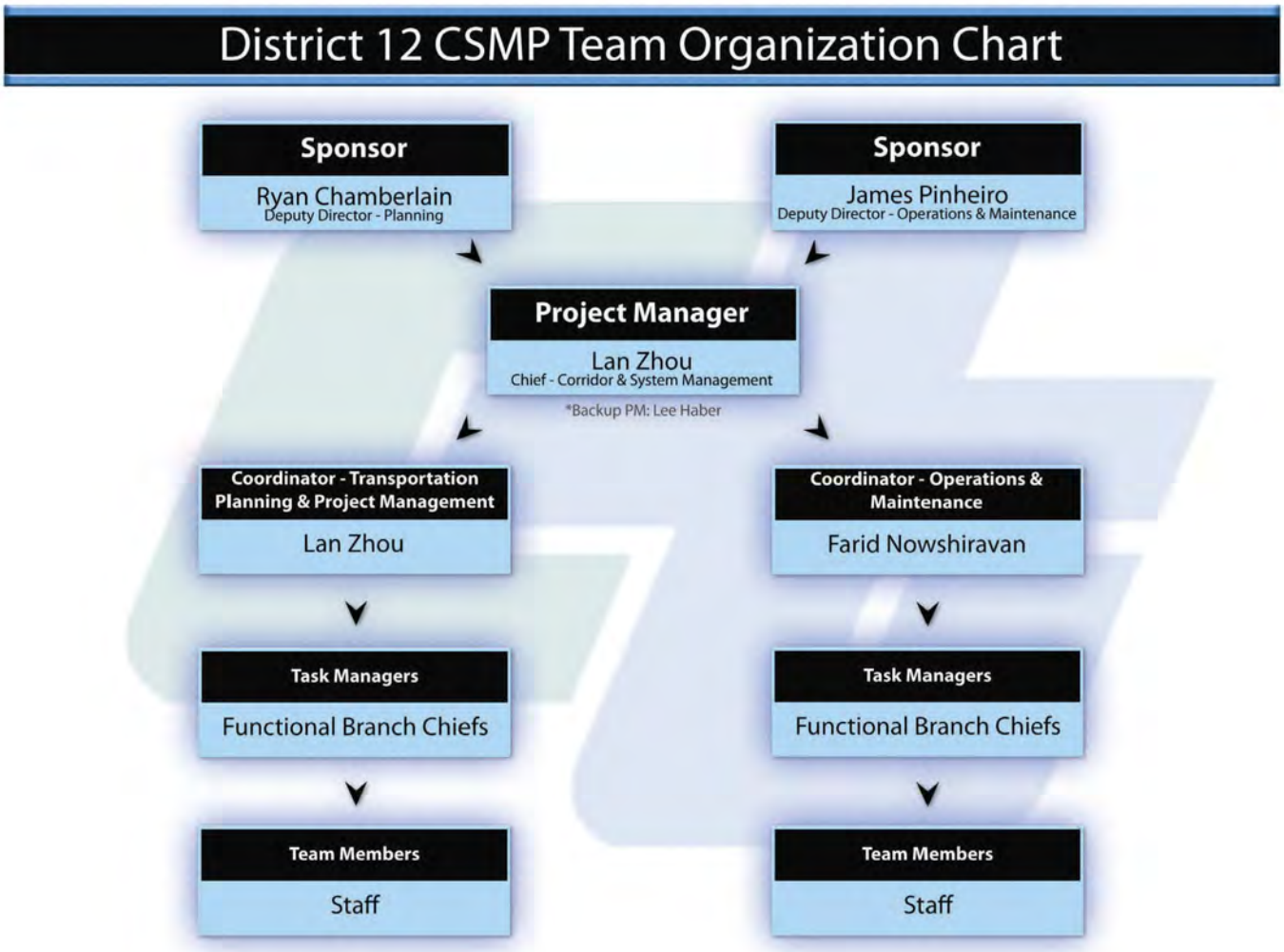



Exhibit ES-27: District 12 CSMP Team Organization Chart