Interstate 5

Corridor System Management Plan

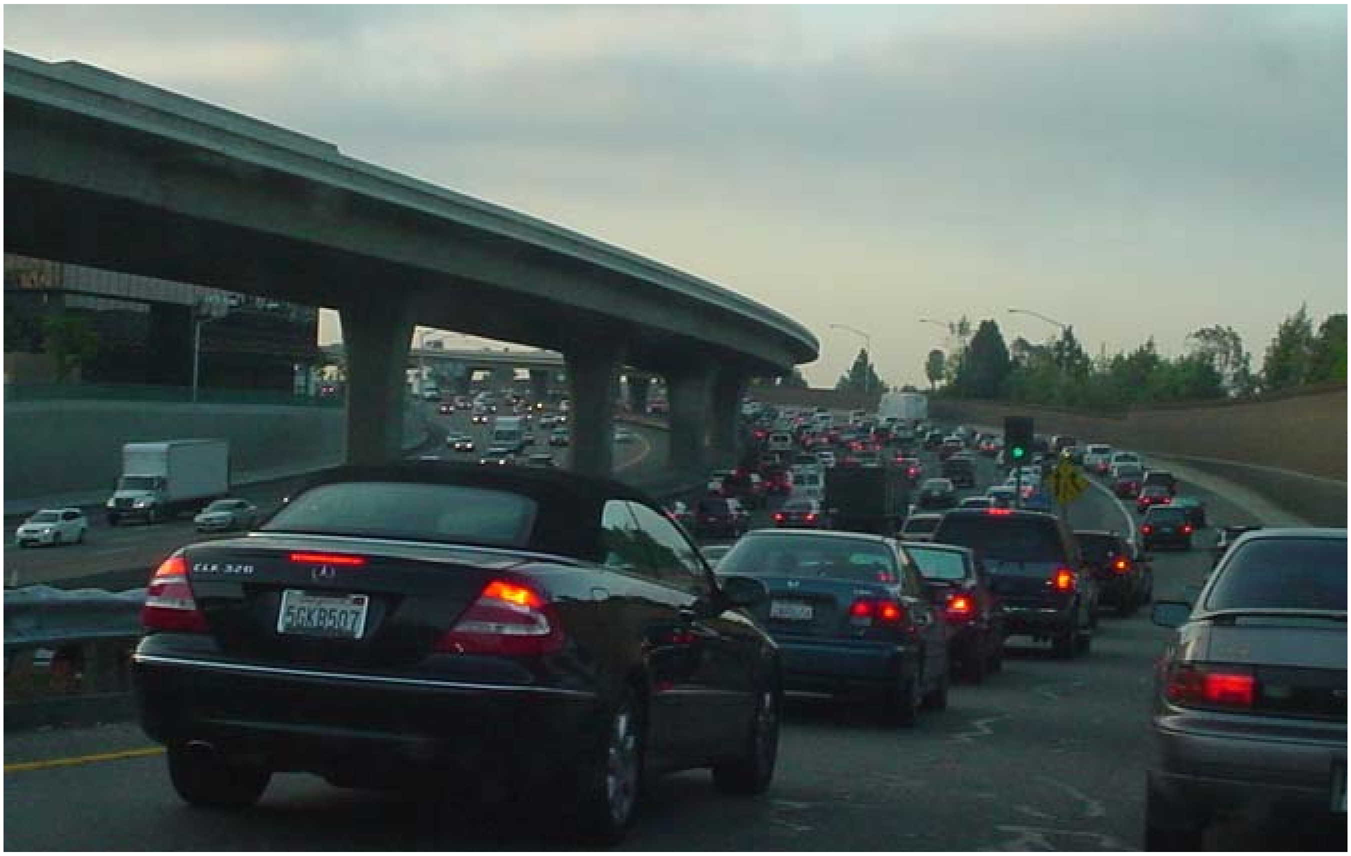
May 2012

csmp

CALTRANS DISTRICT 12

corridor system management plans

Caltrans



Corridor System Management Plan
Interstate 5 (Orange County)

Executive Summary

Caltrans District 12

Interstate 5

Corridor System Management Plan

APPROVED BY:

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5/29/2012
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LIST OF EXHIBITS

1. Introduction

This document represents the Executive Summary for the Orange County Interstate 5 (I-5) Corridor System Management Plan (CSMP) developed on behalf of the California Department of Transportation (Caltrans) by System Metrics Group, Inc. A more detailed technical CSMP is available upon request.

A CSMP defines how corridors will be managed over time, focusing on operational strategies in addition to the already funded expansion projects for the corridor. CSMPs include performance assessments of existing conditions and identification of corridor bottlenecks and causality. It also includes development of micro-simulation models that test short-term and medium– to long-term project scenarios with detailed benefit-cost assessments to determine the return on investment for each scenario. The goal of system management is to get the most out of the existing system and to maintain or improve corridor performance.

This Executive Summary and technical CSMP represent the results of a study that included several key steps:

- Corridor Performance Assessment
- Bottleneck Identification and Causality Analysis

- Scenario Development and Analysis
- Conclusions and Recommendations.

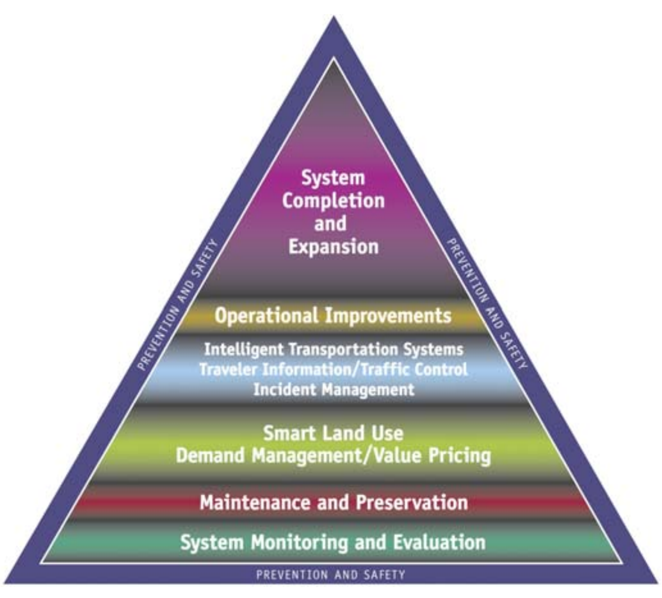
Each of these steps are highlighted in later sections of this Executive Summary.

2. Background

Orange County's transportation system faces numerous challenges — the demand for travel 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 this 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 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 to complement traditional system expansion investments. All of these strategies build on a strong foundation of system monitoring and evaluation.

The I-5 CSMP defines 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 2010 Base Year model for the I-5 corridor. This model was calibrated using California and Federal Highway Administration (FHWA) guidelines. Following approval of the 2010 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 agreed to use 2020 as the Horizon Year since micro-simulation models are best suited for short- to medium-term forecasting. Note that latent demand over and beyond the Orange County Transportation Authority (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 a first generation CSMP, this report is more focused 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. Corridor Performance Assessment

This section briefly describes the I-5 corridor and summarizes the results of the comprehensive corridor performance assessment conducted as the first step in this study.

CORRIDOR DESCRIPTION

Exhibit ES-2 shows the Orange County I-5 CSMP corridor. The study corridor covers the entire length of the county from the San Diego County Line (PM 0.0) in the south to the Los Angeles County Line (PM 44.38) in the north. The I-5 corridor passes through the cities of San Clemente, Dana Point, San Juan Capistrano, Mission Viejo, Laguna Hills, Irvine, Tustin, Santa Ana, Orange, Anaheim, Fullerton, and Buena Park. It includes nine major freeway-to-freeway interchanges at SR-1, SR-22, SR-55, SR-57, SR-73, SR-74, SR-91, SR-133, and I-405.

I-5 is an eight to sixteen-lane freeway with a concrete median barrier that separates northbound and southbound traffic. 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 High Occupancy Vehicle (HOV) lane in both directions of the corridor from SR-1/Camino Las Ramblas at the south end to the Los Angeles County Line at the north end. Most of the HOV facility is buffer-separated with limited points of ingress/egress with the exception of the northbound segment from Tustin Ranch to Redhill Avenue, which has continuous HOV access. There are HOV direct connectors linking the I-5 HOV facility with the SR-55, SR-57, and SR-91 HOV facilities.

According to the Caltrans Traffic and Vehicle Data Systems Annual Traffic Volumes Report for 2009, Orange County I-5 carries between 88,000 and 347,000 annual average daily traffic (AADT). The highest average daily traffic volume occurs near 17th Street in Santa Ana, just south of the SR-22 interchange.

As a key route that links Mexico with the largest cities on the west coast, I-5 carries a relatively high volume of trucks. It is designated a Surface Transportation Assistance Act (STAA) route, which means that trucks are allowed to operate on the corridor. According to the latest truck volumes from the 2009 Caltrans Annual Average Daily Truck Traffic data, trucks comprise between three and ten percent of total daily traffic along the corridor. Truck volumes are higher at the north end of the corridor, approaching the Los Angeles County Line.

Three major transit operators provide service on or near I-5: Southern California Regional Rail Authority (SCRRA) commonly known as Metrolink, Amtrak Pacific Surfliner and Southwest Chief train service, and OCTA.

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: the Orange County Line which provides service from Los Angeles Union Station to Oceanside, the Inland Empire-Orange County line which provides service from San Bernardino to Oceanside, and the SR-91 Line which provides service from Riverside to Los Angeles Union Station via Fullerton and Buena Park.

While Metrolink provides intra-regional service throughout Southern California, Amtrak provides interregional service. Two Amtrak trains use the same route as Metrolink's trains. Amtrak's Pacific Surfliner, which offers service from San Diego to San Luis Obispo, travels along the same route as Metrolink's

Exhibit ES-2: Orange County I-5 CSMP Corridor Map

Southwest Chief, which offers service from Los Angeles to Chicago, travels along the same route as Metrolink's Inland Empire-Orange County Line.

In addition, OCTA provides fixed-route bus and paratransit services throughout the county, operating several local and express routes along the study corridor: Route 206, Route 464, and Route 758.

Intermodal facilities such as the Fullerton Municipal Airport and John Wayne Airport, along with many park and ride facilities serve the Orange County area near the I-5 study corridor. The corridor has high HOV lane usage with average vehicle occupancy rates (AVO) up to 3.36 persons per vehicle at the Disney Way exit.

Several major special event facilities generate significant trips along the I-5 corridor including the Disneyland Resort and Theme Park; "Angels Stadium of Anaheim," home of the Los Angeles Angels professional baseball team; the "Honda Center" arena, home to the Anaheim Ducks professional hockey team; and the Orange County Great Park which serves as a park with a Farmers Market and special events activities.

Other major trip generators located within close proximity to the I-5 corridor include universities/ colleges, medical facilities, and shopping centers. Universities and colleges include: Cal State University Fullerton, Santa Ana College, Irvine Valley College, University of California at Irvine, and Saddleback College.; medical facilities include: UC Irvine Medical Center, St. Joseph Hospital, The Children's Hospital of Orange County, Saddleback Memorial Medical Center Laguna Hills and San Clemente, Mission Hospital Regional Medical Center, Kaiser Irvine Medical Center, and Hoag Memorial Hospital Presbyterian. Shopping centers include: Westfield MainPlace, The Block at Orange, Irvine Spectrum Center, Tustin Marketplace, The Laguna Hills Mall, and the Shops at Mission Viejo.

CORRIDOR PERFORMANCE ASSESSMENT

The I-5 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 automatic detection data and forecasted using macro or micro models. The Performance Measurement System (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 that are used to estimate speed, delay and travel time.

Delay

Delay is defined as the observed travel time less the travel time under non-congested conditions at 60 miles per hour (mph) and is reported as vehicle-hours of delay. Exhibit ES-3 shows the average weekday daily vehicle-hours of delay for each month between 2008 and 2010 for both mainline (ML) and HOV lanes. These trends exclude weekends and holidays. This exhibit reveals the following:

- As expected, the mainline 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 also experience congestion, but slightly more in the southbound direction than in the northbound direction.
- For both mainline and HOV facilities, delay decreased from 2008 to 2009 but increased from 2009 to 2010.
- Delay was greatest in the PM peak for both the mainline and HOV facility.

Delay can be segmented into two components. *Severe delay* is delay that occurs when speeds are below 35 mph and *other delay* 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 cause temporary slowdowns. However, it can also 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 these exhibits:

- Severe delay makes up about 78 percent and 83 percent of all weekday delay on the corridor for the mainline and HOV facilities, respectively.
- On both the mainline and HOV facilities, Fridays in the northbound direction experienced the highest and most severe delays. In 2010, Fridays in the northbound direction experienced over 10,500 vehicle-hours of delay with over 8,300 vehicle-hours of "severe" delay.

