# Corridor System Management Plan (CSMP)

## Los Angeles I-5 North Corridor

From I-10 to I-210

Final Report

Executive Summary

September 2010

I approve this Corridor System Management Plan (CSMP) for the I-5 North Corridor in Caltrans District 7 as the overall Policy Statement and Strategic Plan that will guide transportation decisions and investment for the I-5 Corridor from I-10 to I-210 in Los Angeles County.

**Approval**

for 5/4/11

MICHAEL MILES — Date

District 7 Director

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This document represents the Executive Summary for the Los Angeles Interstate 5 (I-5) North 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.

This CSMP is the direct result of the November 2006 voter-approved Proposition 1B (The Highway Safety, Traffic Reduction, Air Quality, and Port Security Bond Act of 2006). This ballot measure included a funding program deposited into a Corridor Mobility Improvement Account (CMIA). CMIA money is partially funding one project on the northern section of I-5. The project will construct high occupancy vehicle (HOV) lanes in the median of I-5 from State Route134 (SR-134) to SR-170, a distance of about 10 miles. Approximately, $73 million in CMIA funds have been adopted by the CTC for this project.

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

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

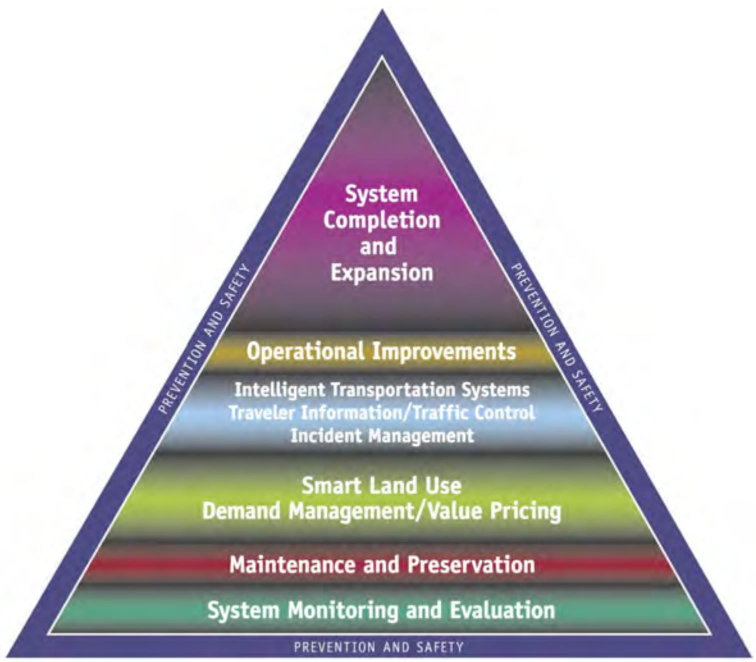
Highlights of each of these steps are included in later sections of this summary.

## BACKGROUND

Los Angeles 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 keep expanding the infrastructure to keep up with demand. Caltrans recognized that infrastructure expansion cannot keep pace with demand, and adopted a system management philosophy to address current and future transportation needs in a comprehensive manner.

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

**Exhibit ES-1: System Management Pyramid**




This CSMP defines how Caltrans and its stakeholders will manage the I-5 North 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.

Caltrans develops integrated multimodal projects in balance 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.

## STAKEHOLDER INVOLVEMENT

The I-5 North Corridor CSMP involved corridor stakeholders including representatives from cities bordering I-5, the Southern California Association of Governments (SCAG), and the Los Angeles County Metropolitan Transportation Authority (Metro). Caltrans briefed 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:

- Southern California Association of Governments (SCAG)
- Los Angeles County Metropolitan Transportation Authority (Metro)
- Los Angeles Department of Transportation (LADOT)
- City of Burbank
- City of Glendale.

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.

# CORRIDOR PERFORMANCE ASSESSMENT

This section briefly describes the I-5 North Corridor and summarizes the results of the comprehensive corridor performance assessment.

## *Corridor Description*

Exhibit ES-2 is a map showing the Los Angeles I-5 North CSMP Corridor. The study corridor extends approximately 26 miles from the I-10 interchange at Post Mile (PM) 18.452 to the I-210 interchange at PM 44.014. It traverses the cities of Los Angeles, Glendale, Burbank, and San Fernando. It connects with eight major freeways from south to north: I-10, SR-110, SR-2, SR-134, SR-170, SR-118, I-405, and I-210.

I-5 is a six 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 with some only available on one side of the freeway. As of 2010, there are HOV lanes in both directions of the corridor north of SR-118.

According to 2008 traffic volumes from Caltrans, I-5 carries between 138,000 and 290,000 annual average daily traffic (AADT) depending on location. The highest traffic occurs just north of the SR-170 junction at the Osborne Street interchange.

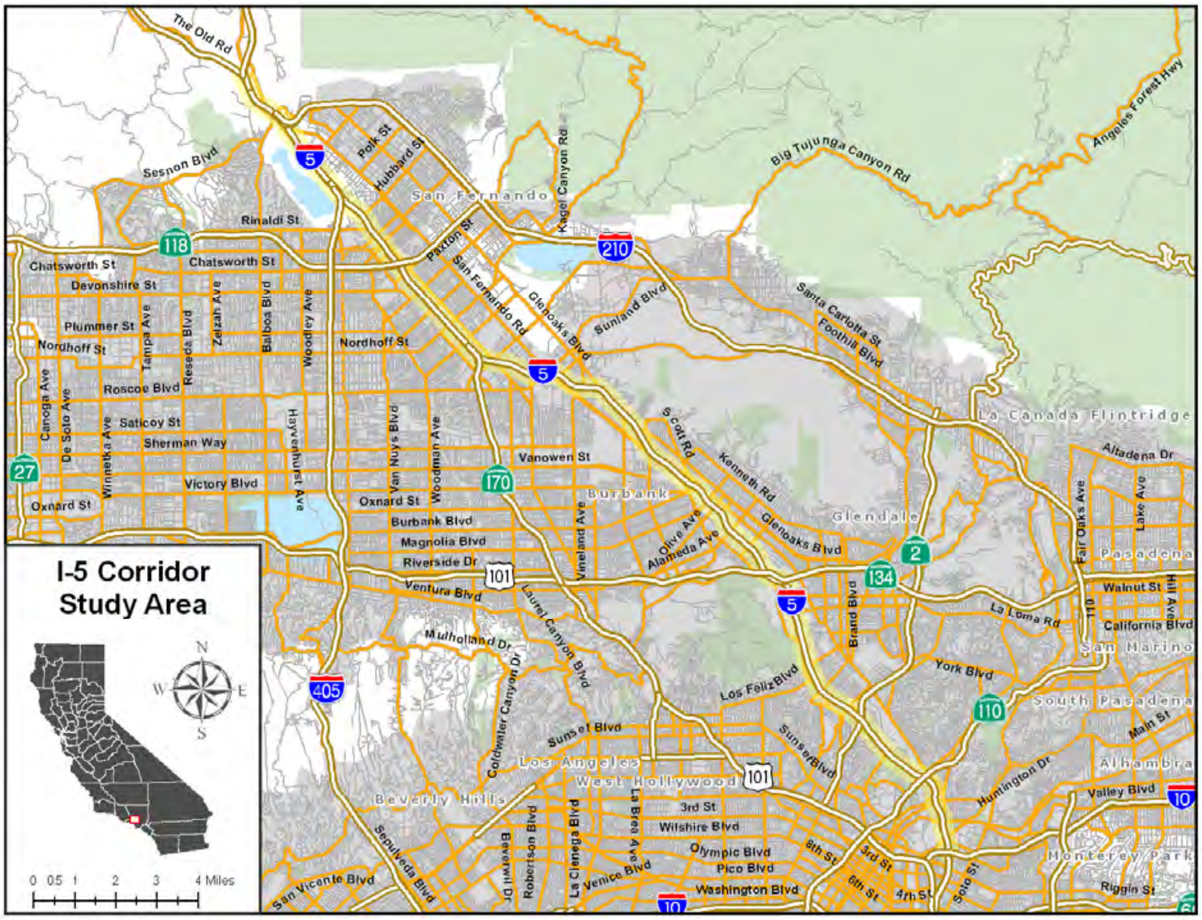
I-5 is a Surface Transportation Assistance Act (STAA) state truck route. According to 2008 Caltrans Annual Average Daily Truck Traffic data, verified truck counts comprise between 5.2 and 9.0 percent of the total daily traffic along the corridor with the highest percentage at the I-5/I-405 Junction. There are truck lanes in both directions near this location, immediately north of the study corridor at the SR-14 split. They are about two and a half miles in length. These lanes separate trucks from mixed-flow traffic to enhance safety and/or stabilize traffic flow. The trucks that are traveling northbound are likely carrying transloaded cargo to other parts of the state.

Several transit operators provide service to the areas near the corridor. Metro operates bus lines on routes parallel to the corridor: Route 224 runs along Lankershim Boulevard; Routes 90, 91, 94, and 394 run along San Fernando Road; Route 230 runs along Laurel Canyon Boulevard; Route 292 runs along Glenoaks Boulevard; and Route 96 runs along Riverside Drive.

Santa Clarita Transit Express buses operate on the I-5 Corridor and provide access from the Santa Clarita Valley to the downtown Los Angeles area: SC784, SC788, SC794, and SC799.

Antelope Valley Transit Authority operates a fleet of 25 commuter coaches from Antelope Valley to Los Angeles and San Fernando Valley Monday through Friday. Ridership has tripled over the last decade of operation. Antelope Valley Transit currently operates AV785 and AV786 commuter coaches from the Antelope Valley to the San Fernando Valley and downtown Los Angeles area.

**Exhibit ES-2: Los Angeles I-5 North CSMP Corridor Map**




The City of Los Angeles Department of Transportation also operates Commuter Express (CE) buses that run on or adjacent to the I-5 Corridor. These routes include CE413 and CE419.

Metrolink operates the Antelope Valley Line, which runs parallel to the I-5 Corridor along San Fernando Road. It connects Lancaster to downtown Los Angeles and carries an average weekday ridership of 7,302. The Ventura County Line also operates along San Fernando Road from the SR-134 interchange connecting Ventura County to the downtown Los Angeles area with an average weekday ridership of 4,317.

There are several bike paths near I-5. Two of these bike paths parallel the northern section of the study corridor and run along San Fernando Road and Glendale Boulevard. In the southern section of the corridor, a bike path runs along the LA River

The I-5 Corridor serves Dodger Stadium, which is adjacent to downtown Los Angeles, and northwest of the I-5/SR-110 interchange. Dodger Stadium is the home of the Los Angeles Dodgers Major League Baseball team. The stadium has a seating capacity of approximately 56,000. The Staples Center is another sports arena in Downtown Los Angeles. It is home to several professional sports franchises - the NBA's Los Angeles Lakers and Los Angeles Clippers, the NHL's Los Angeles Kings and the WNBA's Los Angeles Sparks.

Three major medical facilities are located close to the corridor: Providence Holy Cross Medical Center in Mission Hills, Olive View-UCLA Medical Center, and Los Angeles County-USC Medical Center.