Exhibit ES-3: Average Weekday Delay by Month (2008-2010)

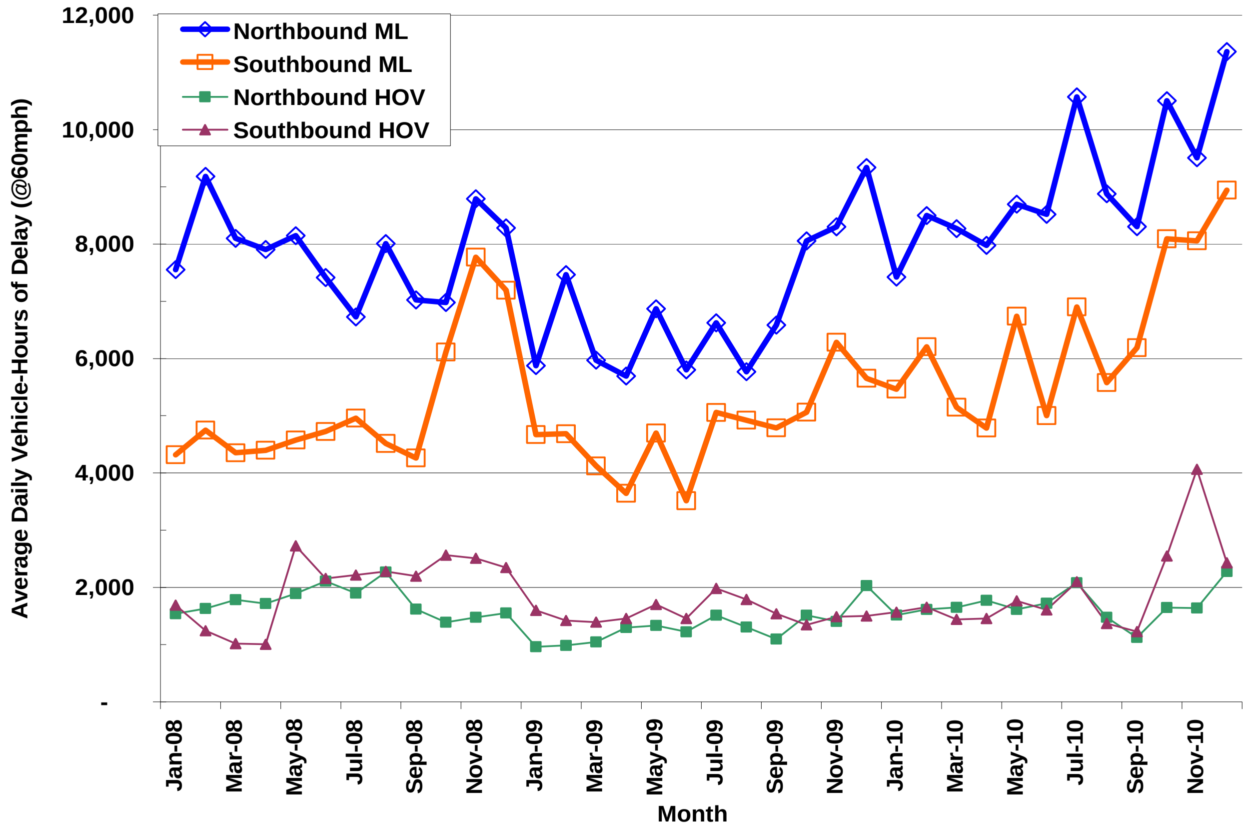


Exhibit ES-4: Mainline Lanes Delay by Day of Week (2008-2010)

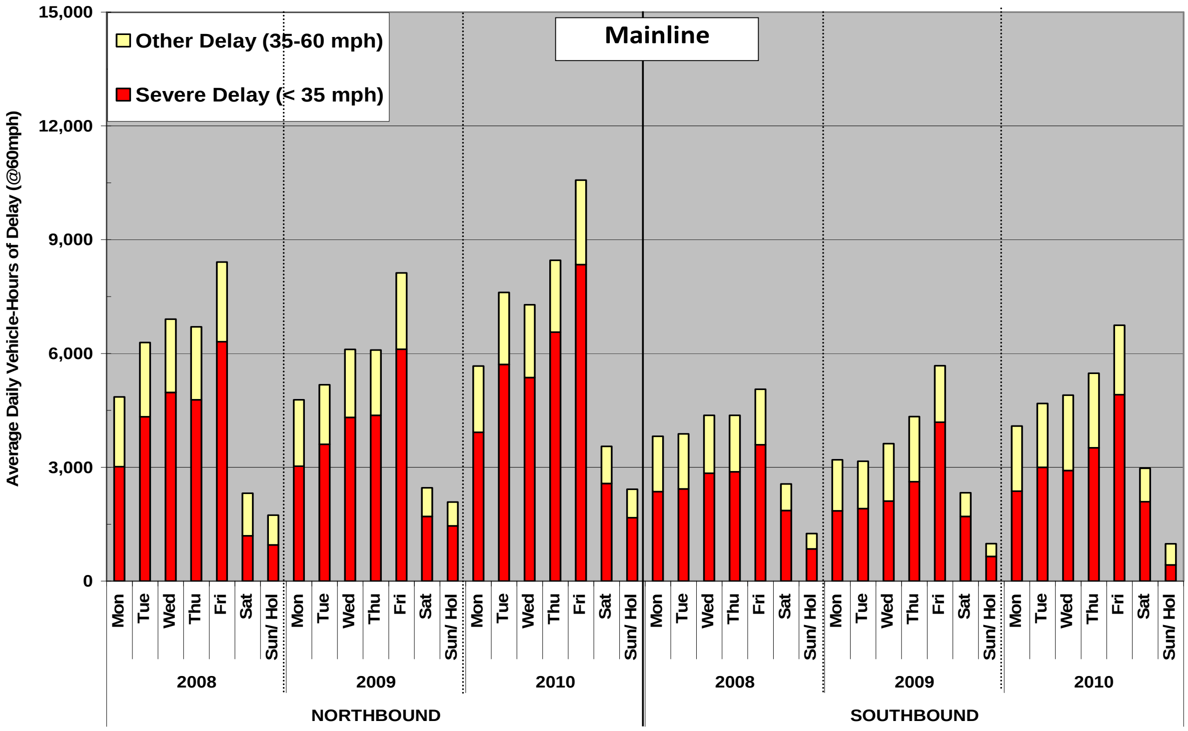
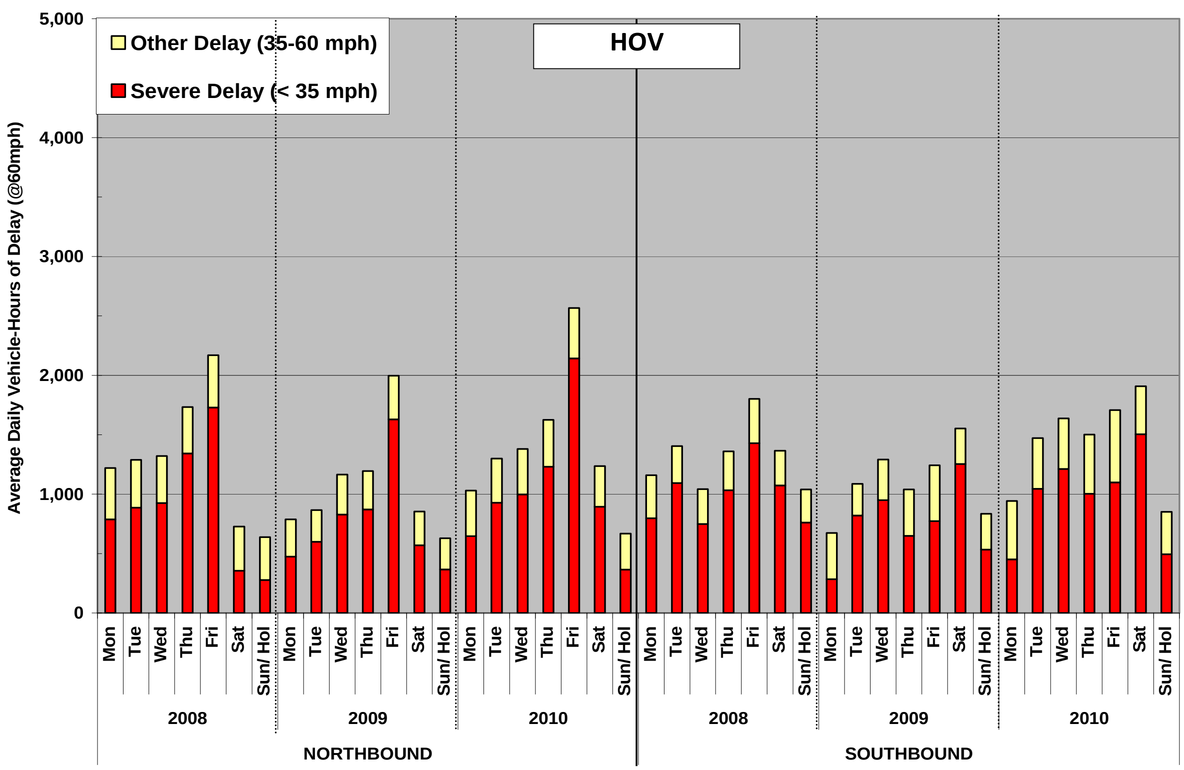


Exhibit ES-5: HOV Lanes Delay by Day of Week (2008-2010)



Exhibits ES-6 and ES-7 summarize average annual weekday delay by hour of the day for the mainline facility for the northbound and southbound directions, respectively. Exhibits ES-8 and ES-9 summarize delays for the HOV facility. This data allows planners and decision makers to understand trends in peak period delay spiking and peak period spreading. A few notes on these four exhibits:

- The PM peak period in the northbound direction has almost twice the congestion of other periods and directions.
- The AM peak period delay spike occurs between 7:00 and 8:00 AM, and the PM peak hour is at 5:00 PM. This is typical for an urban corridor serving a large number of work trips during the peak period.
- The duration of congestion on the mainline is much longer during the PM peak period, starting around 2:00 PM and lasting until 7:00 PM. In contrast, the AM peak period starts from approximately 6:30 AM until 9:00 AM.
- The mainline peak period congestion in 2010 was highest, followed by 2008, then 2009. In 2010, the northbound mainline PM peak hour congestion was over 1,700 vehicle-hours, an increase of over 30 percent and 25 percent over 2009 and 2008 PM peak hour delays, respectively.
- On the HOV facility, the northbound direction PM peak period experienced the highest amount of congestion, with over 300 vehicle-hours of delay at 5:00 PM in 2010 .

Travel Time

The travel time performance measure represents the average time it takes for a vehicle to travel between the San Diego County Line and the Los Angeles County Line and vice versa (over 44 miles).

Exhibits ES-10 and ES-11 summarize estimated average annual travel times for the corridor by hour of day for the years 2008-2010. Similar to delay trends, travel times were highest in 2010 compared to the prior two years. As shown in Exhibit ES-10, the northbound direction of the mainline had travel times ranging from 55 to 60 minutes during the PM peak hour. During the 5:00 PM peak hour, travel times in the northbound direction decreased slightly from 57 minutes in 2008 to 55 minutes in 2009, and then increased to 60 minutes in 2010. As shown in Exhibit ES-11, the southbound direction had travel times of approximately 47 to 51 minutes during the 8:00 AM peak hour. The PM peak hour at 5:00 PM also had similar travel times ranging from 49 to 51 minutes. Again, travel times decreased from 2008 to 2009, and increased from 2009 to 2010.

Exhibit ES-6: Northbound Mainline Lanes Hourly Delay (2008-2010)

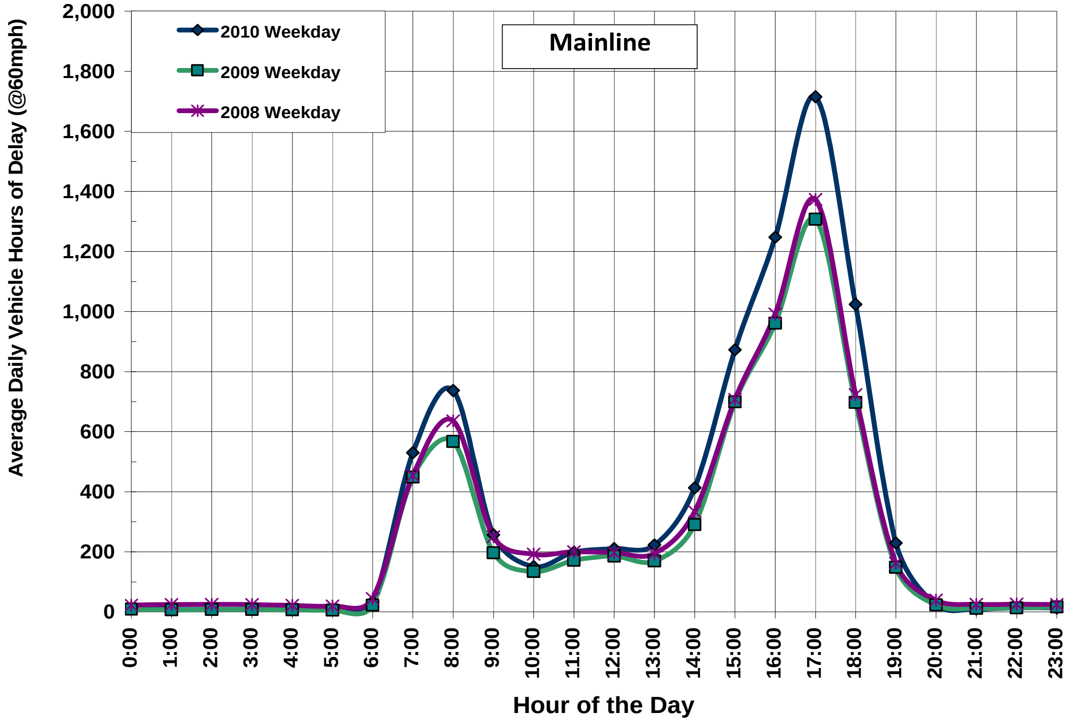


Exhibit ES-7: Southbound Mainline Lanes Hourly Delay (2008-2010)

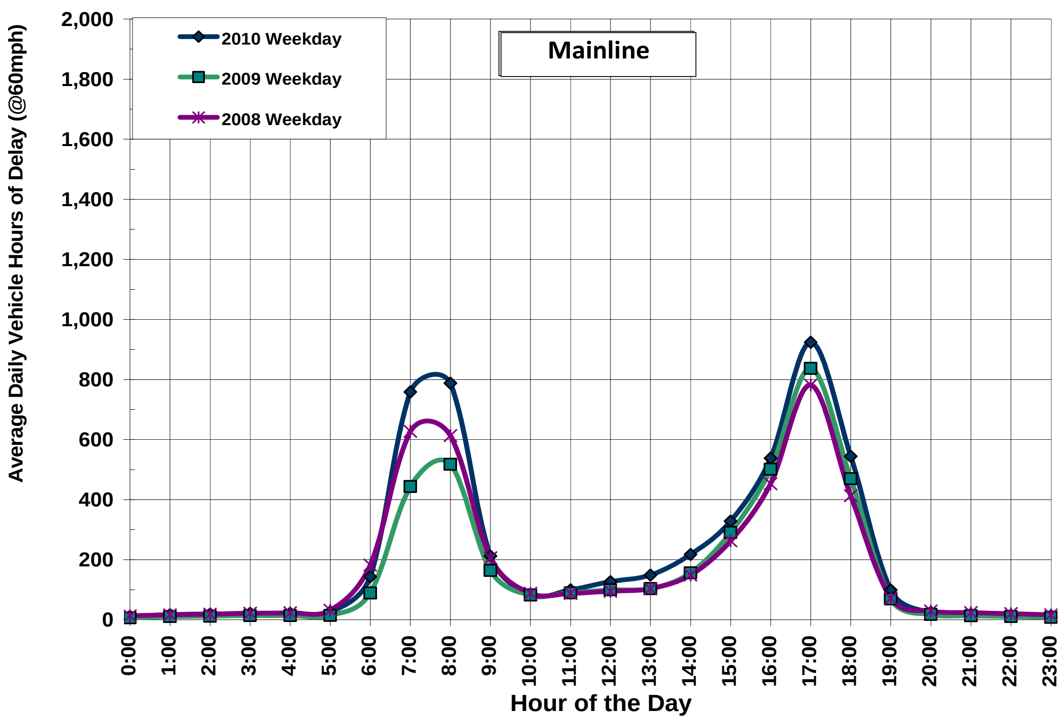


Exhibit ES-8: Northbound HOV Lanes Hourly Delay (2008-2010)