Other trip generators include Burbank Town Center, Glendale Galleria, The Americana, and Eagle Rock Plaza, which are all large shopping centers located within the southern portion of the I-5 Corridor.

In addition to the facilities listed above, Los Angeles Union Station, located in downtown Los Angeles approximately one mile west of the I-5, is the terminus for four long-distance Amtrak trains. Union Station serves as the hub for Metrolink’s passenger trains and provides connections to the Metro Red, Purple, and Gold light-rail lines. Patsaouras Transit Plaza is attached to Union Station. It provides many bus services including regular Metro and Metro Rapid bus lines, downtown DASH shuttles, FlyAway express service to Los Angeles World Airports, and several other municipal bus lines.

## *Corridor Performance Assessment*

I-5 CSMP performance measures focus on four areas discussed in detail below:

- *Mobility* describes how well people and freight move along the corridor
- *Reliability* captures the relative predictability of travel 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 were used to quantify mobility: delay and travel time. Each can be estimated from field automatic detection data and forecasted using macro or micro models. The Performance Measurement System (PeMS) [1] was used to extract the historical freeway detection data needed to compute mobility measures. PeMS collects detector volume and vehicle occupancy data on the freeway, which can then be used to estimate delay and travel time.

### *Delay*

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

Exhibit ES-3 shows the average weekday daily vehicle-hours of delay for each month between 2005 and 2009 for the I-5 North Corridor. These figures exclude weekends and holidays. This exhibit reveals the following delay trends:

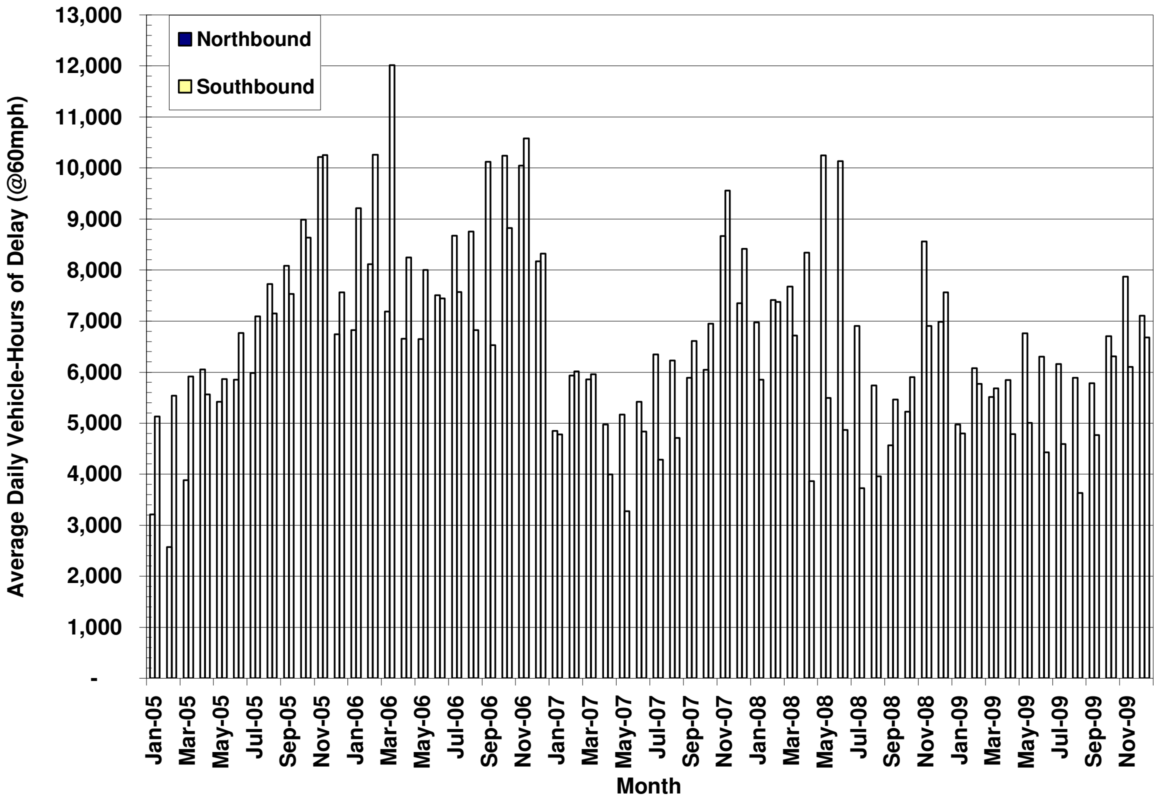
- Congestion on the corridor increased from 2005 to 2006, which was probably due to economic growth in the region and the country. In 2007, however, delay decreased and leveled off, most likely due to the global financial meltdown and the associated recession. As of the end of 2009, congestion levels had still not reached 2006 levels.

- Delay was lower during the summer months and was highest in the year 2006.

- In the northbound direction, delay increased steadily from November 2007 to June 2008. However during the same period, the southbound direction experienced a gradual decline in delay. In 2009, the delay in both directions is lower than all the other years.

[1] Developed and maintained by Caltrans and accessible at http://pems.dot.ca.gov.

**Exhibit ES-3: I-5 Average Weekday Delay by Month (2005-2009)**

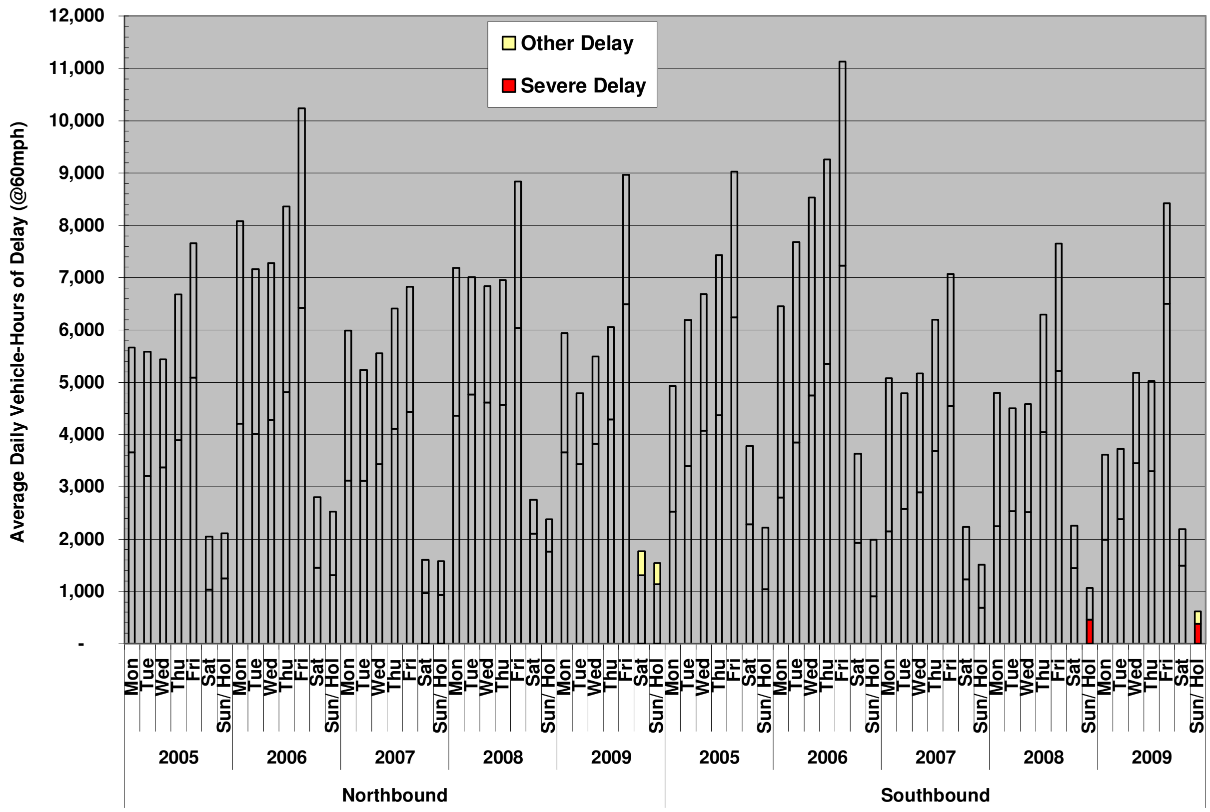



The CSMP further separates delay into two components: severe delay and other delay. *Severe delay* occurs when speeds are below 35 mph and *other delay* occurs when speeds are between 35 and 60 mph. Severe delay represents breakdown conditions. "Other" delay represents conditions approaching or leaving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

Exhibit ES-4 shows average severe and other daily vehicle-hours of delay by day of the week. A few notes related to this exhibit:

- Severe delay makes up about 60 percent of all weekday delay on the corridor in either the northbound or the southbound directions.
- Fridays in the southbound direction experience the highest delays, probably due to weekend travel. The second highest delays generally occurred on Thursdays.
- Delay was highest in 2006 and northbound delay tended to be greater in magnitude than southbound delay, particularly in 2007 to 2009.

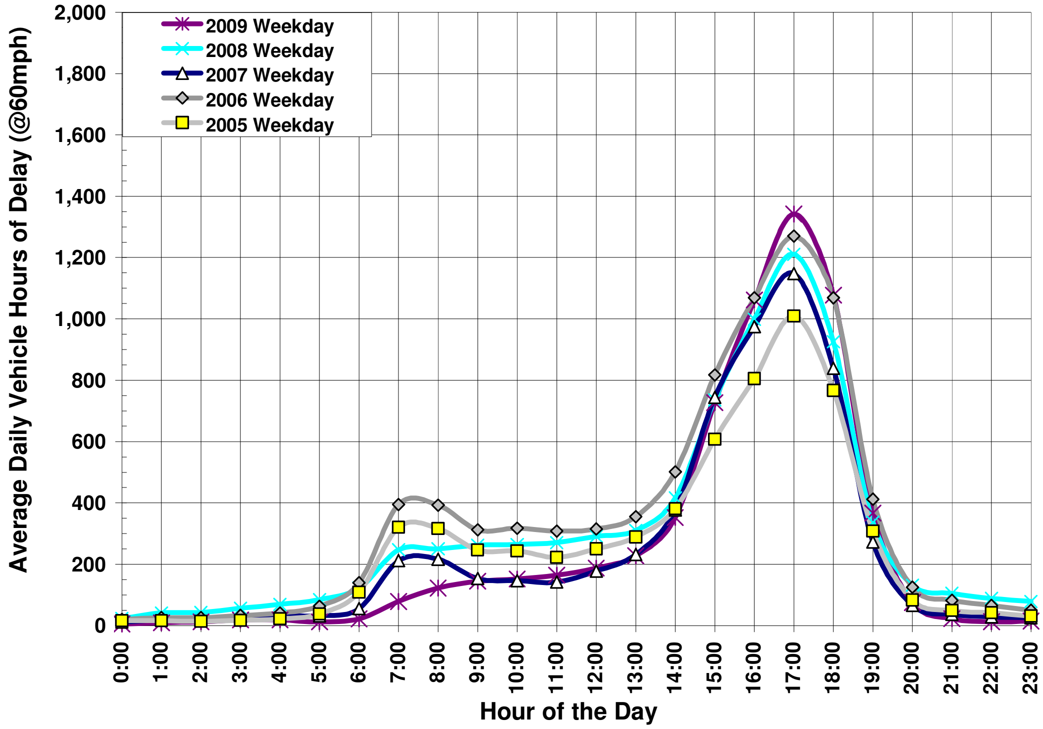
**Exhibit ES-4: I-5 Delay by Day of Week by Severity (2005-2009)**