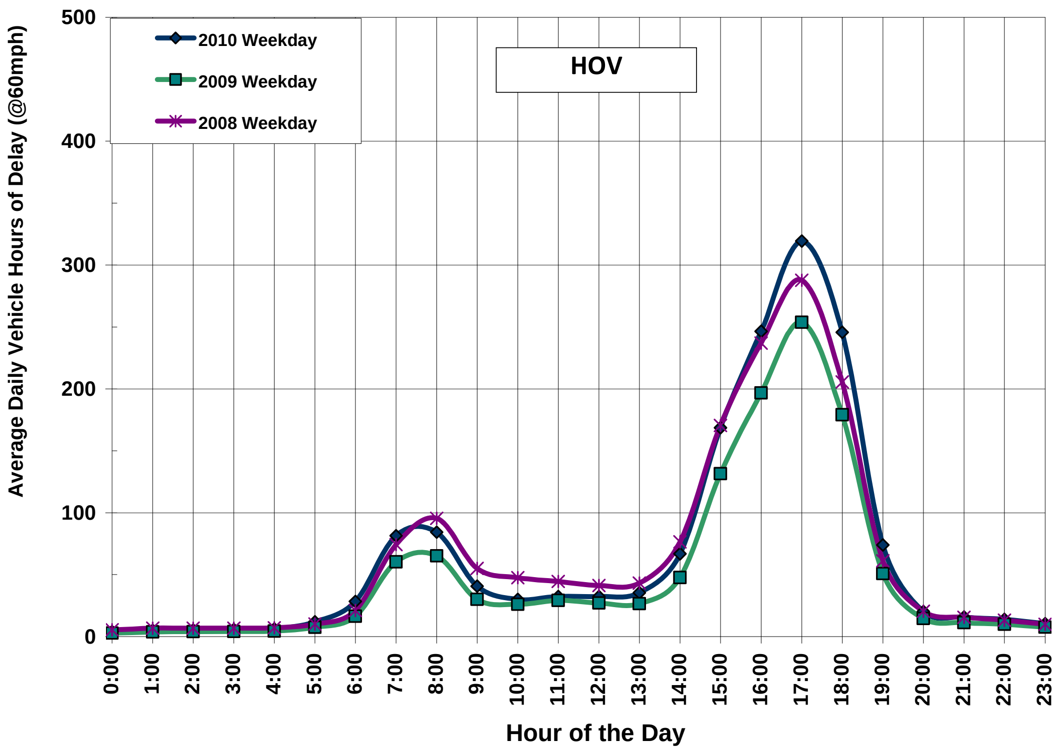


Exhibit ES-9: Southbound HOV Lanes Hourly Delay (2008-2010)

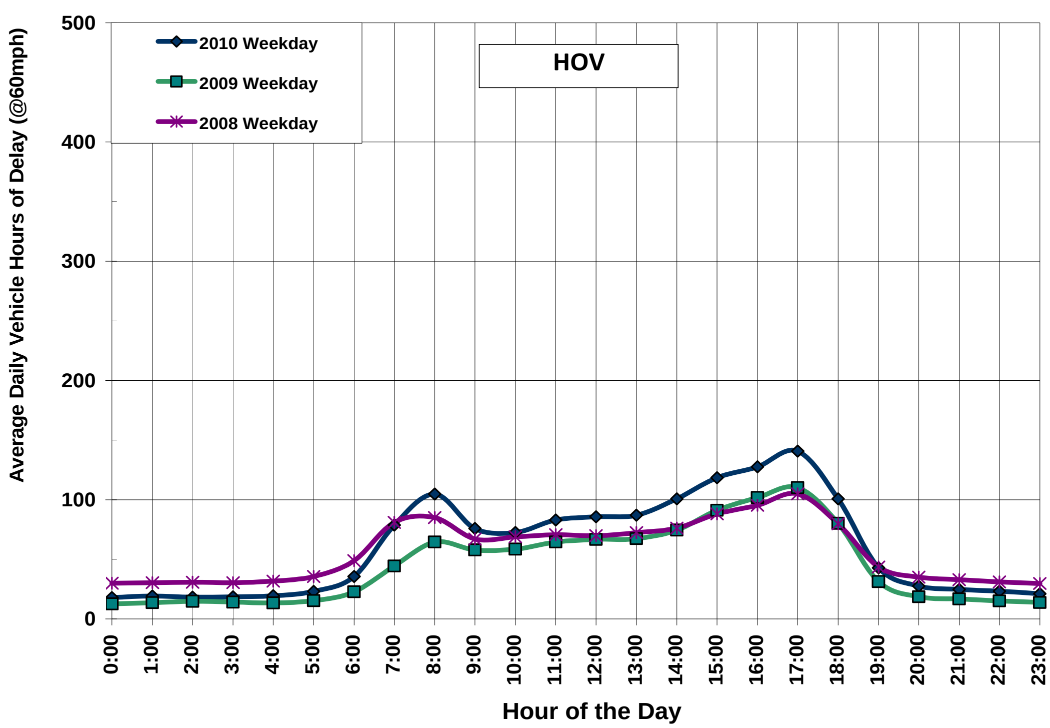


Exhibit ES-10: Northbound Mainline Lanes Travel Time by Hour (2008-2010)

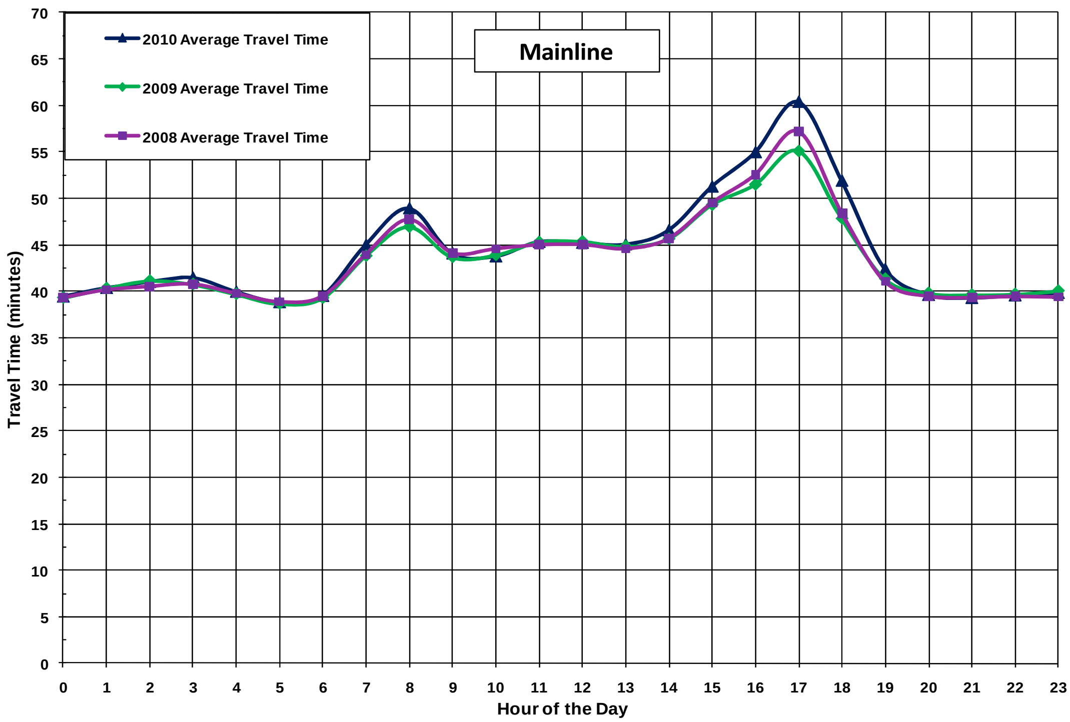


Exhibit ES-11: Southbound Mainline Lanes Travel Time by Hour (2008-2010)

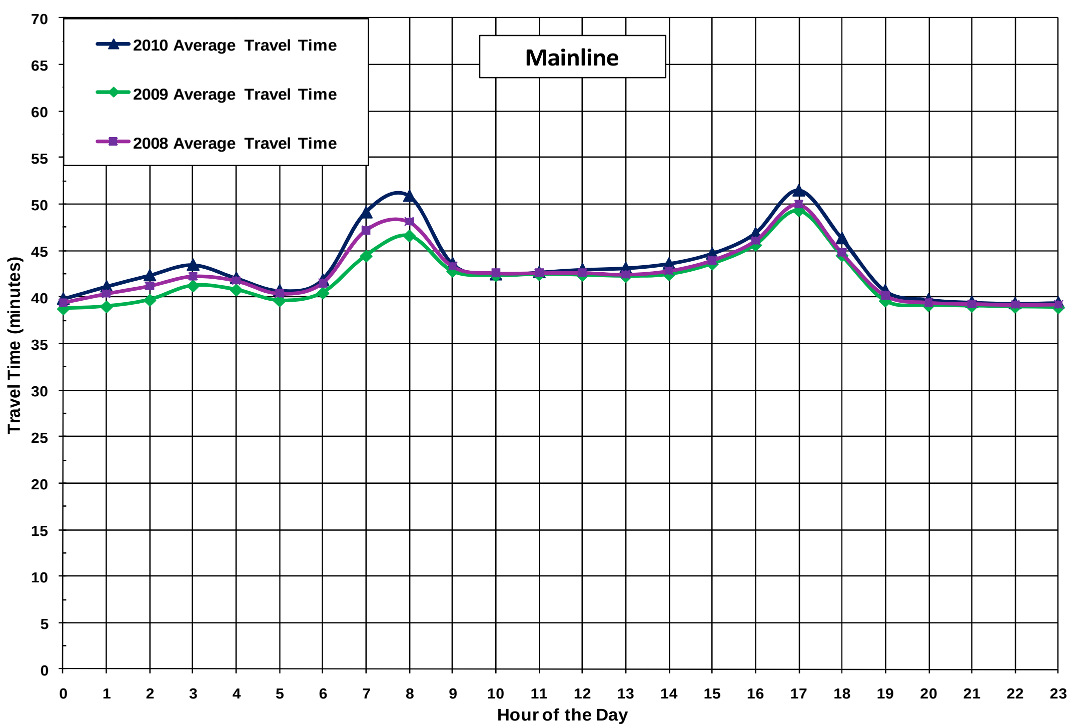


Exhibit ES-12: Northbound HOV Lanes Travel Time by Hour (2008-2010)

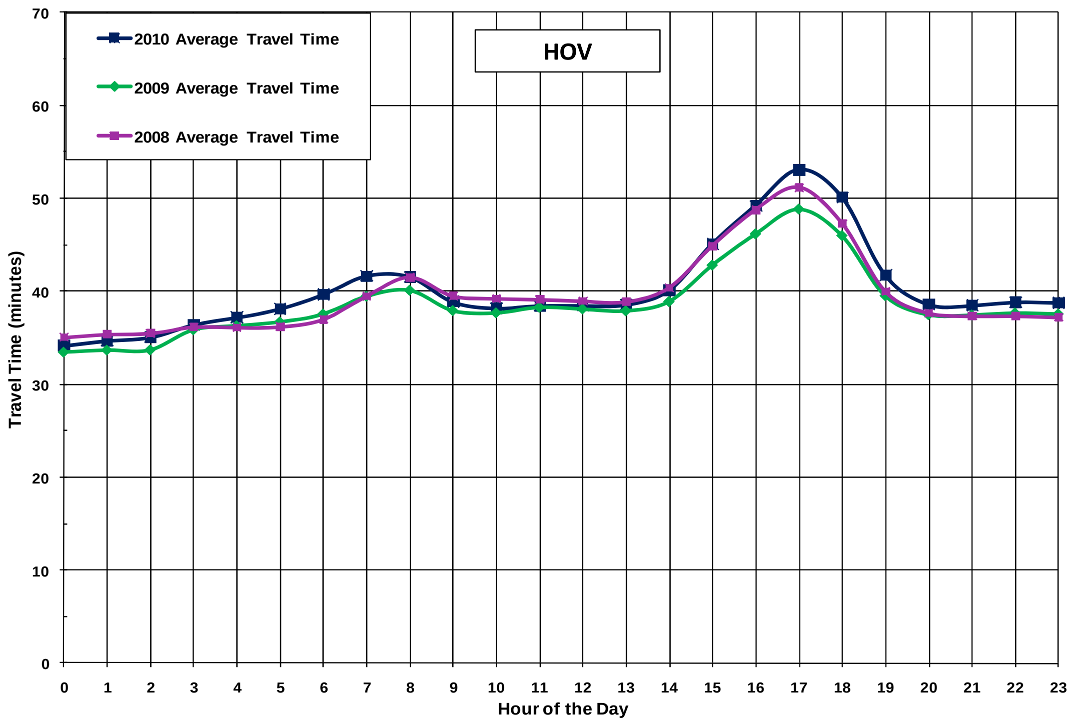
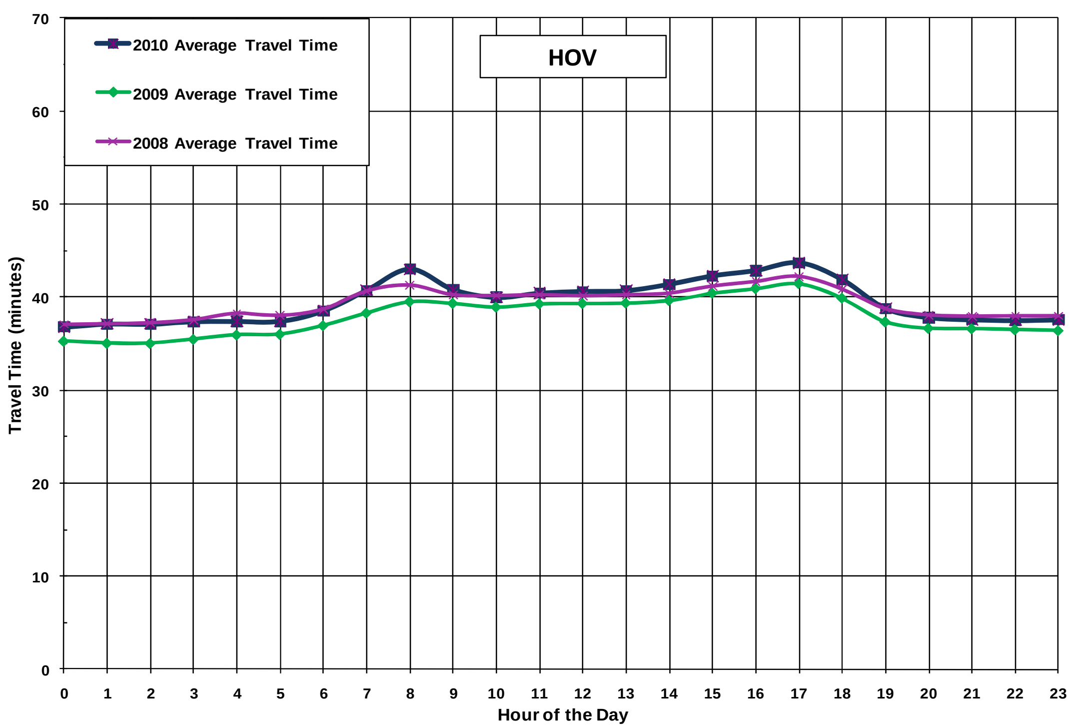


Exhibit ES-13: Southbound HOV Lanes Travel Time by Hour (2008-2010)



To travel the entire 38 miles of the HOV facility, it takes 38 minutes traveling at 60 mph. As shown in Exhibit ES-12, the northbound direction had typical travel times of approximately 49 to 53 minutes during the PM peak period. This is slightly higher than the typical travel times of 47 to 51 minutes for the mainline facility within the HOV limits. For both facilities, travel times during the 5:00 PM hour slightly decreased from 2008 to 2009 and increased from 2009 to 2010. The same trend can be seen in the southbound direction of the HOV facility (as shown in Exhibit ES-13) and in the mainline facility within the HOV limits. Overall, 2010 experienced the highest travel times from 2008 through 2010 in both the northbound and southbound directions.