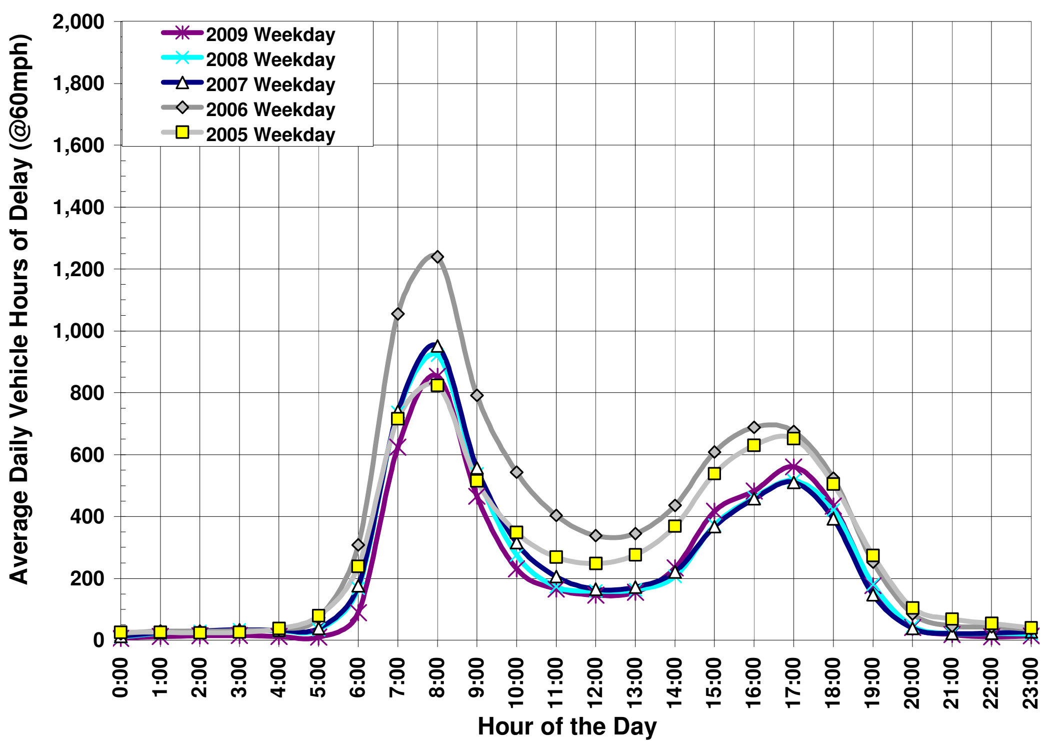

Exhibits ES-5 and ES-6 summarize average annual weekday delay by hour of the day for the five-year period for both directions of the corridor. These exhibits allow planners and decision makers to understand the trend in peak period delay spiking (greater variance/differences) and peak period spreading (longer duration) by comparing the intensity and duration of the peak period congestion.

- The corridor is highly directional with the northbound direction experiencing significant delay during the PM peak and the southbound direction experiencing significant delay during the AM peak period.
- The AM peak hour occurs between 7:00 AM and 8:00 AM, and the PM peak hour occurs between 5:00 PM and 6:00 PM. This is typical for an urban corridor serving a large number of work trips during the peak period.
- In 2009, southbound AM peak period congestion was over 30 percent less than the 2006 peak (from an estimated high of over 1,240 in 2006 to around 825 hours in 2009). However, northbound PM peak congestion in 2009 was higher than the previous years at around 1,375 hours.
- Midday congestion is present on both directions of the corridor at around 200-400 hours.

## Exhibit ES-5: Northbound I-5 Hourly Delay (2005-2009)




## Exhibit ES-6: Southbound I-5 Hourly Delay (2005-2009)



*Travel Time*

The travel time performance measure represents the average time it takes for a vehicle to travel between the I-10 and I-210.

Exhibits ES-7 and ES-8 summarize average annual travel times estimated for the corridor by hour of day for years 2005 through 2009. Similar to delay, travel times in 2009 were highest in the northbound direction during the PM peak, but lowest in the southbound direction during the AM peak. PM peak period travel time in the northbound direction slightly increased from 39 minutes in 2006 to 40 minutes in 2009. In contrast, AM peak period travel time decreased from 39 minutes in 2006 to 34 minutes in 2009.

**Exhibit ES-7: Northbound I-5 Travel Time by Hour (2005-2009)**

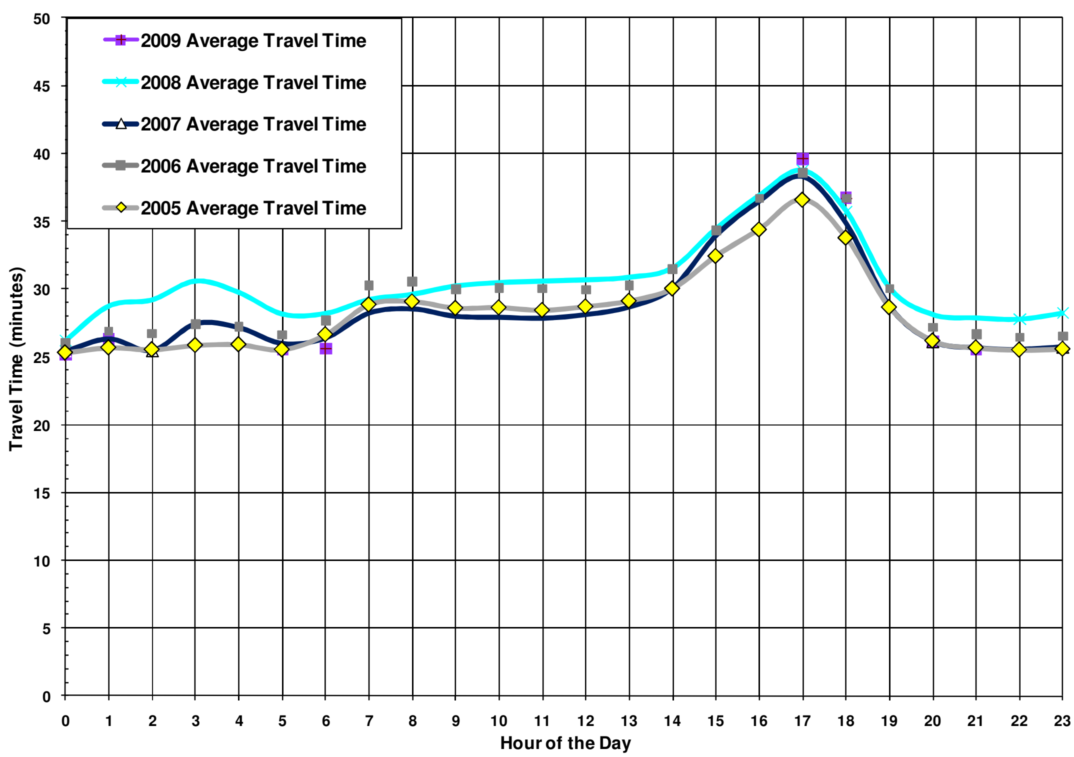
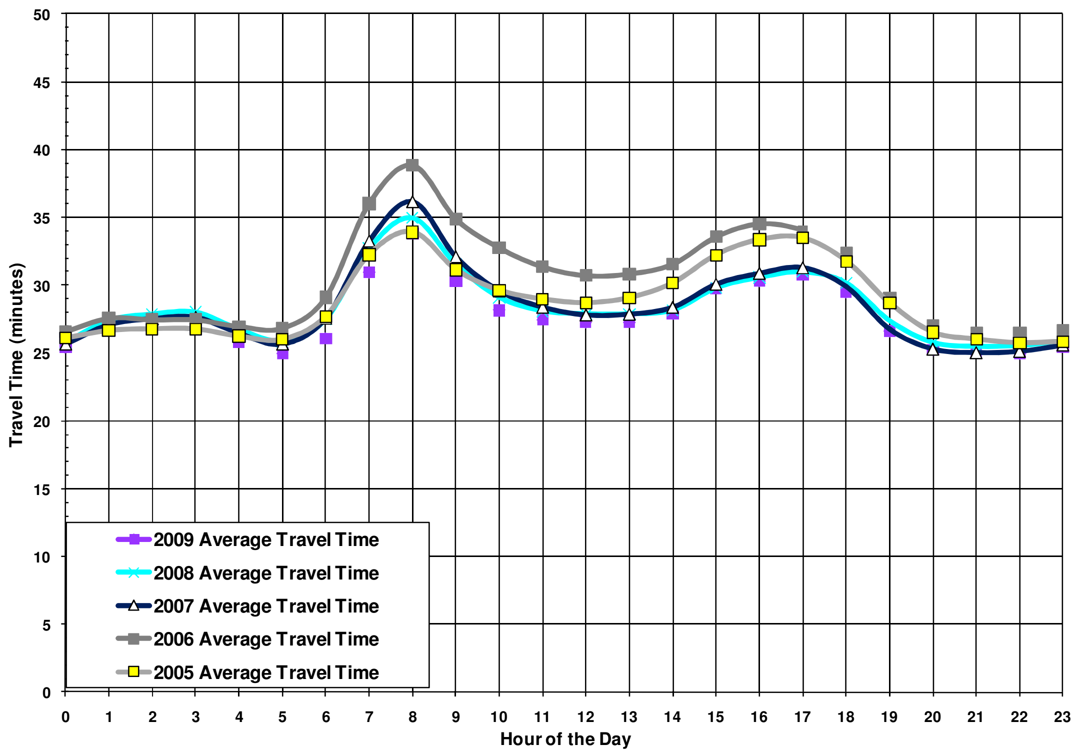


**Exhibit ES-8: Southbound I-5 Travel Time by Hour (2005-2009)**




## 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, but the 95th percentile represents a balance between days with extreme events (e.g., major accidents) and other, more "typical" travel days.

Exhibits ES-9 and ES-10 illustrate travel time variability along I-5 on non-holiday weekdays for 2007. The technical CSMP shows the buffer index for the years 2005 to 2009, but this Executive Summary reports only the data for the mainline freeway in 2007 since that year was used as the base year for modeling.

Exhibit ES-9 shows that during the 5:00 PM hour, motorists driving northbound for the entire length of the corridor had to add 6 minutes to an average travel time of 38 minutes (for a total travel time of 44 minutes) to ensure that they arrived on time 95 percent of the time. Southbound, during the 8:00 AM peak hour (Exhibit ES-10), a driver needed to add 10 minutes to the 36-minute average (46 minutes total) to ensure an on-time arrival.

**Exhibit ES-9: Northbound I-5 Travel Time Variability (2007)**

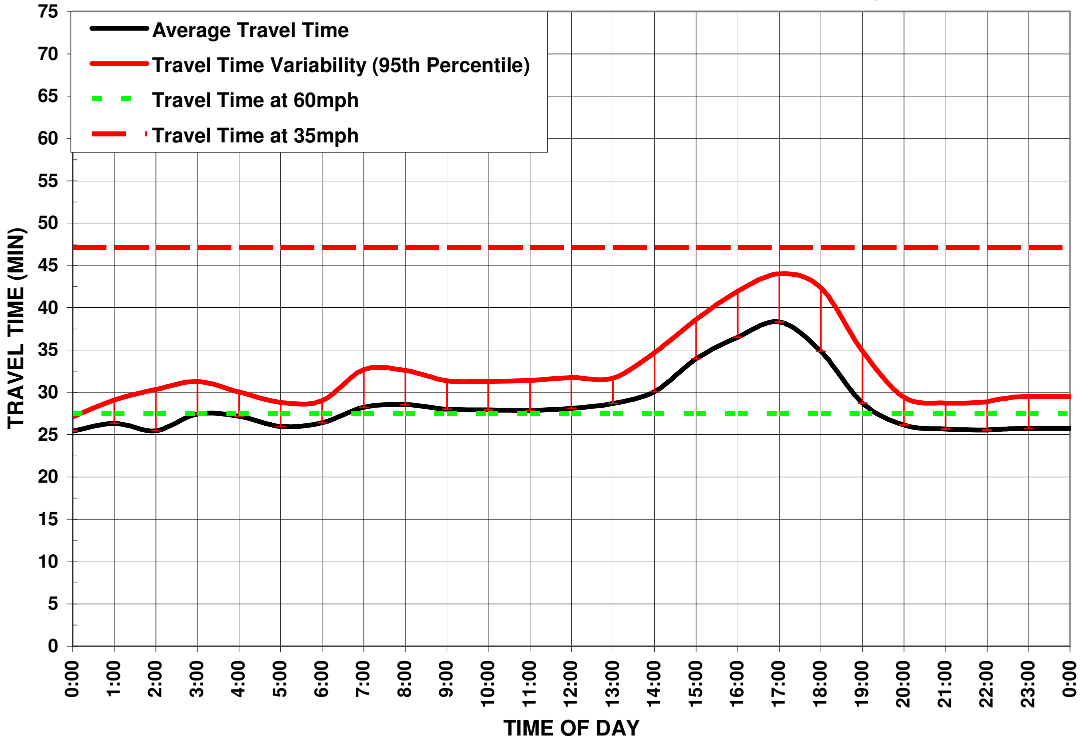
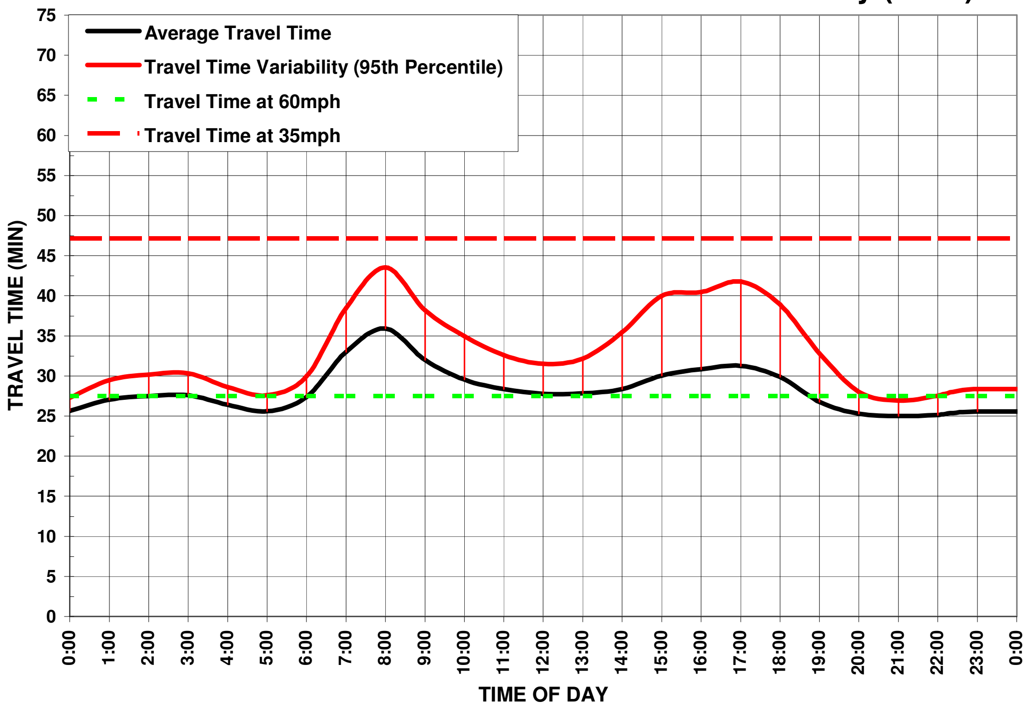


**Exhibit ES-10: Southbound I-5 Travel Time Variability (2007)**



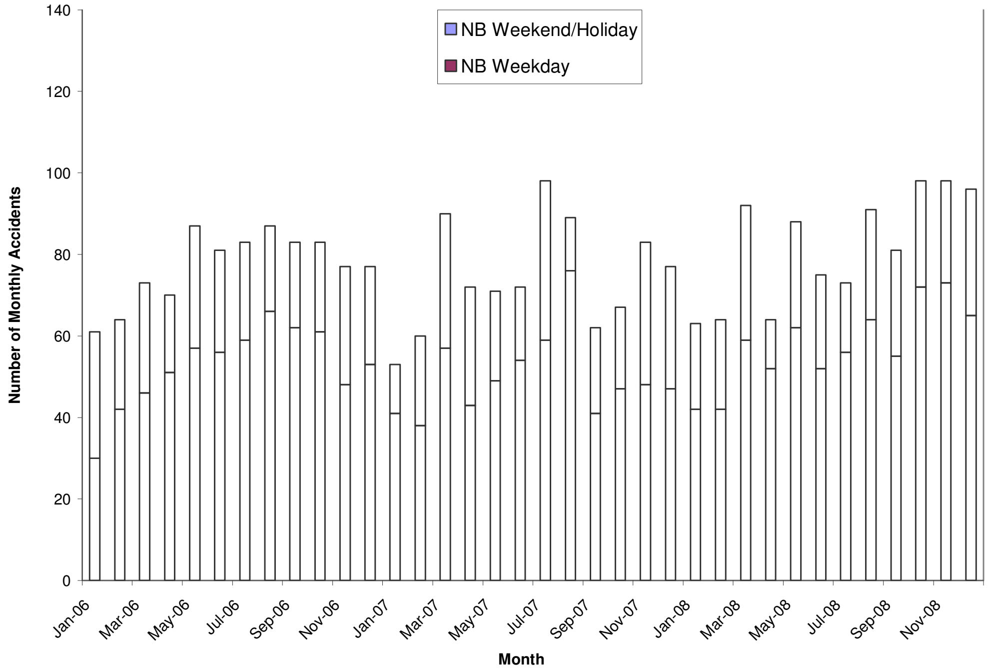

## Safety

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).

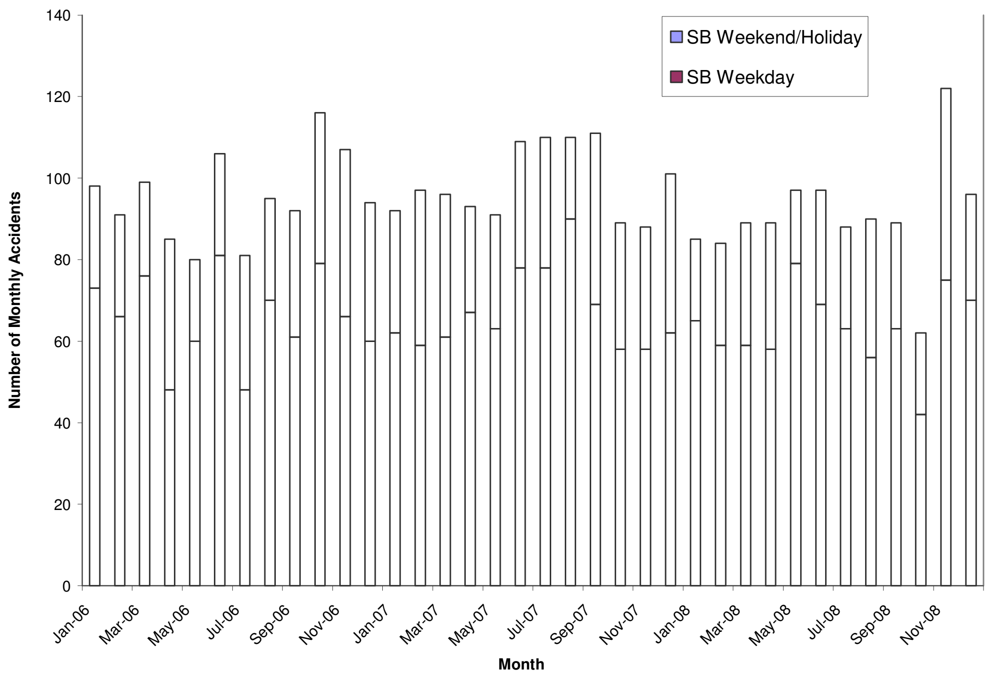
The safety assessment in this report intends to characterize the overall accident history and trends in the corridor, and to highlight notable accident concentration locations or patterns that are readily apparent. This report does not intend to supplant more detailed safety investigations routinely performed by Caltrans staff.

Exhibits ES-11 and ES-12 summarize the I-5 northbound and southbound accidents by month, respectively. The exhibits summarize the latest available three-year data from January 1, 2006 through December 31, 2008. Weekday accidents comprised typically over 70 percent of total accidents. The number of northbound incidents decreased from 2006 to 2007 but increased in 2008 toward the latter part of the year. This may have reduced incident-related delays. Southbound accident rates increased slightly from 2006 to 2007 and decreased from 2007 to 2008. The average monthly number of collisions during this three-year period was greater in the southbound direction.

## Exhibit ES-11: Northbound I-5 Monthly Collisions (2006-2008)




## Exhibit ES-12: Southbound I-5 Monthly Collisions (2006-2008)



## Productivity

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

Exhibit ES-13 illustrates how congestion leads to lost productivity. The exhibit uses observed I-5 data from sensors for a typical 2010 afternoon peak period (May 12, 2010). It shows speeds (in red) and flow rates (in blue) on northbound I-5 at Alameda Avenue, one of the most congested locations on the corridor.

Flow rates (measured as vehicle-per-hour-per-lane or "vphpl") at Alameda Avenue averaged slightly over 1,650 vphpl between 2:00 PM and 2:30 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. With any additional merging or weaving, traffic breaks down and speeds can rapidly plummet to below 35 mph. In essence, every incremental merge takes up two spots on the freeway for a short time. However, since the volume is close to capacity, these merges lead to queues. Rather than accommodating the same number of vehicles, flow rates also drop and vehicles back up, creating bottlenecks and associated congestion.