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 following exhibits illustrate travel time variability along the I-5 Corridor on non-holiday weekdays for 2010. The main report shows the buffer index for the additional years (2008-2009) for both the mainline and HOV facilities, but this Executive Summary reports only the data for the 2010 mainline since that year was used as the base year for modeling.

The following observations on the reliability results are worth noting in respect to the mainline facility:

- In 2010 in the northbound direction of the mainline facility, 5:00 PM had the highest estimated average travel time at approximately 60 minutes and the highest estimated buffer index time of 19 minutes for a buffer index of 30 percent. In other words, to arrive on time 95 percent of the time, a commuter would need to leave for work 79 minutes before the start time to travel the entire length of the I-5 Corridor.

- In the southbound direction of the mainline facility, travel time variability was 68 minutes at 7:30 AM and 65 minutes at 5:00 PM hour from the average travel time of 51 minutes with an estimated buffer index of 30 percent.

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-14: Northbound Mainline Lanes Travel Time Variability (2010)

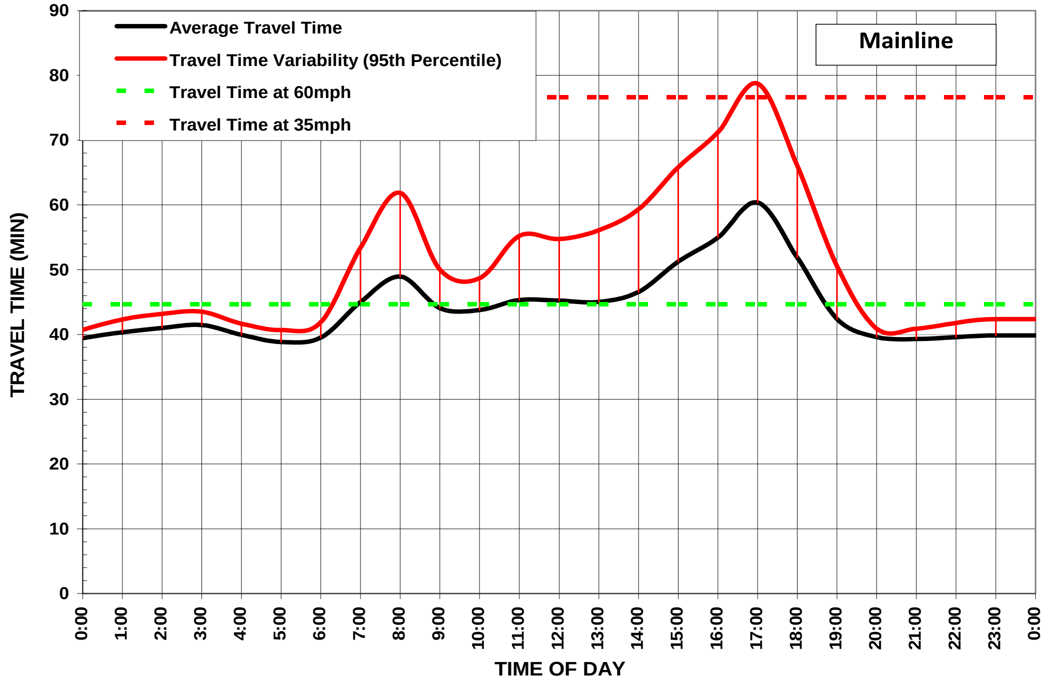
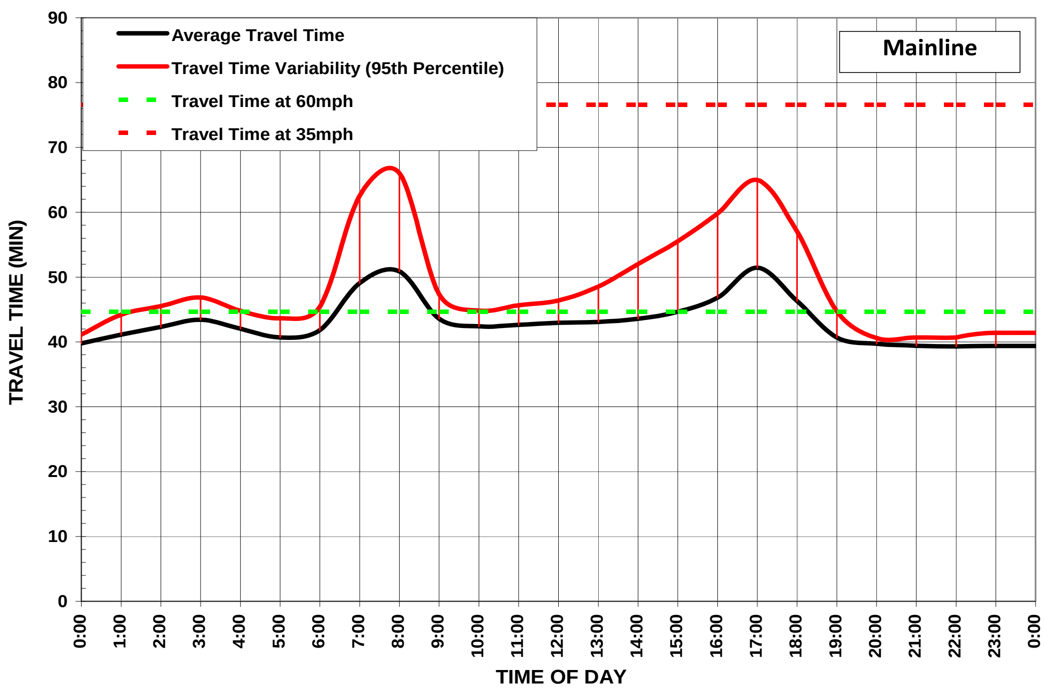


Exhibit ES-15: Southbound Mainline Lanes Travel Time Variability (2010)



Safety

The performance measures to assess safety are 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 on 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-16 and ES-17 show the I-5 Corridor 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, 2007 through December 31, 2009.

As indicated in Exhibit ES-16, the number of northbound accidents increased from approximately 1,960 in 2007 to 2,070 in 2008 but decreased to 1,850 in 2009. In the southbound direction, accidents decreased annually during the three-year period (from 1,800 in 2007, to 1,700 in 2008, and 1,650 in 2009). The northbound direction outnumbered the southbound direction in the number of accidents during all three years. Rear end accidents comprise over 50 percent of all accidents for each of the three years, followed by 20 percent sideswipes, and 20 percent hit objects. Primary collision factors were speeding, other violations, and improper turns. The high percentage of rear end accidents are generally associated with congested conditions.

Exhibit ES-16: Northbound Monthly Accidents (2007-2009)

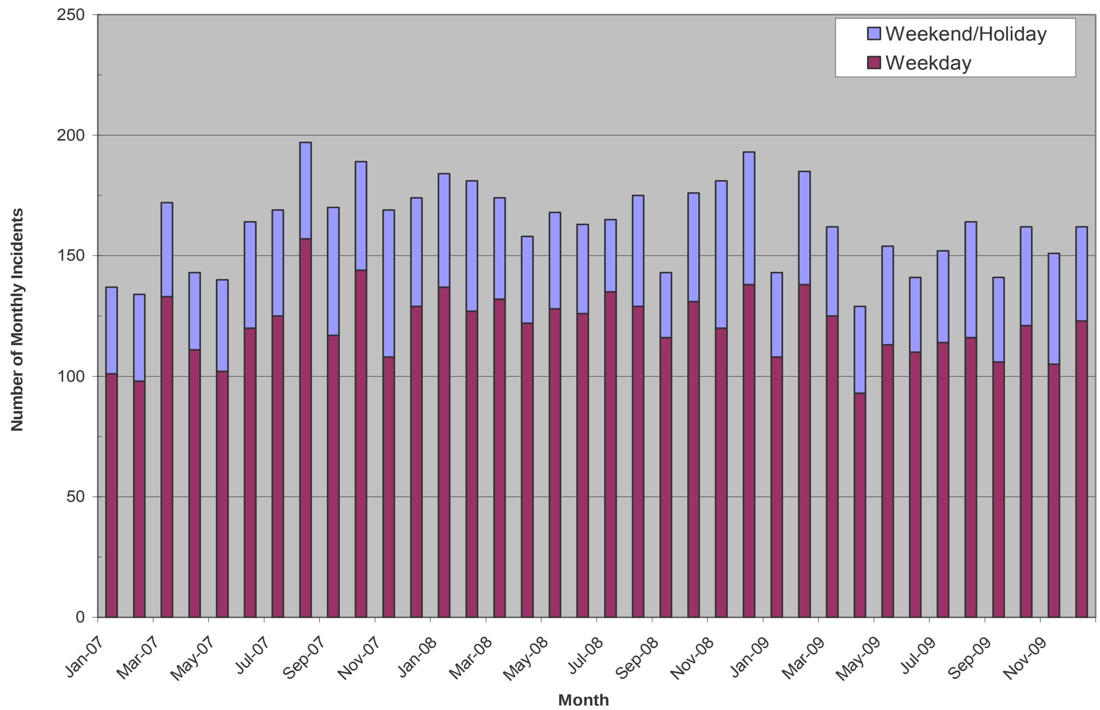
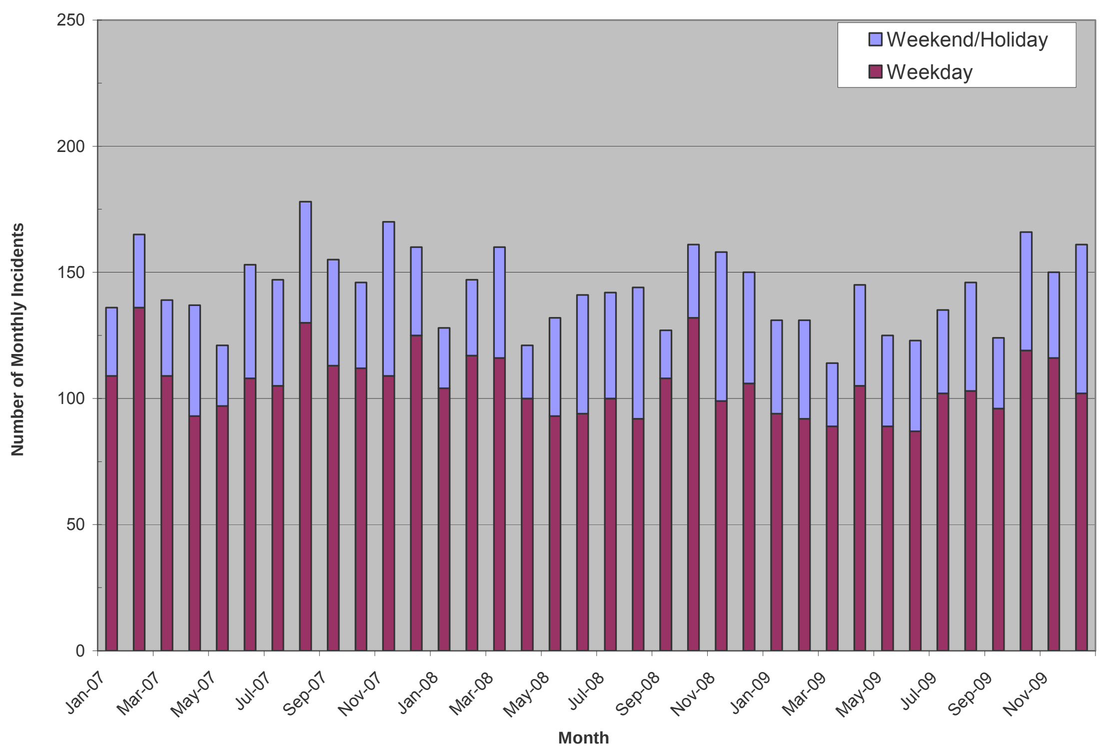


Exhibit ES-17: Southbound Monthly Accidents (2007-2009)



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-18 illustrates how congestion leads to lost productivity. The exhibit was created using observed I-5 data from a non-holiday weekday in October 2010 from detection data. It shows speeds (red line) and flow rates (blue line) on northbound I-5 at the SR-55 interchange, a highly congested location on the corridor. As traffic flow increases to the capacity limits of a roadway, speeds decline rapidly and throughput drops dramatically. The loss in throughput is the lost productivity of the system, expressed in "equivalent lost lane-miles."

Exhibit ES-19 summarizes the productivity losses on the mainline from 2008 to 2010. The largest productivity losses occurred during the PM peak hours in the northbound direction (as noted by the taller blue shaded bars), which is the time period and direction that experienced the most congestion or delay. During the PM peak in 2010, the northbound direction lost over eight equivalent lane-miles, which is an increase from the prior years. The southbound direction of the mainline (aqua shaded bars) also experienced significant productivity losses during the PM peak, but experienced the highest loss in productivity during the AM peak in 2010.

Exhibit ES-20 summarizes the productivity losses on the HOV facility during the same period. Again, the northbound direction shows the greatest productivity losses during the PM peak period.