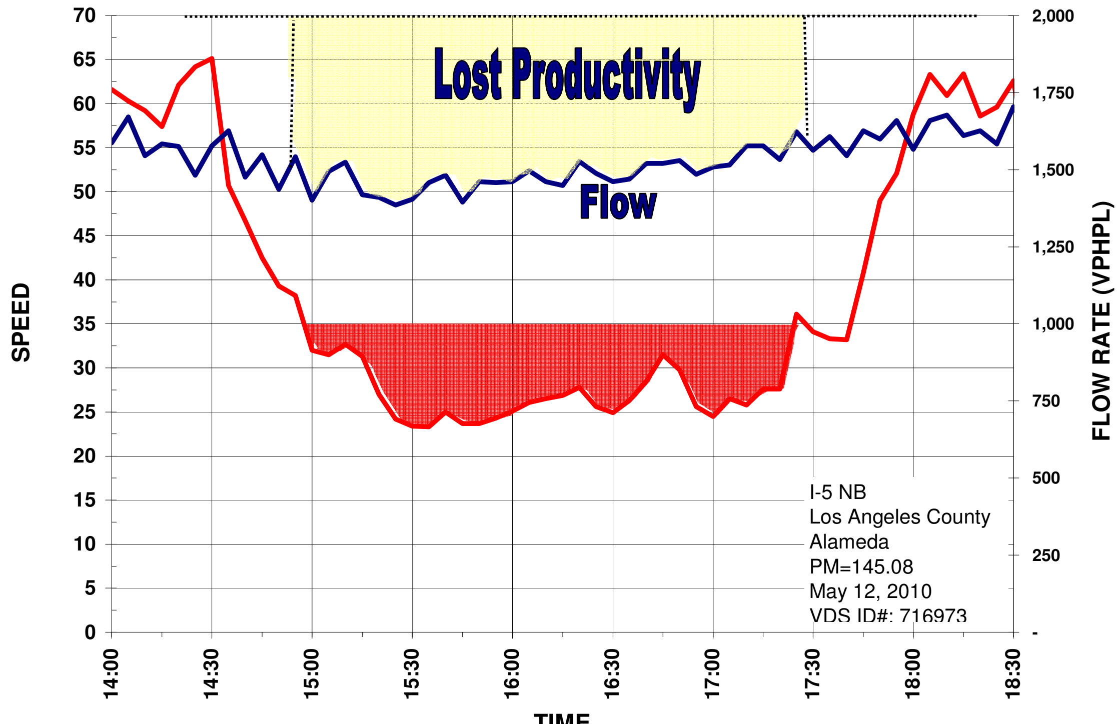
At the location shown in Exhibit ES-13, throughput drops by nearly 10 percent on average during the peak period (from over 1,650 to around 1,500 vphpl). This four-lane road therefore operates with 10 percent less capacity when demand is at its highest. Stated differently, just when the corridor needed 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".

The estimated average non-holiday, weekday equivalent lost lane-miles by period and year on I-5 is shown in Exhibit ES-14. A few notes on this exhibit:

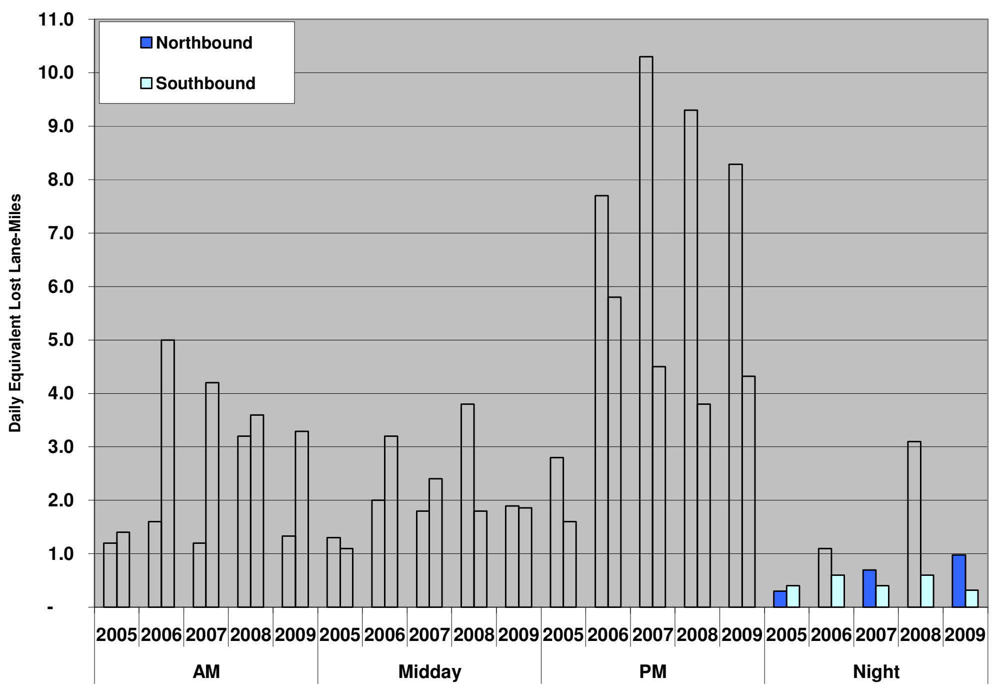
- The largest productivity losses occurred in the PM peak hours in the northbound direction. Productivity during the PM peak in both directions generally improved from 2007 to 2009.
- Productivity during the AM peak also improved in the northbound direction from 2006 to 2009.

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-13: Lost Productivity Illustrated




## Exhibit ES-14: I-5 Average Daily Equivalent Lost Lane-Miles by Direction, Time Period, and Year (2005-2009)



# BOTTLENECK IDENTIFICATION AND CAUSALITY ANALYSIS

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.

Exhibit ES-15 summarizes the northbound and southbound bottleneck locations, the time period that these bottlenecks are active, and the causes of the bottlenecks. Exhibits ES-16 and ES-17 are maps of the corridor showing the bottleneck locations for the AM and PM peak periods, respectively.

The specific location and causality of each major I-5 North Corridor 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 explains in detail the process and results of the bottleneck identification and causality analysis.

## Exhibit ES-15: Los Angeles I-5 North Bottleneck Locations

### Northbound

| Abs | CA | Bottleneck Location | Active Period | | Causality Summary |
|---|---|---|---|---|---|
| | | | AM | PM | |
| 135.2 | 18.6 | I-10 On | | ✓ | Heavy volumes from the I-10 connector |
| 138.0 | 21.3 | SR-110 On | ✓ | ✓ | Heavy ramp merge; lost of lane to SR-2 exit |
| 143.5 | 26.8 | SR-134 On | | ✓ | Heavy ramp merge; roadway curves |
| 145.2 | 28.6 | Alameda On | | ✓ | Heavy ramp merge; unmetered collector-distributor; roadway curves |
| 152.7 | 36.1 | Sheldon On | | ✓ | Heavy ramp merge; roadway curves |
| 153.9 | 37.2 | Osborne Off | ✓ | ✓ | Merging and weaving between SR-170 and Osborne |
| 155.6 | 38.9 | SR-118 Off | | ✓ | Reduction in capacity from 7 to 3 lanes |

### Southbound

| Abs | CA | Bottleneck Location | Active Period | | Causality Summary |
|---|---|---|---|---|---|
| | | | AM | PM | |
| 155.5 | 38.9 | SR-118 On | ✓ | | Heavy ramp merge |
| 153.0 | 36.4 | SR-170 Off | ✓ | | Queuing on the SR-170 off-ramp |
| 143.5 | 26.9 | SR-134 Off | | ✓ | Queuing on the SR-134 off-ramp |
| 139.3 | 22.7 | SR-2 Off | ✓ | ✓ | Loss of lane to SR-2 and Stadium Way |
| 138.5 | 21.9 | SR-2 On | ✓ | ✓ | Heavy ramp merge |
| 137.6 | 21.0 | I-110 Off | ✓ | ✓ | Queuing on the I-110 off-ramp |