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

Exhibit ES-18: Lost Productivity Illustrative Example

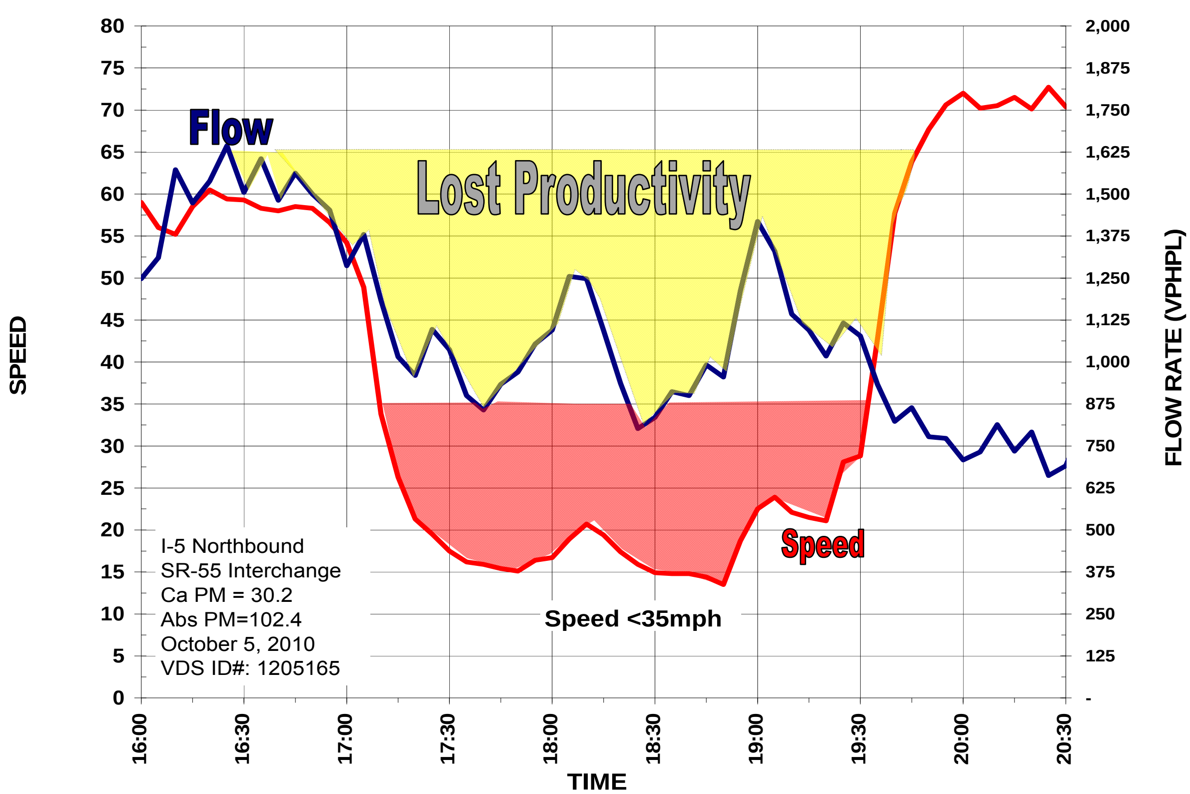


Exhibit ES-19: Mainline Lost Lane-Miles by Direction and Period (2008-2010)

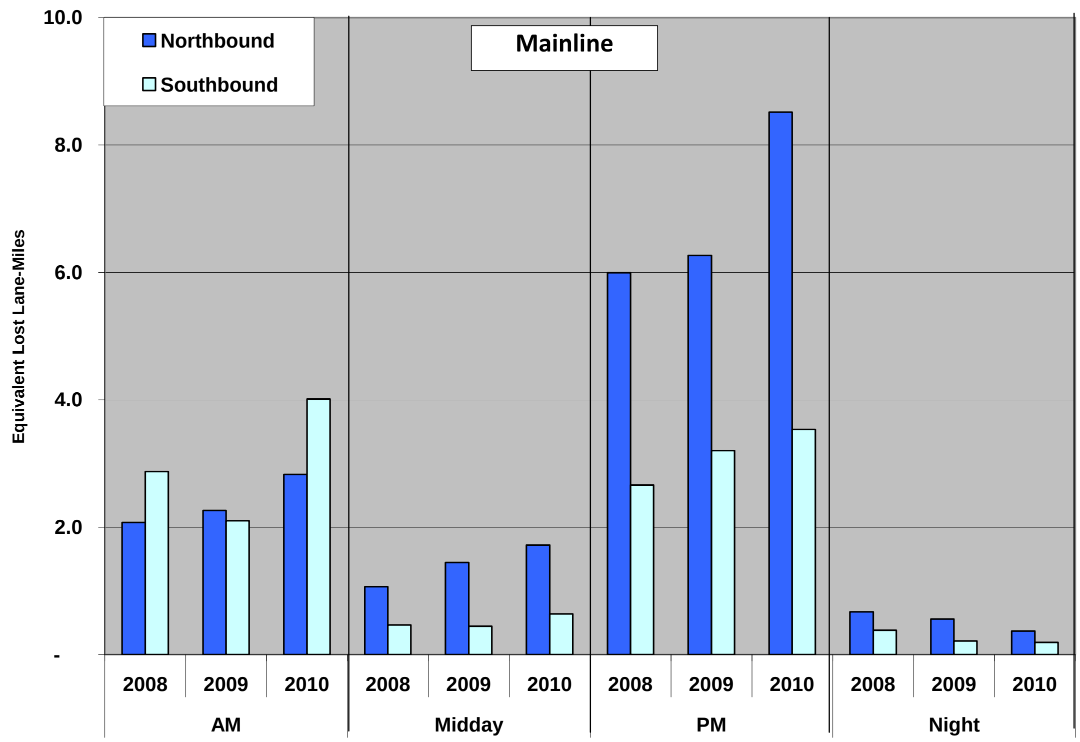
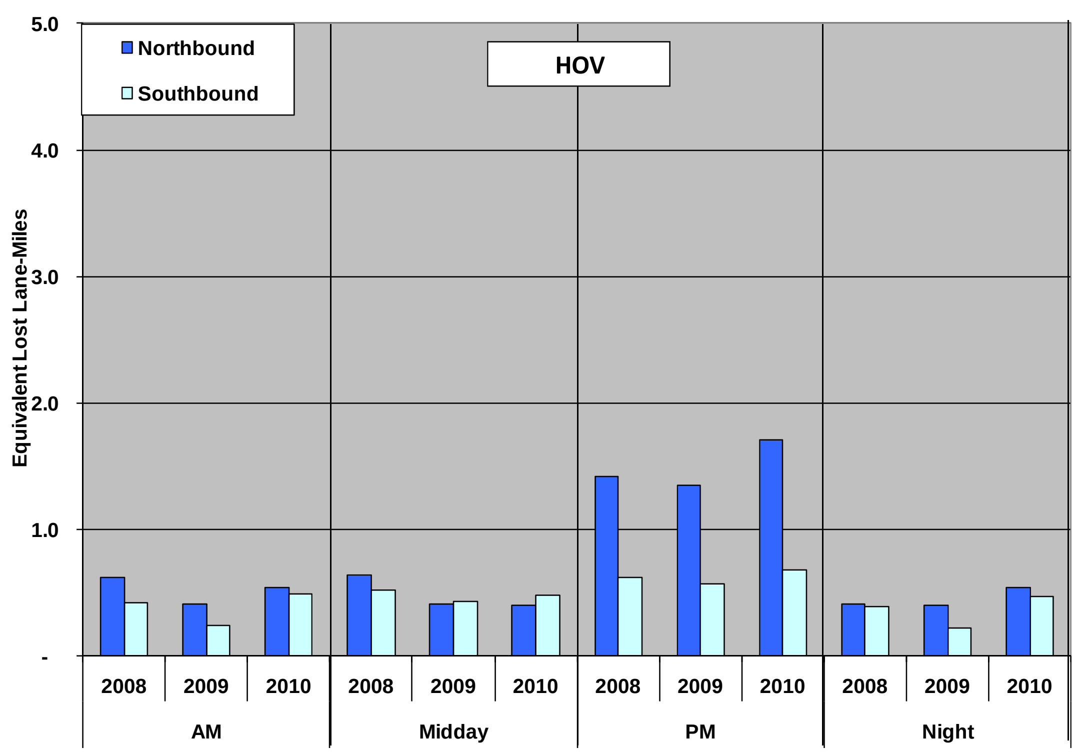


Exhibit ES-20: HOV Lost Lane-Miles by Direction and Period (2008-2010)

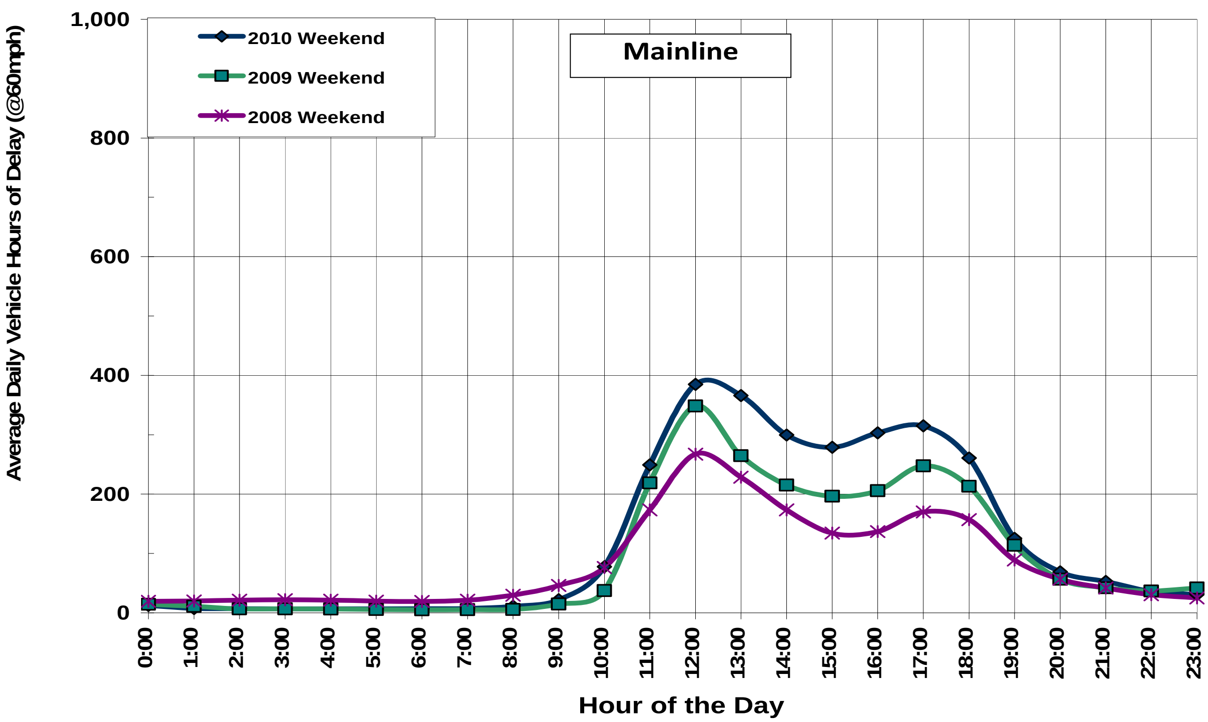


Weekend Performance Measures Summary

A weekend performance assessment was also conducted for the three-year period (2008-2010) as the I-5 corridor is a heavily traveled corridor on weekends, providing access to San Diego, Los Angeles, and other destinations to the north. Weekend delay on the mainline facility was greater in the northbound direction than in the southbound direction during the three-year period. The greatest delays for both directions were concentrated during the midday period. Delays in the northbound direction, as shown in Exhibit ES-21, increased every year from 2008 to 2010 while delays in the southbound direction decreased from 2008 to 2009 but increased from 2009 to 2010. On the HOV facility for the same three-year period, total delay was highest in the southbound direction. Delay in the northbound direction was highest during the PM peak period while delay in the southbound direction was highest during the midday peak period.

Detailed analysis of the weekend performance measures is included in Appendix A of the final report.

Exhibit ES-21: Weekend Northbound Mainline Lanes Hourly Delay (2008-2010)



4. Bottleneck Identification and Causality Analysis

Exhibit ES-22 summarizes the northbound and southbound bottleneck locations, the period these bottlenecks are active, and the causes of the bottlenecks. Exhibits ES-23 and ES-24 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. 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.

Bottlenecks along the Orange County I-5 Corridor were identified and verified based on a variety of data sources, including Caltrans detector data, recently conducted probe vehicle runs using GPS technology, State Highway Congestion Monitoring Program (HICOMP) data, and extensive consultant team field observations and video-taping. Some of the field observations were conducted collaboratively with Caltrans District 12 staff to verify bottlenecks and their causes. These efforts resulted in confirming consistent sets of bottlenecks for both directions of the freeway.

The final report explains in detail the process and results of the bottleneck identification and causality analysis.