**Exhibit ES-16: Map of Major AM Bottlenecks on I-5 North Corridor**

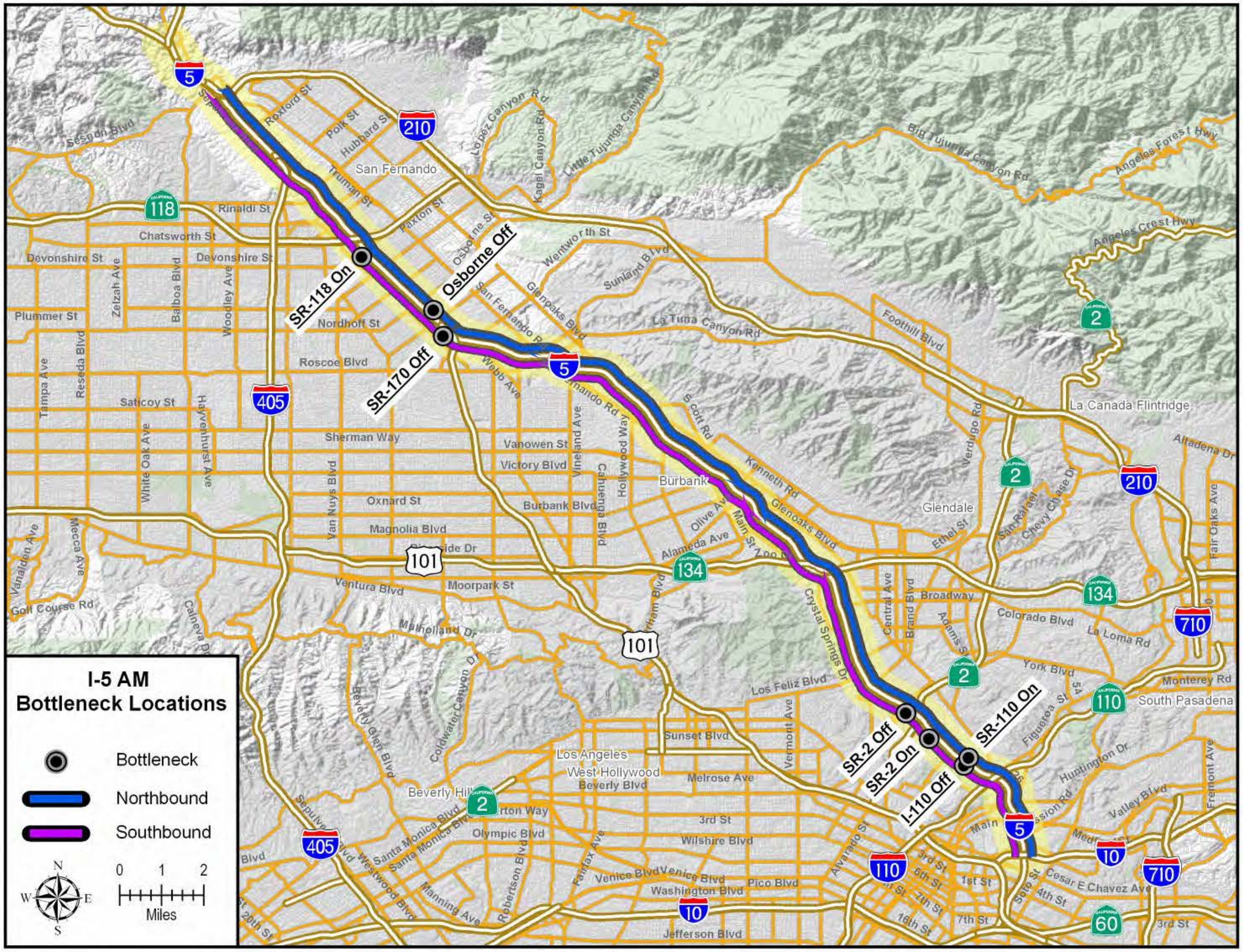
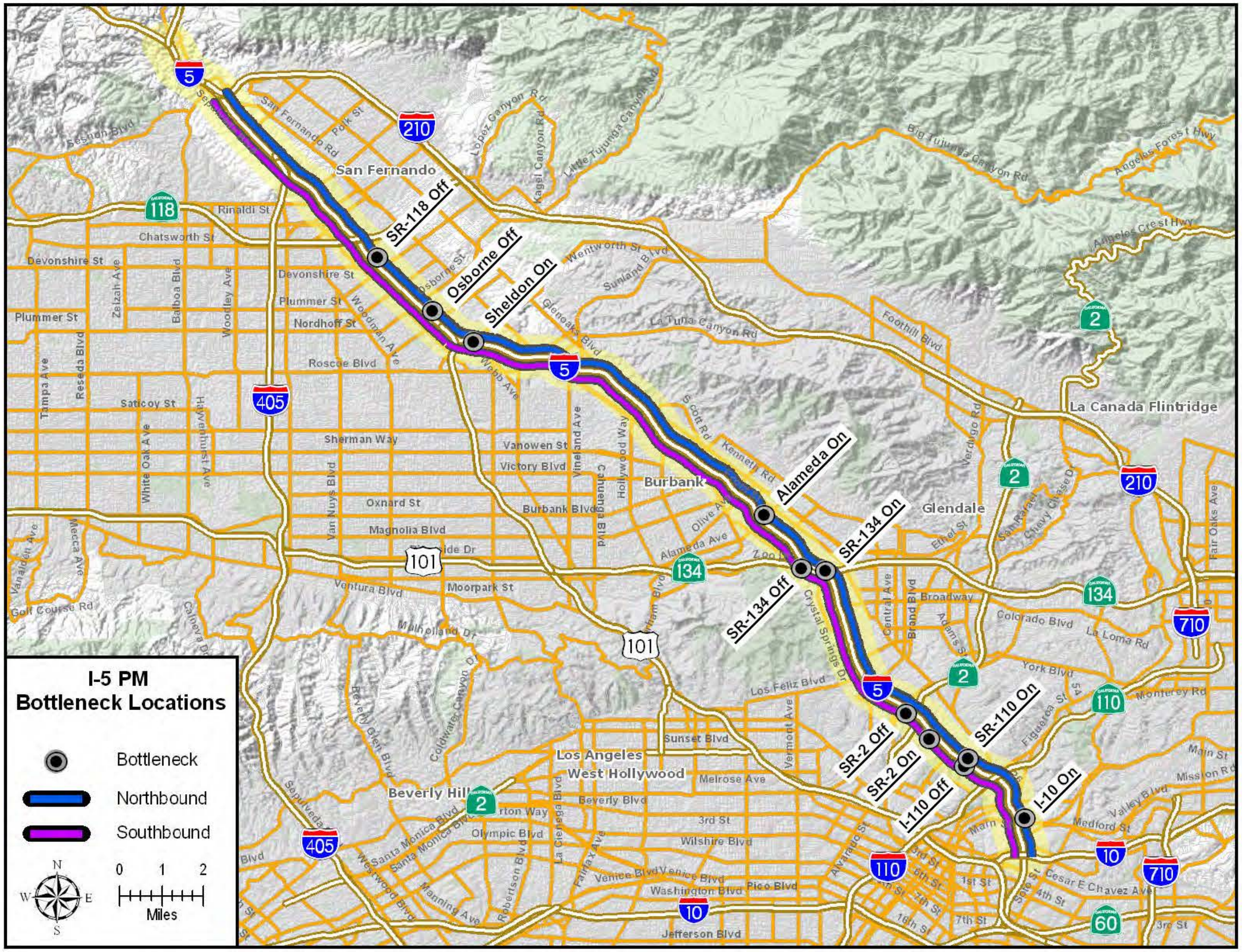


**Exhibit ES-17: Map of Major PM Bottlenecks on I-5 North Corridor**



# 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 VISSIM 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.

The model was calibrated against 2007 conditions. This was a resource-intensive effort, requiring several submittal and review cycles until the model reasonably matched bottleneck locations and relative severity. Once calibration was approved, a 2020 model was also developed based on SCAG's travel demand model projections.

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

Exhibit ES-18 depicts the network included in the model. There are no parallel arterials in the model with the exception of arterials at interchanges. All freeway interchanges were included as well as on-ramps and off-ramps.

**Exhibit ES-18: I-5 North Micro-Simulation Model Network**


## *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 fully programmed.
- Operational projects were generally combined separately from expansion projects in order to distinguish between their benefits.

- Short-term projects to be delivered by 2011 were used to develop scenarios to be tested with the 2007 model.
- Long-term projects to be delivered by 2020 were used to develop scenarios to be tested with the 2020 model.

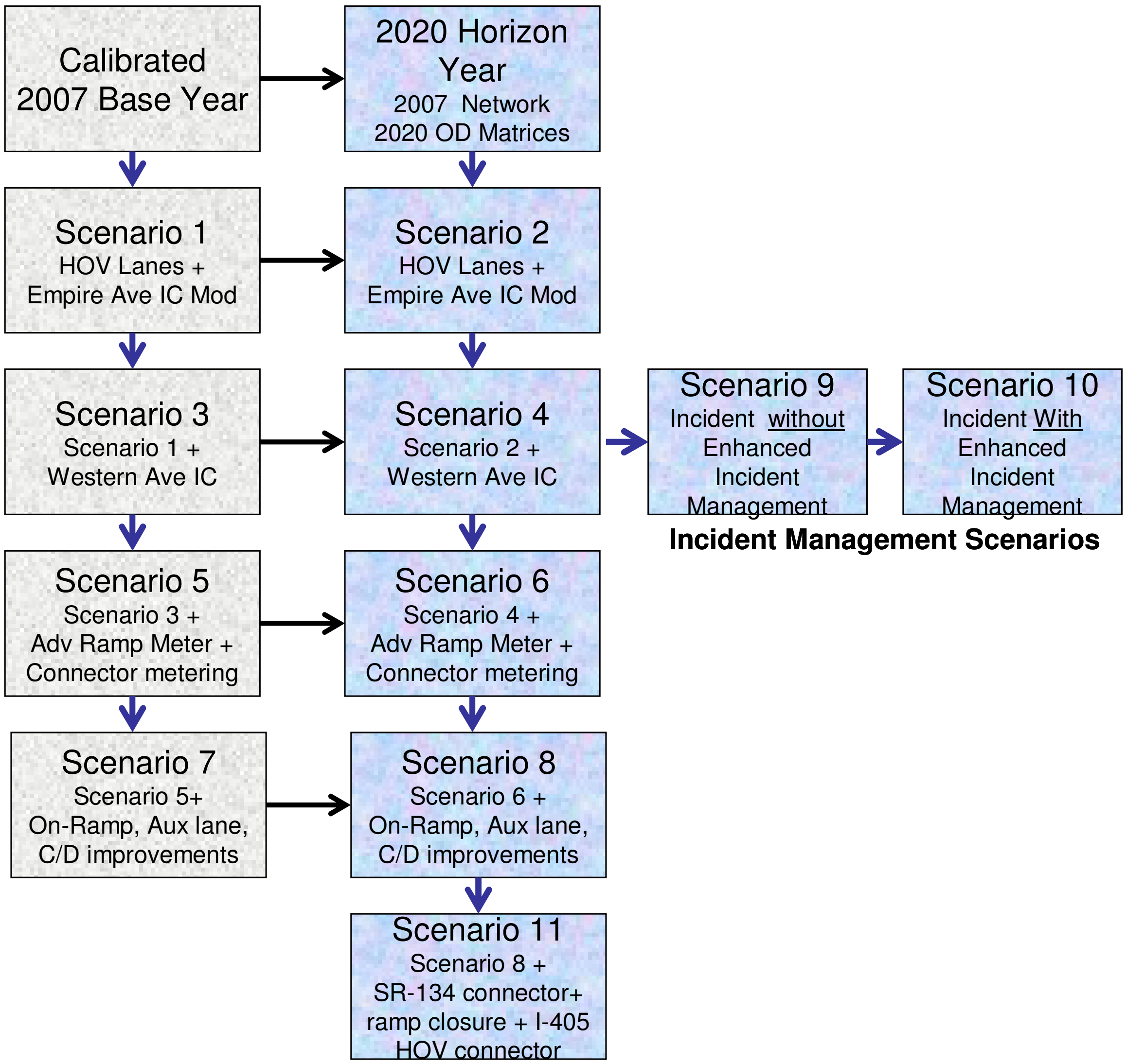
The study team assumed that projects delivered before 2011 could reasonably be evaluated by using the 2007 base year model. The 2020 forecast year for the I-5 North corridor was consistent with the SCAG regional travel demand model origin-destination matrices. When SCAG updates its travel demand model and Regional Transportation Plan (RTP), Caltrans may wish to update the micro-simulation model with revised demand projections.

Project lists used to develop scenarios were provided by SCAG and Caltrans from the Regional Transportation Improvement Program (RTIP), the RTP, the State Highway Operation and Protection Program (SHOPP), 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.

Scenario testing performed for the I-5 North CSMP differed from traditional "alternatives evaluations" done for Major Investment Studies (MIS) or Environmental Impact Reports (EIRs). An MIS or EIR focuses 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 I-5 North 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 since CSMPs are new and are often compared with alternatives studies.

Exhibit ES-19 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. As can be seen in the exhibit, most projects were tested in both the short-term and long-term and built upon prior scenarios. Enhanced incident management was tested in Scenarios 9 and 10 by comparing congestion with and without enhanced incident management. These scenarios assume that the prior scenario projects were built in the horizon year model and are expected for the longer term and were not tested using the short-term model.