Exhibit ES-22: Orange County I-5 Bottleneck Locations

Northbound

No.	Major Bottleneck Location	Hidden Bottleneck Location	Causality	Active Period		From		To (At)	
				AM	PM	Abs	CA	Abs	CA
NB1A		Avenida Pico	Merging, uphill grade, lane drop at Ave Vista Hermosa Off	✓				75.8	3.6
NB1	Ave Vista Hermosa		Merging consecutive ramps	✓	☑	72.3	0.0	76.5	4.2
NB2	Camino Las Ramblas		Uphill grade, roadway curve, sight distance, lane drop, merging	✓		76.5	4.2	79.2	6.9
NB3A		Crown Valley On	Merging	✓	☑			86.2	13.9
NB3	Oso Pkwy On		Merging (consecutive ramps)	✓	☑	79.2	6.9	87.6	15.4
NB4B		La Paz On	Merging (loop ramp)	✓				89.0	16.7
NB4A		Alicia Pkwy On	Merging (1 mile aux lane lost at El Toro)	✓				89.9	17.7
NB4	El Toro On		Limited sight dist (vert), merging (loop ramp - short taper)	✓	☑	87.6	15.4	91.1	18.8
NB5E		Sand Canyon On	Merging		✓			96.4	24.1
NB5D		Jeffrey On	Merging		✓			97.5	25.2
NB5C		Jamboree On	Merging		✓			100.0	27.7
NB5B		Tustin Ranch On	Merging		✓			100.7	28.4
NB5A		Red Hill/Newport On	Merging, weaving (with SR55 off), uphill grade, +1000 vph on		✓			101.5	29.2
NB5	NB-55 Off		Weaving (w/Red Hill On), number of lanes reduction	☑	✓	91.1	18.8	102.3	30.0
NB6C		NB-55 On	Merging, high demand		✓			102.9	30.6
NB6B		4th On	Merging, grade, roadway curve, limited sight dist, clearance		✓			103.5	31.2
NB6A		Grand Off	HOV lane drop congestion, merging from out of aux ln		✓			103.9	31.6
NB6	17th Street On		HOV exit merging, weaving (SR22/57), uphill grade, rdwy curve		✓	102.3	30.0	104.9	32.6
NB7A		SR-22 Off (Main St)	Weaving, traffic backing up from SR22/SR57		✓			105.5	33.2
NB7	Anaheim On		Uphill grade, merging (Katella/Ball), 5th lane ends at Katella		✓	104.9	32.6	108.9	36.6
NB8A		Ball Road	Merging		✓			110.0	37.7
NB8	Los Angeles County		Loss of lanes at Carmenita IC	✓	✓	108.9	36.6	116.6	44.4

Southbound

No.	Major Bottleneck Location	Hidden Bottleneck Location	Causality	Active Period		From		To (At)	
				AM	PM	Abs	CA	Abs	CA
SB1	Euclid On		Merging	✓		116.6	44.38	111.4	39.2
SB2	Katella On (Disney Wy)		Merging (first ramp)	✓		111.4	39.2	108.5	36.3
SB3	SR22/SR57 On (Main)		Merging, lane drop	✓	☑	108.5	36.3	105.4	33.2
SB4C		Penn On (17th St)	Merging, short aux lane (less than 800 feet)	✓	☑			104.5	32.3
SB4B		Grand On	Merging	✓				104.1	31.9
SB4A		First On	Weaving (w/SR55 off), merging	✓				103.0	30.8
SB4	SB-55 Off		Queue backup to m/l, weaving (w/1st on), no of lanes reduced	✓	☑	105.4	33.2	102.6	30.4
SB5	SB-55 On		Merging, high demand	✓	☑	102.6	30.4	101.8	29.6
SB6	Jeffrey On		Merging	✓		101.8	29.6	96.9	24.7
SB7A		SR-133	Lane drop		✓			95.1	22.9
SB7	SB-405 On		Merging, lane drop		✓	96.9	24.7	92.9	20.7
SB8B		Truck bypass On	Merging with trucks (Bake On)		✓			92.4	20.2
SB8A		Lake Forest On	Merging - truck bypass aux lane (1-mile long) ends at El Toro		✓			91.9	19.7
SB8	El Toro On		Merging (consecutive), backup to m/l		✓	92.9	20.7	90.7	18.5
SB9	Alicia Parkway Off		Queue backup to m/l		✓	90.7	18.5	89.8	17.6
SB10	Oso Parkway On		Merging (consecutive ramps)		✓	89.8	17.6	87.2	15.0
	None					87.2	15.0	72.3	0.0

NOTES:

Causality was verified with multiple field observations and video taping during June and July 2011.

Hidden bottlenecks are bottlenecks hidden by queuing from downstream bottleneck.

Bottleneck area is the segment from one major bottleneck location to the next major bottleneck location. It does not represent the queue length.

✓ Primarily active during this peak period

☑ Less active but also occurs during this peak period

Exhibit ES-23: Map of Existing I-5 AM Bottlenecks

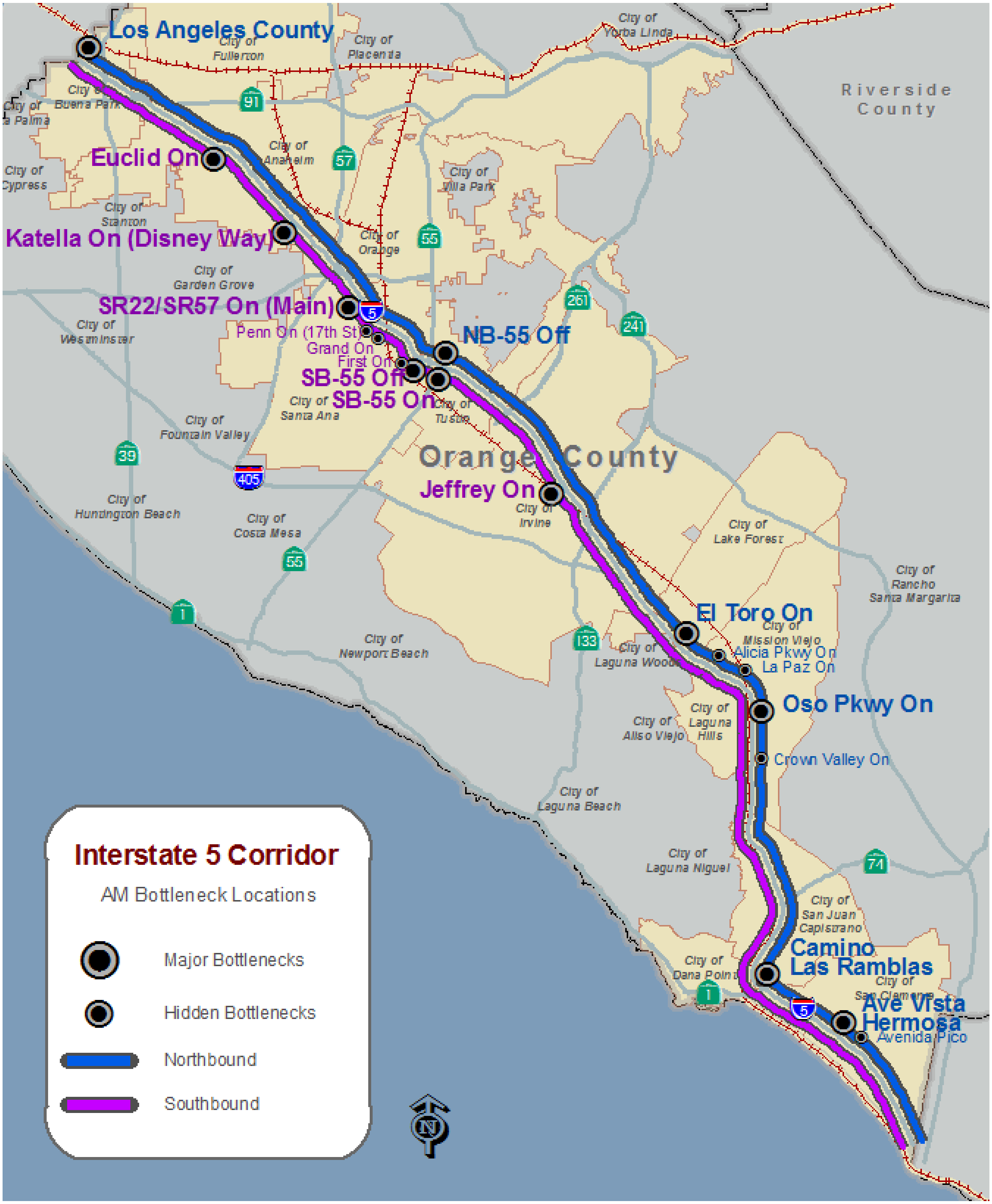
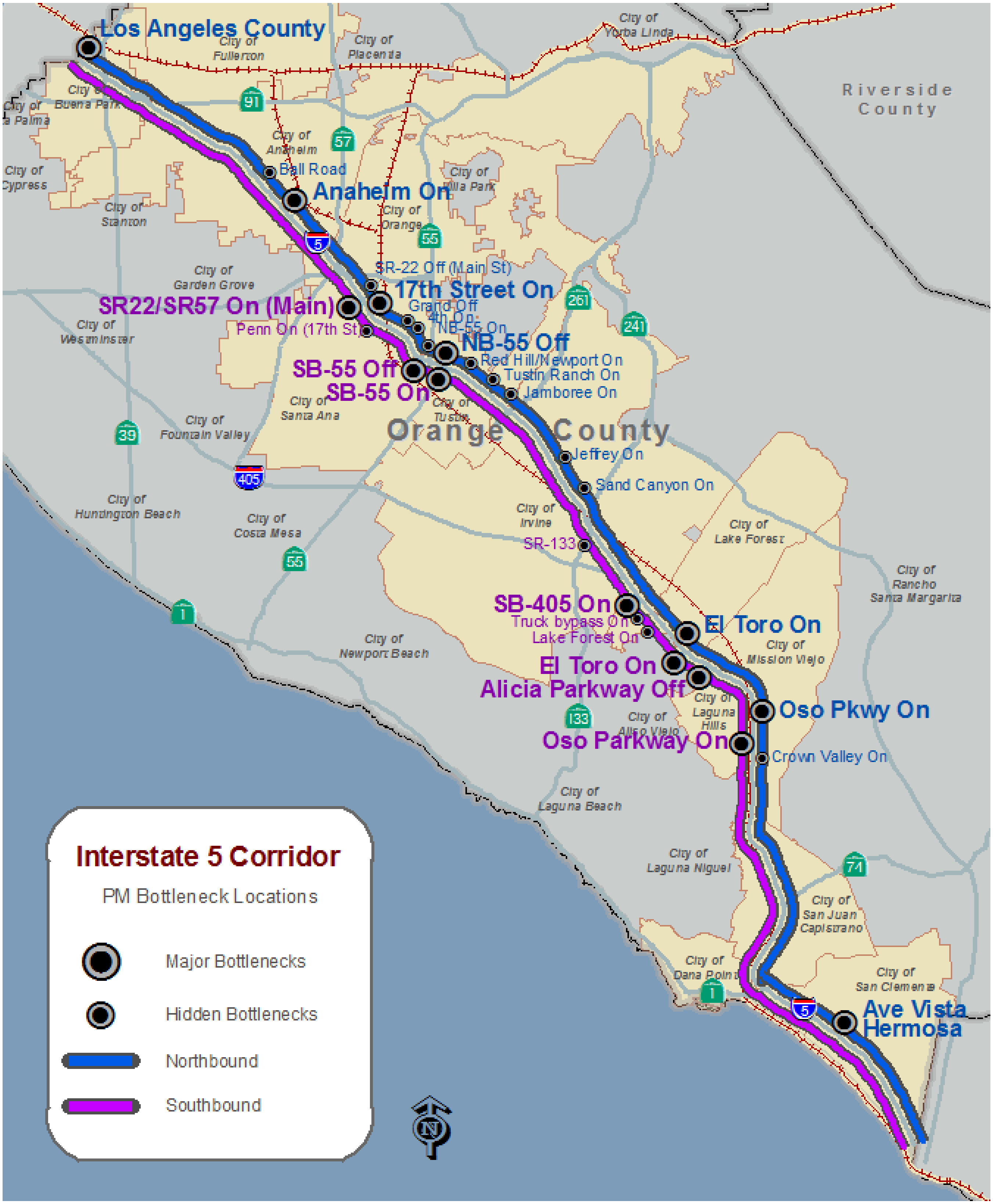


Exhibit ES-24: Map of Existing I-5 PM Bottlenecks



5. 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 the 2010 base year and 2020 horizon year.
- 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.

Micro-simulation models should typically start and end at areas with stable flow conditions in order to better estimate the demands of the model and replicate vehicles' releasing patterns during simulation. The modeled corridor extends from the San Diego County line in the south to north of the SR-22/SR-57 interchange in the north. ES-25 depicts the roadway network included in both models. All freeway interchanges were included as well as on and off-ramps.

The model was calibrated against 2010 conditions. Calibrating the model was a resource intensive effort, requiring multiple iterations until the model reasonably matched bottleneck locations and relative severity. Once the 2010 base year calibration was approved, a future 2020 horizon baseline model was also developed based on the OCTA Orange County Transportation Analysis Model (OCTAM) travel demand model projections. Based on the growth projections extracted from the OCTAM model, congestion on I-5 was projected to grow significantly, more than any other CSMP corridor.

These two models were then used to evaluate different scenarios (combinations of projects) to quantify the associated congestion relief benefits and to compare total project costs against their benefits.

SCENARIO DEVELOPMENT FRAMEWORK

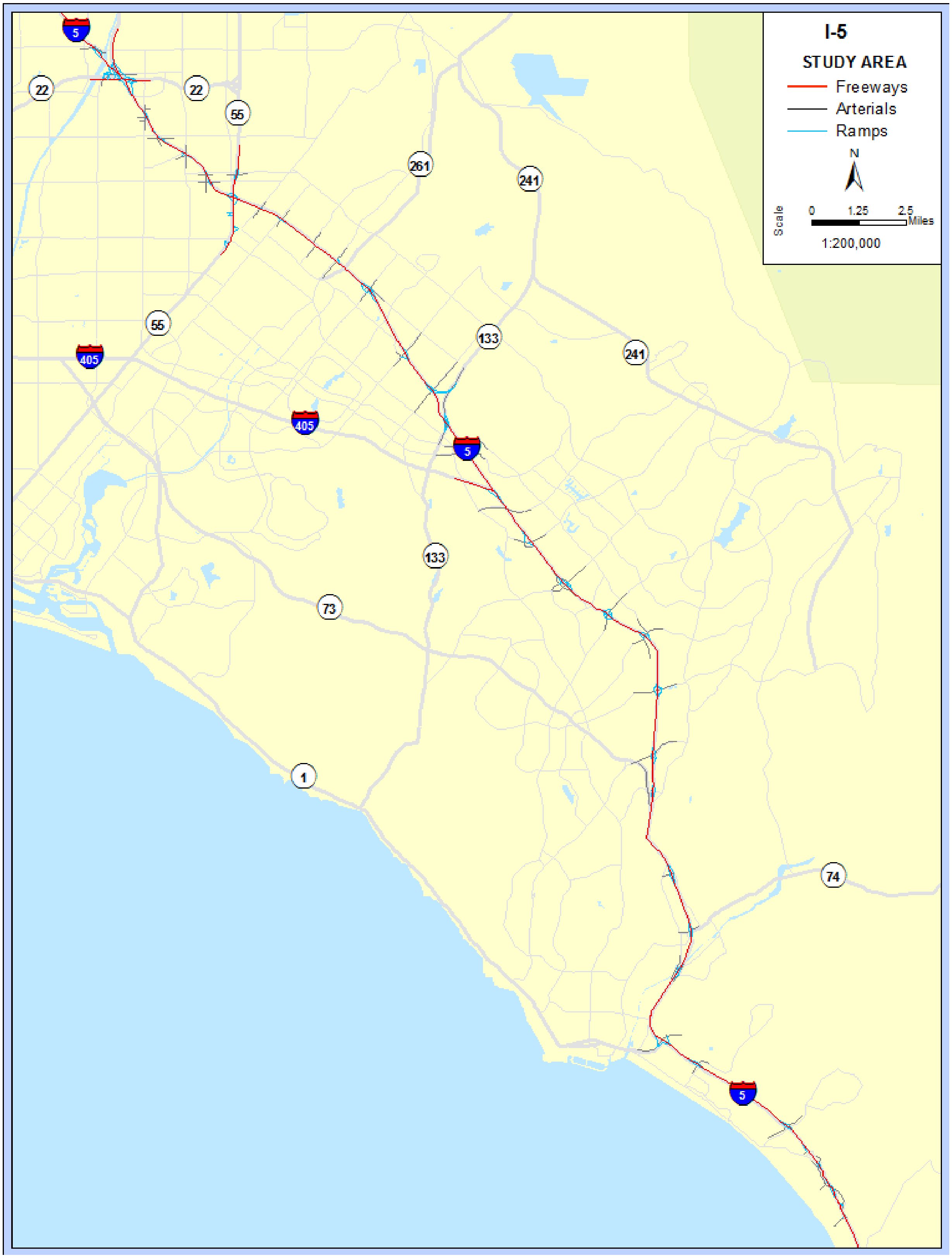
The study team developed a framework for combining projects into scenarios. Ideally, the study team would evaluate every possible combination of projects. However, this would have entailed thousands of model runs. Instead, the team combined projects based on a number of factors, including:

- Fully programmed and funded projects were combined separately from projects not yet funded.
- Short-term projects (typically delivered by 2014) were used to develop scenarios tested with both the 2010 and 2020 models.
- Long-term projects (delivered after 2014, but before or close to 2020) were used to develop scenarios tested only with the 2020 model.