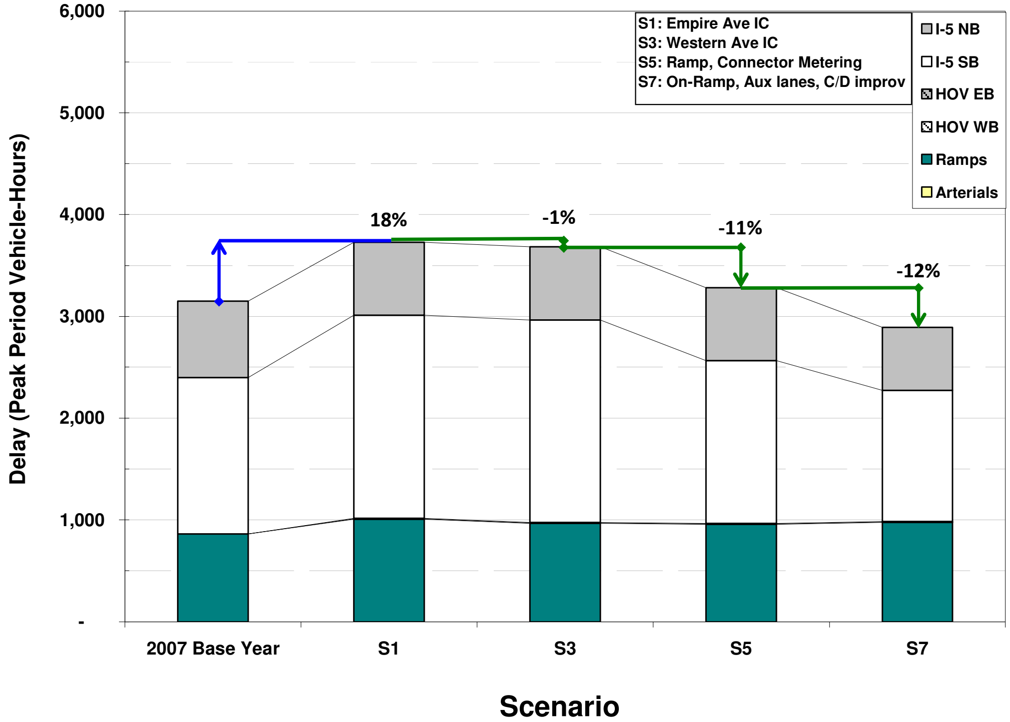
**Exhibit ES-19: Micro-Simulation Modeling Approach**



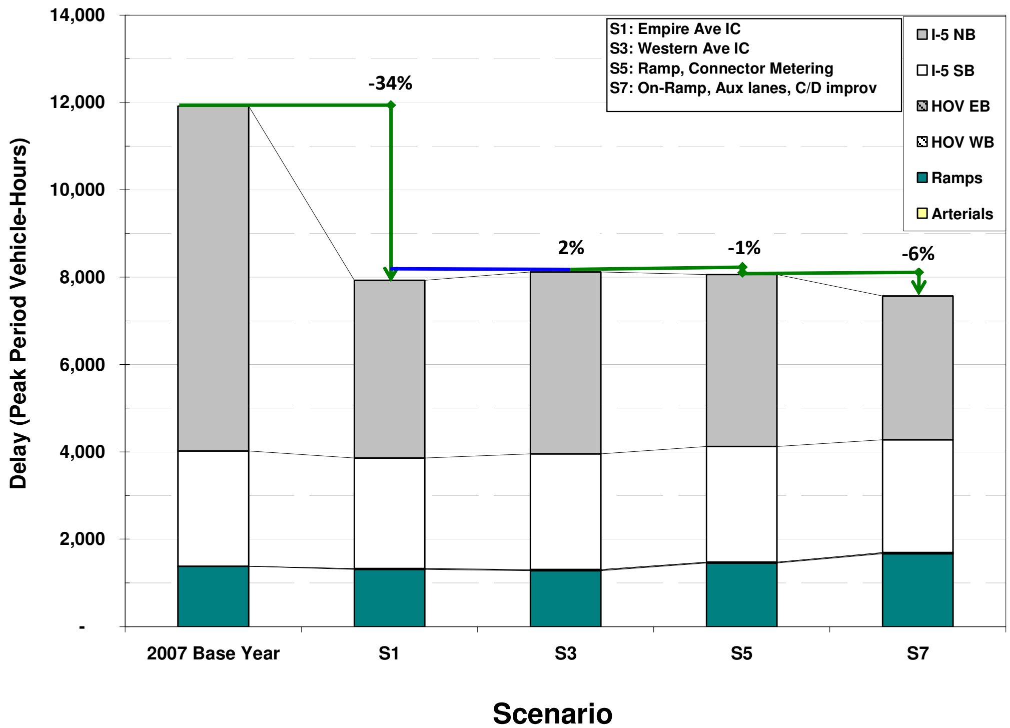

## *Scenario Evaluation Results*

Exhibits ES-20 and ES-21 show the delay results for all the 2007 scenarios evaluated for the AM and PM peak periods, respectively. Exhibits ES-22 and ES-23 show the delay results for all the 2020 scenarios evaluated for the AM and PM peak periods, respectively. For each scenario, the modeling team produced results by facility type (i.e., mainline, HOV, arterials, and ramps) and vehicle type (SOV, HOV, and 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. The following sections summarize findings for each scenario tested and reviewed by the study team.

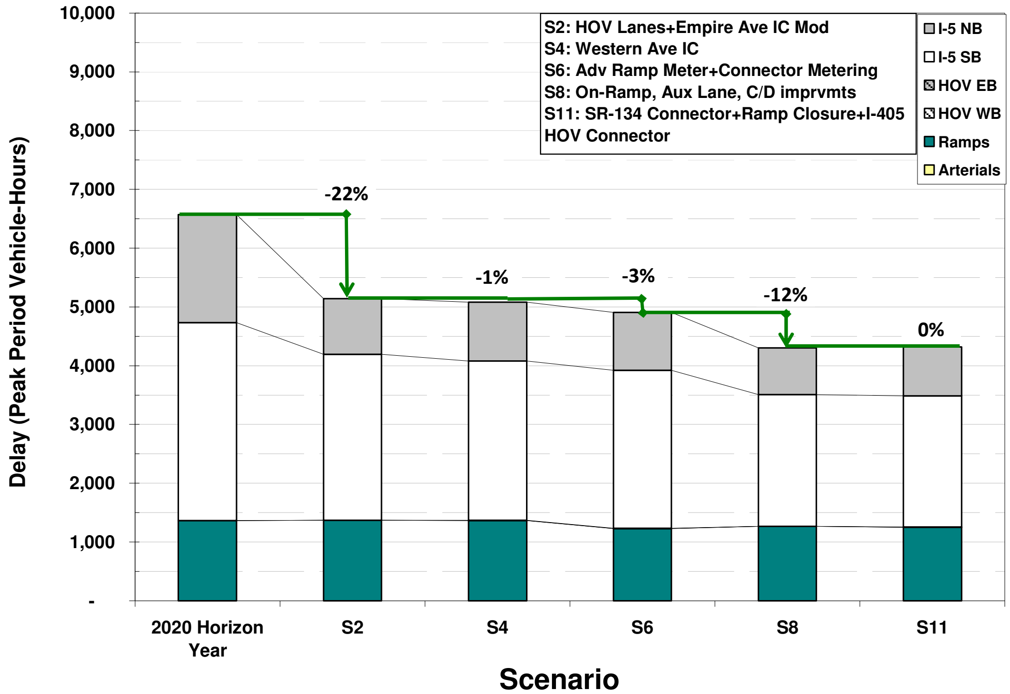
## Exhibit ES-20: AM Peak Micro-Simulation Delay Results by Scenario (2007)



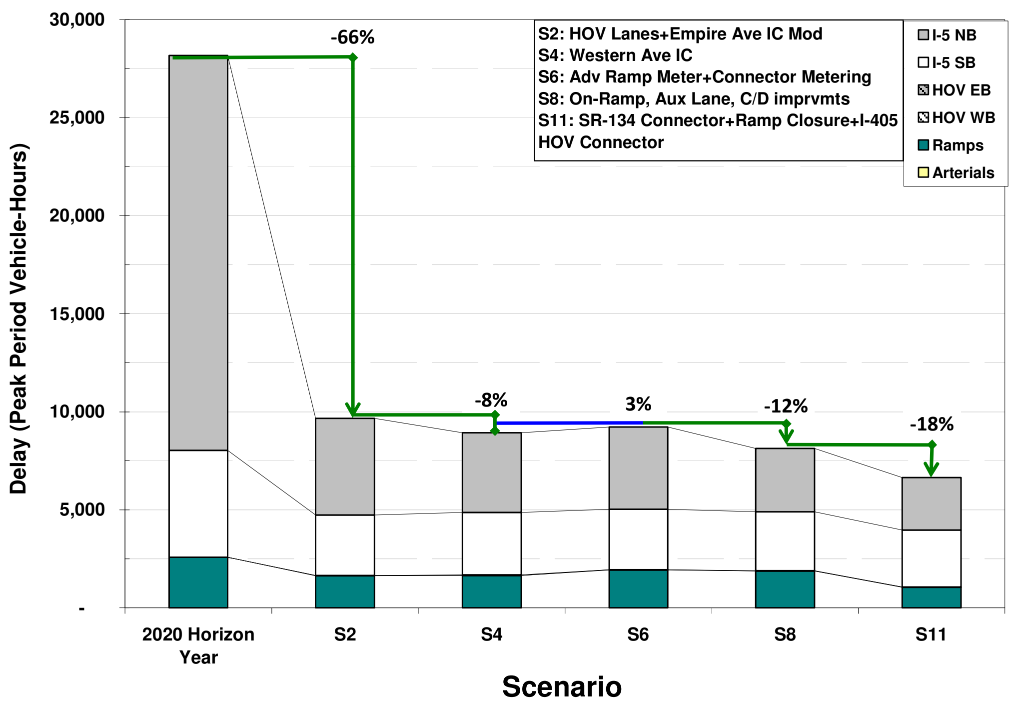

## Exhibit ES-21: PM Peak Micro-Simulation Delay Results by Scenario (2007)



## Exhibit ES-22: AM Peak Micro-Simulation Delay Results by Scenario (2020)




## Exhibit ES-23: PM Peak Micro-Simulation Delay Results by Scenario (2020)



**2007 Base Year and 2020 "Do Minimum" Horizon Year**

Absent any physical improvements, the modeling team estimates that total delay (mainline, HOV, and ramps) will more than double compared to 2007 (from a total of around 15,000 hours daily to more than 35,000 hours). As described below, the short term programmed projects lead to significant decreases and improved mobility on the corridor.

**Scenarios 1 and 2 (HOV Lanes + Empire Ave Interchange Modification)**

The first two scenarios include both completed (from 2008 to 2010) and fully funded programmed projects, including CMIA funded projects slated for completion by 2011. These projects include:

- Add one HOV lane in each direction from SR-118 to SR-14 (completed in 2008)
- Add one HOV lane in each direction from SR-134 to SR-170 (CMIA)
- Modify the Empire Avenue interchange; construct auxiliary lanes in both directions between Burbank Boulevard and Empire Avenue
- Add one HOV lane in each direction from SR-170 to SR-118, Construct I-5/SR-170 HOV to HOV connector; reconstruct I-5/SR-170 mixed flow connector.

The 2007 model estimates that these projects would reduce overall delay on the corridor by approximately 23 percent or about 3,500 vehicle-hours for both AM and PM peak period combined. It estimates that the PM peak period delay would decrease by approximately 34 percent or about 4,000 vehicle-hours. However, it would increase in the AM peak period by 18 percent or about 600 vehicle-hours, mostly in the southbound direction at the downstream segments where the HOV lane terminates and merges with the mainline traffic stream.

The 2020 model estimates that the projects would reduce total delay on the corridor by over 57 percent, almost 20,000 vehicle-hours for both AM and PM peak period combined. While both the AM and PM peak periods are estimated to reduce delay, the more significant reduction in delay occurs during the PM peak period when it drops from 28,000 vehicle-hours to 9,700 vehicle-hours with implementation of the HOV and interchange modification projects. The largest reduction in delay is estimated to occur in the northbound direction from Alameda to Sheldon.

**Scenarios 3 and 4 (Western Avenue Interchange)**

Scenarios 3 and 4 build on Scenarios 1 and 2 by adding a fully funded and programmed interchange improvement project at the Western Avenue interchange by realigning on- and off-ramps and providing for more capacity at the northbound Western Avenue off-ramp to Flower Street.

The 2007 model estimates that with the Western Avenue interchange improvements, not much change in the delay are expected either in the AM or PM peak periods on the freeway corridor, although they are expected to improve local circulation and access while removing the currently inefficient collector/distributor interchange configuration.

**Scenarios 5 and 6 (Advanced Ramp Metering + Connector Metering)**

Scenarios 5 and 6 build on Scenarios 3 and 4 by adding advanced ramp metering system such as dynamic or adaptive ramp metering system with connector metering with queue control (to ensure queuing does not exceed the capacity of the connector) at the following locations:

- SR-118 connector ramp to I-5
- Southbound SR-2 connector ramp to I-5

The 2007 model indicates that the projects would reduce delay in the AM peak by over 10 percent or 400 vehicle-hours and there would be negligible change in the PM peak. The 2020 model shows that the projects would reduce delays in the AM peak by three percent or 175 vehicle-hours, but could increase delays in the PM peak also by three percent, almost 300 vehicle-hours. Overall, the two models estimate that advanced ramp and connector metering would reduce congestion along the corridor by approximately 350 vehicle-hours of delay.

There are various types of advanced ramp metering systems deployed around the world, including the System-wide Adaptive Ramp Metering System (SWARM) tested on Los Angeles I-210 freeway corridor. For modeling on the I-5 South Corridor, the ALINEA system was tested as proxy for any advanced ramp metering system, since its algorithm for the model was readily available (and the algorithm for SWARM was not). However, the study team is not necessarily recommending ALINEA be deployed on I-5, but rather some type of advanced ramp metering system that would produce similar or better results.

**Scenarios 7 and 8 (Operational Improvements)**

Scenarios 7 and 8 build on Scenarios 5 and 6 by adding the following operational improvement projects proposed by the study team and Caltrans Traffic Operations staff:

- Extend the northbound I-10 on-ramp to improve merging
- Modify the Pasadena Avenue on-ramp to merge into the new collector-distributor (from Broadway) and move on-ramp merge further downstream
- Modify Riverside Drive on-ramp to northbound SR-110 on-ramp; reduce the SR-110 merge to one lane before merge with northbound I-5
- Restripe the northbound SR-134 on-ramp merge to solid white striping 1000-feet downstream of merge point; reduce on-ramp merge to one lane further upstream
- Modify the northbound Alameda interchange to eliminate the collector-distributor

- Modify the northbound Sheldon interchange to eliminate the collector-distributor
- Extend the fourth southbound lane through the SR-2 interchange.

The 2007 model shows that the combination of these projects would produce over 10 percent reduction in delay in the AM peak period and over five percent reduction in delay in the PM peak period, a total of 880 vehicle-hours. The 2020 model also shows a significant reduction of over 10 percent in delay in both the AM and PM peak periods, over 1,500 vehicle-hours reduction.

**Scenarios 9 and 10 (Enhanced Incident Management)**

Two incident scenarios that build on top of Scenario 4 were tested with only the 2020 model to evaluate the non-recurrent delay reductions resulting from enhanced incident management strategies. The proposed enhanced incident management strategies 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 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 also one 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 7:00 AM, close outermost mainline lane for 35 minutes at absolute post mile 140.7 (at Los Feliz)
- ♦ Northbound PM peak period starting at 5:00 PM, close outermost mainline lane for 40 minutes at absolute post mile 138.8 (south of SR-2).

In the second scenario (Scenario 10), the same collision incidents were simulated with a reduction in duration by 10 minutes for both incidents. It is estimated, based on actual incident management data analysis results provided by Caltrans, that an enhanced incident management system could reduce a 35-minute incident by about 10 minutes.

These scenarios represent a typical moderate incident at one location during the peak period direction. 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 without lane closures that last only a few minutes that also result in congestion. There are also many incidents that occur during off-peak periods.

Without enhanced incident management, the first scenario produced nearly 60 percent increase in delay in the AM peak and over 10 percent increase in delay in the PM peak over Scenario 4, an increase of over 4,000 vehicle-hours of delay. With enhanced incident management strategies by reducing duration by just 10 minutes, a decrease in delay of nearly 1,500 vehicle-hours could result with the improved detection, verification, response, and clearance time of one moderate level incident of both of the peak periods.

**Scenarios 11 (Long-Range Capital Improvements)**

Scenario 11 builds on Scenario 8 and tests several proposed longer-range capital improvement projects with only the 2020 model:

- Construct SR-134 HOV direct connectors
- Close the southbound Stadium Way exit and relocate the Fletcher Avenue exit to include Stadium traffic
- Eliminate one of the southbound lanes on the SR-2 connector on-ramp
- Construct an I-5/I-405 HOV connector.

The 2020 model shows that this group of projects while having nominal impact on delay in the AM peak is estimated to reduce delay by nearly 20 percent or almost 1,500 vehicle-hours in the PM peak.

## *Benefit-Cost Analysis*

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

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

Project costs were developed from SCAG and Caltrans project planning and programming documents. These costs include construction and support costs in current dollars. The study team estimated costs for projects that did not have cost estimates by reviewing similar completed projects. A B/C ratio greater than one means that a scenario's projects return greater benefits than the costs to construct or implement. It is important to consider the total benefits that a project brings. For example, a large capital expansion project can cost a great deal and have a low B/C ratio, but brings much higher absolute benefits to I-5 users.

Exhibit ES-24 shows B/C results for the major scenarios tested in the I-5 North Corridor. The results are classified from low (with a B/C of less than one) to high (with a B/C between 5 and 10).

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

- Scenarios 1 and 2 (HOV lanes + Empire Avenue Interchange Modification) produce a B/C ratio of between one and two. This is consistent with other typical capital expansion projects.
- Scenarios 3 and 4 (Western Avenue Interchange) produce a relatively low benefit-cost ratio of less than two. With just a localized improvement, impact on the entire corridor is expected to be nominal. The project is expected to produce a greater impact to the local traffic circulation and operations that may not be fully realized by the model.
- Scenarios 5 and 6 (Advanced Ramp Metering) produce a relatively low benefit-cost ratio of about one. The mobility gains on the freeway mainline are offset by the increases in delay on the proposed metered connectors. Further analysis may need to be conducted for considering advanced ramp metering deployment along this corridor.
- Scenarios 7 and 8 (Operational Improvements) produce a relatively modest benefit-cost ratio of just over three as compared to other similar type projects. Still, mobility benefits of over 1,500 vehicle-hours daily delay reduction are estimated in 2020.
- Scenarios 11 (Long Range Capital Improvements) produces a relatively low benefit-cost ratio of less than one, primarily due to the high cost of the I-5/I-405 HOV lane connector project estimated at over $330 million.
- The benefit-cost ratio of all the scenarios combined is just over one. In current dollars, costs add up to $1.5 billion whereas the benefits are estimated to be almost $1.8 billion.
- In addition, the projects also alleviate green house gas (GHG) emissions by almost one million tons over 20 years, averaging almost 50,000 tons reduction per year.

**Exhibit ES-24: 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 to 10 |
| 1/2 | HOV Lanes + Empire Ave IC Mod | | ★★ | | |
| 3/4 | Western Ave IC | | ★★ | | |
| 5/6 | Adv Ramp Meter + Connector Metering | ★ | | | |
| 7/8 | On-Ramp, Aux Lane, C/D imprvmts | | | ★★★ | |
| 11 | SR-134 Connector + Ramp Closure + I-405 HOV Connector | ★ | | | |

# CONCLUSIONS AND RECOMMENDATIONS

This section presents the overall conclusions and recommendations based on the micro-simulation analyses presented in the previous section. After a thorough review, the calibrated base year and forecast year model, of each scenario developed and analyzed, the study team believes that both the scenario results are reasonable and allow for more informed decision-making. Caution is advised in making decisions based on modeling alone. There other technical factors to be considered using engineering and professional judgment and experience in order to make the most effective project decisions that affect millions if not billions of dollars of investments.

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

- The combination of all scenarios significantly reduces overall congestion on the corridor. Projected 2020 congestion after implementation of all scenarios is above 2007 levels in the AM but well below 2007 levels in the PM peak period. In the AM peak period, the model projects total delay in 2020 after delivering all projects to be around 4,300 hours compared to the 2007 base year delay of 3,150 hours. This represents an increase of approximately 35 percent. In the PM peak period, the model projects total delay in 2020 after delivering all projects to be around 6,700 hours compared to the 2007 base year delay of almost 12,000 hours. This represents a reduction of almost 50 percent. Clearly, the scenarios deliver significant mobility benefits to the corridor. Despite the growth in demand, future 2020 congestion will be less than experienced in 2007.

- Due to the high cost of the HOV expansion projects in Scenarios 1 and 2, the overall benefit-cost ratio is between one and two meaning that for every investment dollar spend the region will get more than one dollar in benefits. However, the improvements in mobility, particularly in the most heavily congested segments along the corridor, are significant. While substantial mobility improvements are realized in the northbound direction along the entire corridor, the improvements along the southbound corridor are negated by the delay increase in the downstream segments where the proposed HOV lane terminates. An HOV lane extension may need to be considered for the long term.

- The Western Avenue interchange improvements also produced an overall benefit-cost ratio of over one. While the benefits along the freeway corridor are limited by a single point improvement, greater benefits to the local arterials that are not fully captured by the model are expected.

- Advanced ramp metering only brings modest mobility improvements on the corridor. Further analysis with additional measures such as various ramp and interchange modifications may need to be conducted and evaluated in considering advanced ramp metering deployment.

- Operational improvements such as auxiliary lanes and ramp improvements, combined with advanced ramp metering, could leverage on the programmed capital expansion projects by making the corridor more efficient and productive that could result in additional mobility benefits of nearly $100 million.

- Enhanced incident management strategies associated with Scenarios 9 and 10 to address non-recurrent congestion show promise with a delay reduction of over 700 vehicle-hours for one modest level incident with a typical duration of 35 minutes reduced to 25 minutes. With the I-5 North corridor experiencing over 2,000 collisions per year, this would amount to a total annual delay savings of approximately 1.4 million vehicle-hours for the study corridor.

- Long-range capital improvements included in Scenarios 11 are expected to produce relatively modest improvements in mobility with a nominal benefit to cost ratio, primarily due to the high cost of the I-5/I-405 HOV lane connector project estimated at over $330 million.

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 estimated ones in this document so that models can be further improved as appropriate.

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.