The study assumes that the 2010 base year model could support reasonable evaluations of projects developed before 2014. The 2020 horizon year for the I-5 Corridor was extrapolated from 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 Regional Transportation Plan (RTP), Caltrans may wish to update the micro-simulation model with revised demand projections.

Project lists used to develop scenarios were obtained from the Regional Transportation Improvement Program (RTIP), the Regional Transportation

Exhibit ES-25: Micro-Simulation Model Network



Agencies (TCA) improvements, and other sources (e.g., special studies). Projects that do not affect mobility directly were eliminated.

For instance, sound wall, landscaping, or minor arterial improvement projects were not evaluated since primary (non-mobility) benefits of these projects are not captured in micro-simulation models.

Scenario testing performed for the I-5 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. This contrasts with the CSMP approach. For the I-5 CSMP, scenarios build on previous scenarios as long as the incremental scenario results show an acceptable level of performance improvement. This incremental scenario evaluation approach is important since CSMPs are new and are often confused with alternatives studies. Exhibit ES-26 summarizes the scenario-testing approach and scenarios tested. It also provides a general description of the projects included in the 2010 and 2020 micro-simulation runs.

Exhibits ES-27 and ES-28 show the delay results for all the 2010 scenarios evaluated for the AM and PM peak periods, respectively. Exhibits ES-29 and ES-30 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 - 1). The impacts of strategies differ based on factors such as traffic flow, ramp storage, bottleneck locations, and congestion.

For each scenario, the modeling team produced results by facility type (i.e., mainline, HOV, 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 the results to ensure that they were consistent with general traffic engineering principles.

SCENARIO EVALUATION RESULTS

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

Base Year and "Do Minimum" Horizon Year

Absent any physical improvements, the modeling team estimates that by 2020, total delay (mainline, HOV, and ramps) will increase by more than 300 percent compared to 2010 (from a total of around 33,600 hours daily to more than 102,000 hours) in the AM and PM peak hours. These forecasts do not

Exhibit ES-26: Paramics Micro-Simulation Modeling Approach

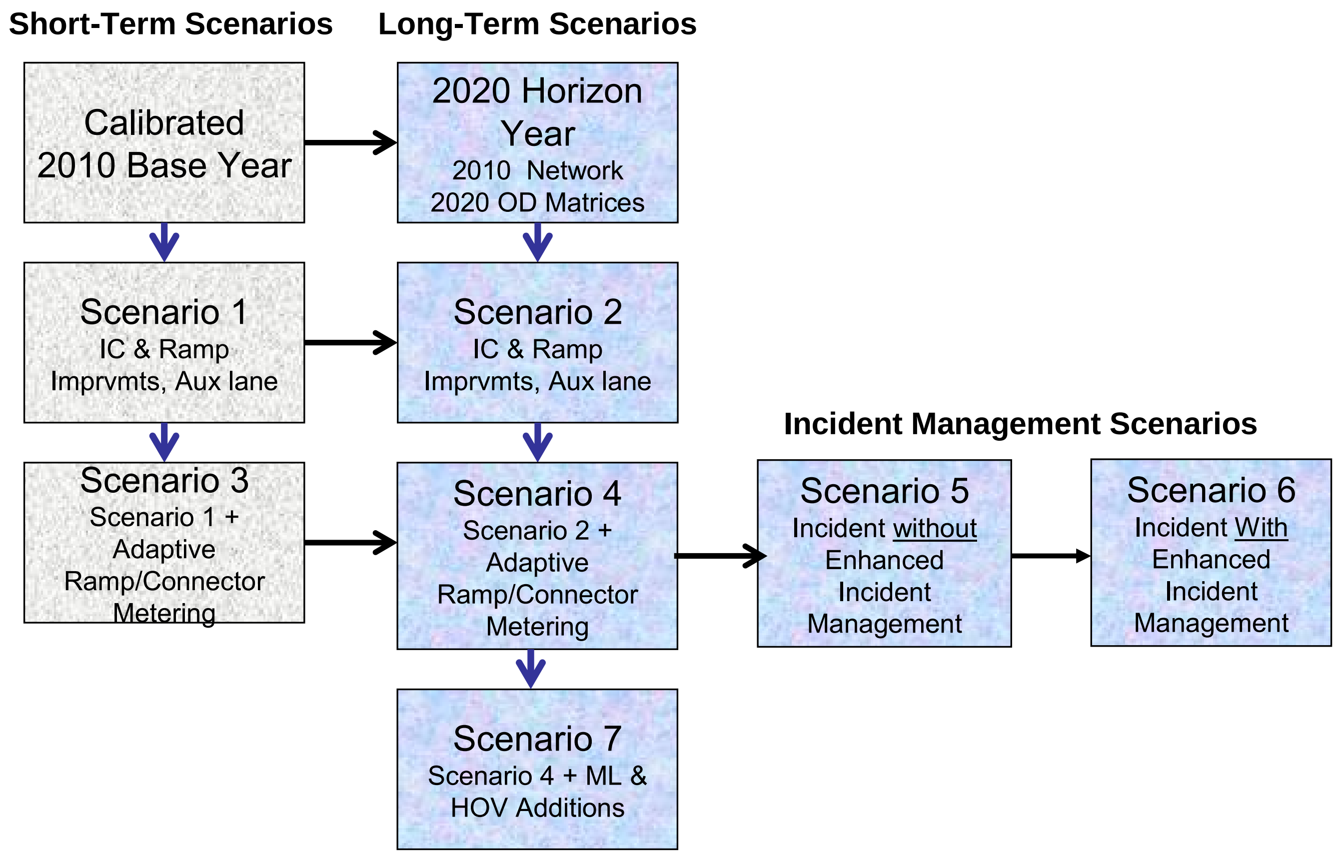


Exhibit ES-27: 2010 AM Peak Micro-Simulation Delay by Scenario

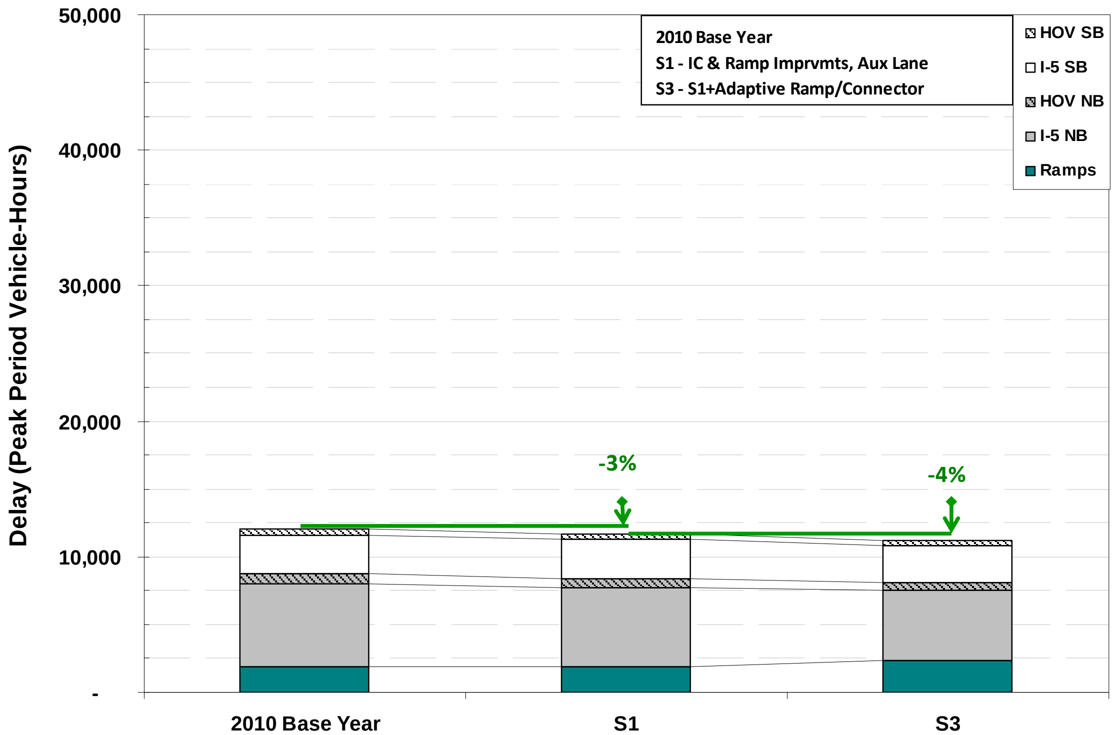


Exhibit ES-28: 2010 PM Peak Micro-Simulation Delay by Scenario

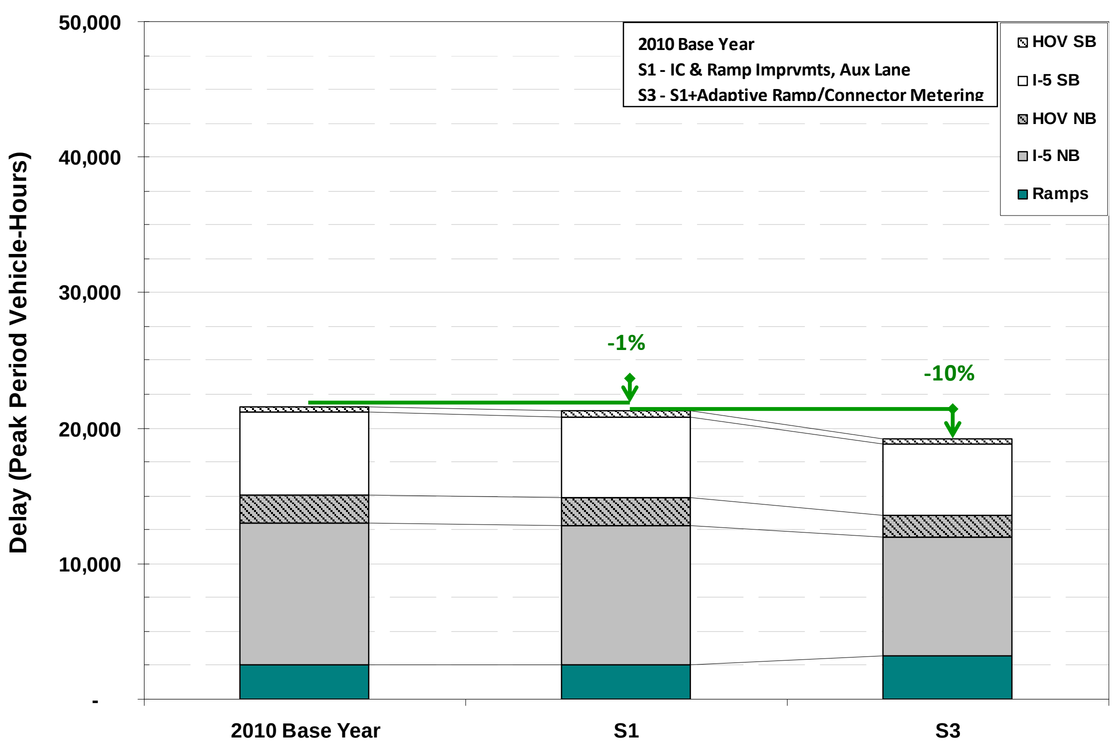


Exhibit ES-29: 2020 AM Peak Micro-Simulation Delay by Scenario

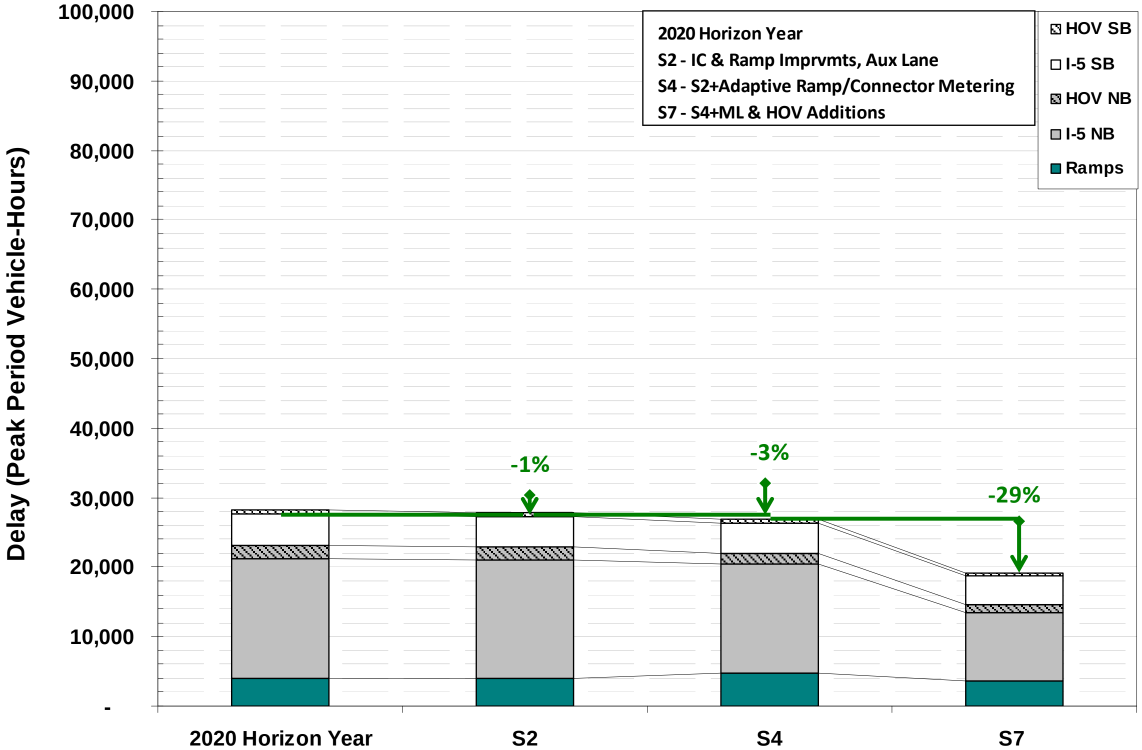
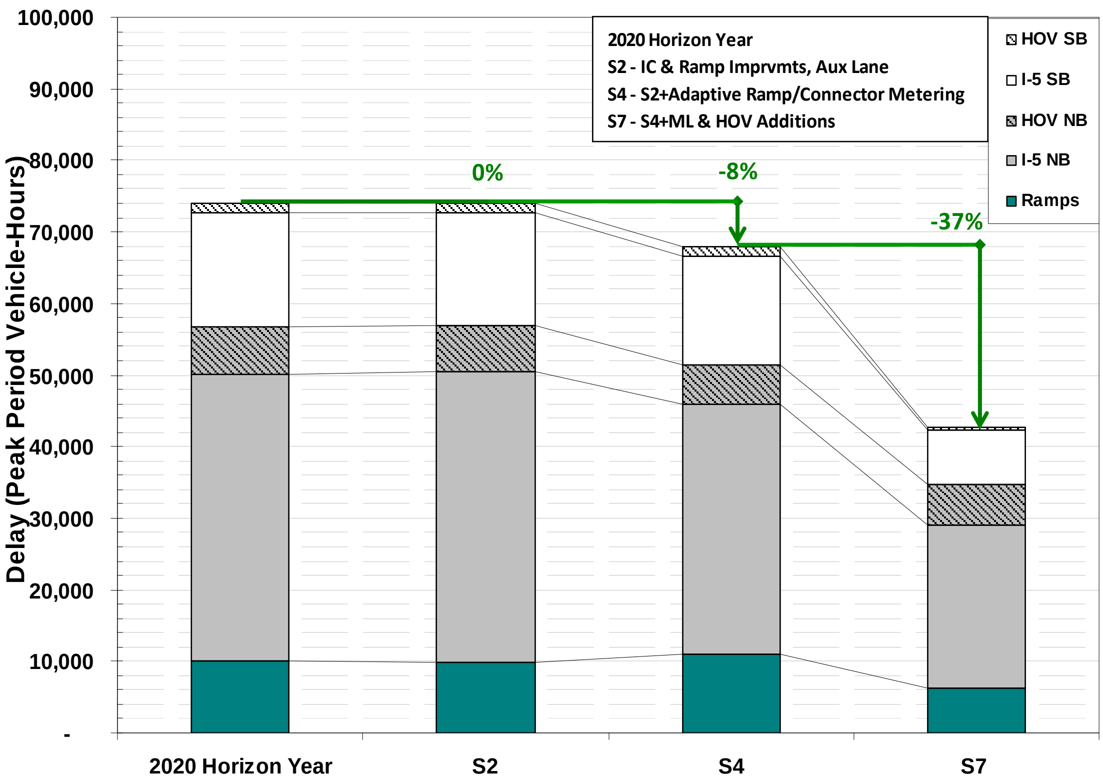


Exhibit ES-30: 2020 PM Peak Micro-Simulation Delay by Scenario



reflect the recent economic conditions of the past few years and may overestimate the demand actually experienced in 2020. However, demand is expected to grow over time and may eventually reach these levels.

Scenarios 1 and 2 – Interchange and Ramp Improvements, Auxiliary Lane

The first two scenarios include fully funded and programmed projects that are operations related and slated for completion by 2014. These projects include:

- Converting a northbound HOV lane to continuous access from Tustin Ranch Road to Red Hill Avenue in the City of Tustin.
- Widening southbound Camino de Estrella off-ramp from one lane to two lanes and widening the overcrossing from five lanes to seven lanes in the City of San Clemente.
- Widening southbound Camino Capistrano off-ramp from two lanes to three lanes
- Expanding La Paz Road from four lanes to six lane and extending the associated on-ramp.
- Constructing a southbound auxiliary lane and widening a southbound off-ramp from one lane to two lanes at Jamboree Road. Widening eastbound undercrossing to create a left turn lane to northbound on ramp.
- Reconstructing the I-5/SR-74 interchange in the City of San Juan Capistrano.

The 2010 model estimates that the projects included in the first scenario (S1) will reduce delay on the corridor by approximately three percent in the AM peak period and by one percent in the PM peak period. In total, this scenario estimates a reduction of almost 650 hours of daily delay. The majority of the delay reduction occurs in the northbound direction during the AM peak period at the El Toro On Ramp to SR-55 Off Ramp bottleneck area. Mobility improves as a result of more opportunities for HOV and mainline vehicles to merge due to the continuous access HOV conversion project.

The 2020 model estimates that the same set of projects will reduce delay on the corridor by one percent in the AM peak period and less than one percent in the PM peak period. With demand increases in 2020, these operational improvement projects only provide minor benefits near the project areas only. The level of congestion by year 2020 suggests that bigger, more beneficial projects would be needed to address these bottlenecks.

Scenarios 3 and 4 – Advanced Ramp Metering, Connector Metering

Scenarios 3 and 4 also test advanced ramp and connector metering on Scenarios 1 and 2. The following ramp and connector metering projects were tested:

- Implementing an advanced ramp metering with queue control.
- Metering the northbound SR-55 to northbound and southbound I-5 connector ramps. Metering the southbound SR-55 to southbound I-5 connector ramp.
- Metering the eastbound SR-91 to southbound I-5 and westbound SR-91 to northbound I-5 connector ramps.
- Metering the southbound SR-57 to southbound I-5 connector ramp.
- Metering the eastbound SR-22 to northbound and southbound I-5 connector ramps.

There are several advanced ramp metering systems deployed around the world. For modeling purposes, the study team 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, so it is not a recommendation for the I-5 corridor. Caltrans should evaluate different algorithms and implement the one it deems most beneficial.

The 2010 model indicates that the projects will improve delay in the AM peak by four percent and PM peak by ten percent. The 2020 model shows that the projects will improve delays in the AM and PM peaks by three and eight percent, respectively. Although the mainline facility experienced an improvement in delay during both the AM and PM peak hours, the ramps and connectors experienced an overall delay increase. This results in a modest improvement for the corridor overall in both the 2010 and 2020 models. Advanced ramp and connector metering are estimated to reduce delay by over 2,500 vehicle-hours for the 2010 model and by almost 7,000 vehicle-hours of delay for the 2020.

Scenarios 5 and 6 – Enhanced Incident Management

Two incident scenarios were tested upon Scenario 4 to evaluate the non-recurrent delay reductions resulting from enhanced incident management strategies. In the first scenario, Scenario 5, 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 2011 actual incident data, at one of the high frequency locations. The following are the Scenario details:

- Northbound AM peak period starting at 7:00 AM, close outermost mainline lane for 45 minutes at postmile 18.685 (at El Toro Road)
- Southbound PM peak period starting at 5:00 PM, close outermost mainline lane for 35 minutes at postmile 18.685 (at El Toro Road)

This scenario represents a typical or 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 to include 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 collision incident was simulated with a reduction in duration by 15 minutes in the northbound direction and ten minutes in the southbound direction to determine the benefits of an enhanced incident management system.

Without enhanced incident management, the first scenario produced a two percent increase in congestion in the AM and a 31 percent increase in the PM over Scenario 4 —an increase of over 21,600 vehicle-hours of delay. The results indicate enhanced incident management would have little effect in the AM peak, but eliminate over 19,000 vehicle-hours of delay in the PM peak using 2020 demand. While these results capture benefits during the peak direction in the peak period, additional benefits could be realized during off-peak hours and in the off-peak direction.

Scenarios 7 – HOV and Mainline Lane Additions

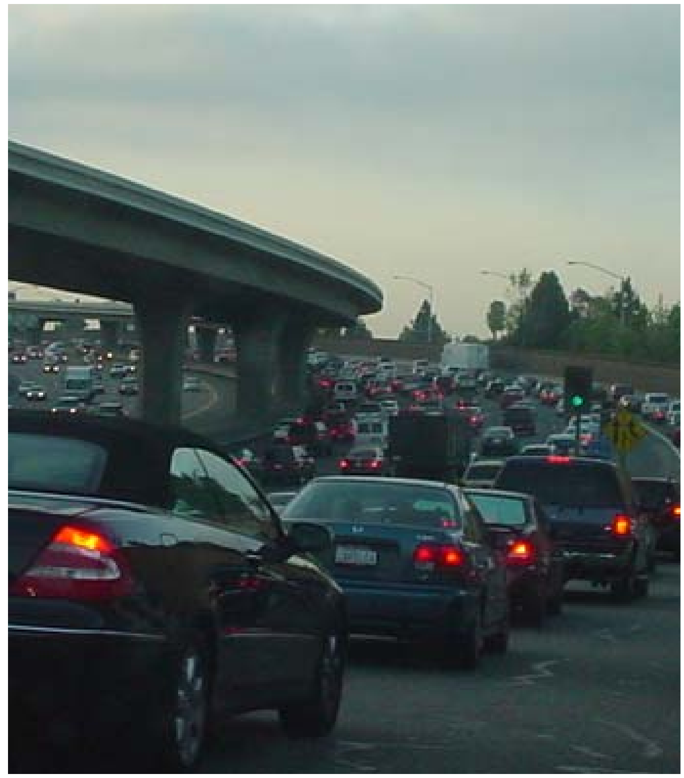
Scenario 7 tests several funded projects to the alternative modeled in Scenario 4:

- Providing a second HOV lane in both directions in the Cities of Tustin and Santa Ana. This is a Measure M2 funded project.
- Providing new lanes in both directions and improving the interchange at the Y (El Toro) from SR-55 to El Toro Interchange. This is a Measure M2 funded project.
- Adding mainline, HOV, and auxiliary lanes and reconfiguring interchanges from El Toro Interchange in Lake Forest to Junipero Serra in San Juan Capistrano. This is a Measure M2 funded project.
- Adding an HOV lane in each direction from Avenida Pico to San Juan Creek Road. Reconfiguring Avenida Pico interchange.

The 2020 model shows that the combination of these projects will produce a 29 percent reduction in delay in the AM peak period and a 37 percent reduction in delay in the PM peak period. Although the combination of these projects produce a significant benefit on the corridor, the delay in the AM and PM peak period still totals almost 62,000 vehicle-hours after Scenario 7.

Post Scenarios 1-7 Conditions

After the completion of Scenarios 1 through 7, the 2020 model reveals that significant residual congestion (almost 62,000 vehicle-hours) remains to be addressed through additional improvements. However, the OCTAM model forecasts do not reflect the economic conditions of the past few years and may overestimate the demand actually experienced in 2020. Even without any improvements to the corridor, congestion is expected to triple due to the high future demand in 2020 according to the OCTAM model. Given such high demand forecasts, the modeled conditions after Scenarios 1 through 7 represent an overall delay reduction of almost 40 percent from the 102,000 vehicle-hours of delay expected in 2020 if no improvements are made.



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 Life-Cycle Benefit/Cost Analysis 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 in 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 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 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 new mainline lanes in each direction from SR-55 to El Toro has a high capital construction cost, which reduces the B/C ratio, but brings much higher absolute benefits to I-5 users.

The benefit-cost findings for each scenario are:

- Scenario 1 and Scenario 2 (interchange and ramp improvements, auxiliary lane at southbound Jamboree Road) produces a low benefit-cost ratio of about 0.7, but these operational improvements are critical before advanced ramp metering can be completed in Scenarios 5 and 6.
- Scenarios 3 and 4 (advanced ramp/connector metering) produce a very high benefit cost ratio of over 10. Combined with Scenarios 1 and 2, these scenarios produce an aggregate benefit cost ratio of 4.2.
- Scenario 7 (mainline and HOV lane additions) produces an average benefit-cost ratio of 3.3:1.
- The combined benefit-cost ratio of Scenarios 1, 2, 3, 4, and 7 is 3.5, which is compelling investment results despite the remaining congestion on the corridor. If all the projects are delivered at current cost estimates, the public will get over three dollars of benefits for each dollar expended. In current dollars, costs add up to over $1.2 billion whereas the benefits are estimated to be over $4.2 billion.
- The projects also alleviate CO_2 gas emissions by three million tons over 20 years, averaging more than 150,000 tons or reductions per year. The emissions are estimated in Cal-B/C using data from the California Air Resources Board (CARB) EMFAC model.

Exhibit ES-31: Scenario Benefit/Cost (B/C) Results

Scenario	Scenario Description	Benefit/Cost Ranges			
		Low	Medium	Medium-High	High
		<1	1 to 2	2 to 5	> 5
1/2	Interchange & Ramp Imprvmts, Aux Lane	★			
3/4	Advanced Ramp/Connector Metering				★★★★
7	ML and HOV Additions			★★★	

6. Conclusions and Recommendations

This section summarizes the conclusions and recommendations of the I-5 CSMP based on the analysis presented in the previous sections. It is important to note that many of these conclusions are based primarily on the micro-simulation model results, which was 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 a project, availability of funding, as well as planning and engineering requirements are all critical for the successful implementation of a project.

Based on the results of the analyses presented herein, the study team offers the following conclusions and recommendations:

- The short-term operational improvements produce a low benefit on the corridor. However, these projects can be implemented within a short timeframe and can result in minor spot improvements. In addition, these improvements are necessary to support advance ramp metering in later steps, which produces a high benefit.

- Subsequent adaptive ramp metering and connector metering deployment provides a high benefit-cost ratio due to the low costs to implement such improvements.

- The capacity-enhancing projects included in Scenario 7 (e,g., mainline lane and HOV lane additions) generate a significant improvement in operations of the corridor. Even with the high cost of implementing these projects, they produce a very compelling benefit-cost ratio of 3.3.

- The I-5 corridor is an example of an extremely congested urban corridor that benefits from operational strategies, however, it requires expansion to significantly improve mobility.

- After these improvements are completed, congestion is still expected to double what it is today due to increases in demand. As a result, the public may not fully appreciate the delay savings achieved (since they never experience the congestion that "would have been"). To address these concerns, Caltrans must consider additional operational and capacity enhancing projects to reduce congestion further.

- Enhanced incident management shows promise as well. With an average delay savings of over 10,000 vehicle-hours per incident, the corridor would experience significant delay savings.

This is the first generation CSMP for the I-5 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 ones estimated in this document so that models can be further improved.

CSMPs, or a variation thereof, should become a 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.

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Exhibit ES-32: District 12 CSMP Team Organization Chart