IFORNIA
I GOVERNMENTS

Corridor System Management Plan (CSMP)

Los Angeles I-210 Corridor

Final Report

September 2010

I approve this Corridor System Management Plan (CSMP) for I-210 in Caltrans District 7 as the overall Policy Statement and Strategic Plan that will guide transportation decisions and investment for the I-210 Corridor from I-5 to SR-57 in Los Angeles County.

Approval

Michael Miles 4/5/11

MICHAEL MILES Date

District 7 Director

Table of Contents

List of Exhibits

1. INTRODUCTION

This document represents the Draft Final Report of the Los Angeles Interstate 210 (I-210) Corridor System Management Plan (CSMP) developed on behalf of the California Department of Transportation (Caltrans) by System Metrics Group, Inc. (SMG).

This report contains the results of a two-year study that included several key steps, including:

- Stakeholder Involvement (discussed below in this Section 1)
- Corridor Description and Performance Assessment (Sections 2 and 3)
- Bottleneck Identification and Causality Analysis (Section 4)
- Scenario Development and Evaluation (Section 5)
- Conclusions and Recommendations (Section 6)

In 2007, SCAG and Caltrans embarked on an I-210 corridor study to identify ways to improve system productivity along the route. The corridor extends approximately 45 miles from the I-5 (Golden State Freeway) interchange in the San Fernando Valley to the SR-57 (Orange Freeway) interchange. The focus of the CSMP is the 20-mile congested urban section between SR-134 (Ventura Freeway) and SR-57. While SCAG and Caltrans are leading this effort, they are doing so in cooperation with Los Angeles County Metropolitan Transportation Authority (Metro), the San Gabriel Valley Council of Governments (SGVCOG), City of Los Angeles, and other local jurisdictions along the corridor.

This report presents a corridor performance assessment, identifies bottlenecks that lead to congestion, and diagnoses the causes for these bottlenecks. Alternative investment strategies were modeled using 2006 as the Base Year and 2020 as the Horizon Year.

This CSMP should be updated by Caltrans on a regular basis since corridor performance can vary dramatically over time due to changes in demand patterns, economic conditions, and delivery of projects and strategies. Such changes could influence the conclusions of the current CSMP and the relative priorities in investments. Therefore, it is recommended that updates occur no less than every two to three years. To the extent possible, this document has been organized to facilitate such updates.

The following discussion provides background to the system management approach in general and CSMPs in particular.

What is a Corridor System Management Plan (CSMP)?

In November 2006, voters 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). To be nominated by a Caltrans district or regional agency, California Transportation Commission (CTC) CMIA guidelines require that a project nomination describe how urban corridor capacity improvements would maintain mobility over time.

The guidelines also stipulate that the CTC will give priority to project nominations that include a CSMP. A CSMP is a comprehensive plan for supporting the congestion reduction and productivity improvements achieved on a CMIA corridor. CSMPs incorporate all travel modes - including State highways and freeways, parallel and connecting roadways, public transit (bus, bus rapid transit, light rail, intercity rail), carpool/vanpool programs, and bikeways. CSMPs also include intelligent transportation technologies such as ramp metering, coordinated traffic signals, changeable message signs for traveler information, and improved incident management.

This CSMP is the first attempt to integrate the overall concept of system management into Caltrans' planning and decision-making processes for the I-210 CSMP Corridor. Traditional planning approaches identify localized freeway problem areas and then develop solutions to fix those problems, often by building expensive capital improvement projects. The I-210 CSMP focuses on the system management approach with greater emphasis on using on-going performance assessments to identify operational strategies that yield higher congestion reduction and productivity benefits relative to the amount of money spent.

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 focused more on reducing congestion and increasing mobility through capital and operational strategies. Future CSMP work will further address pedestrian, bicycle and transit components and seek to manage and improve the whole network as an interactive system.

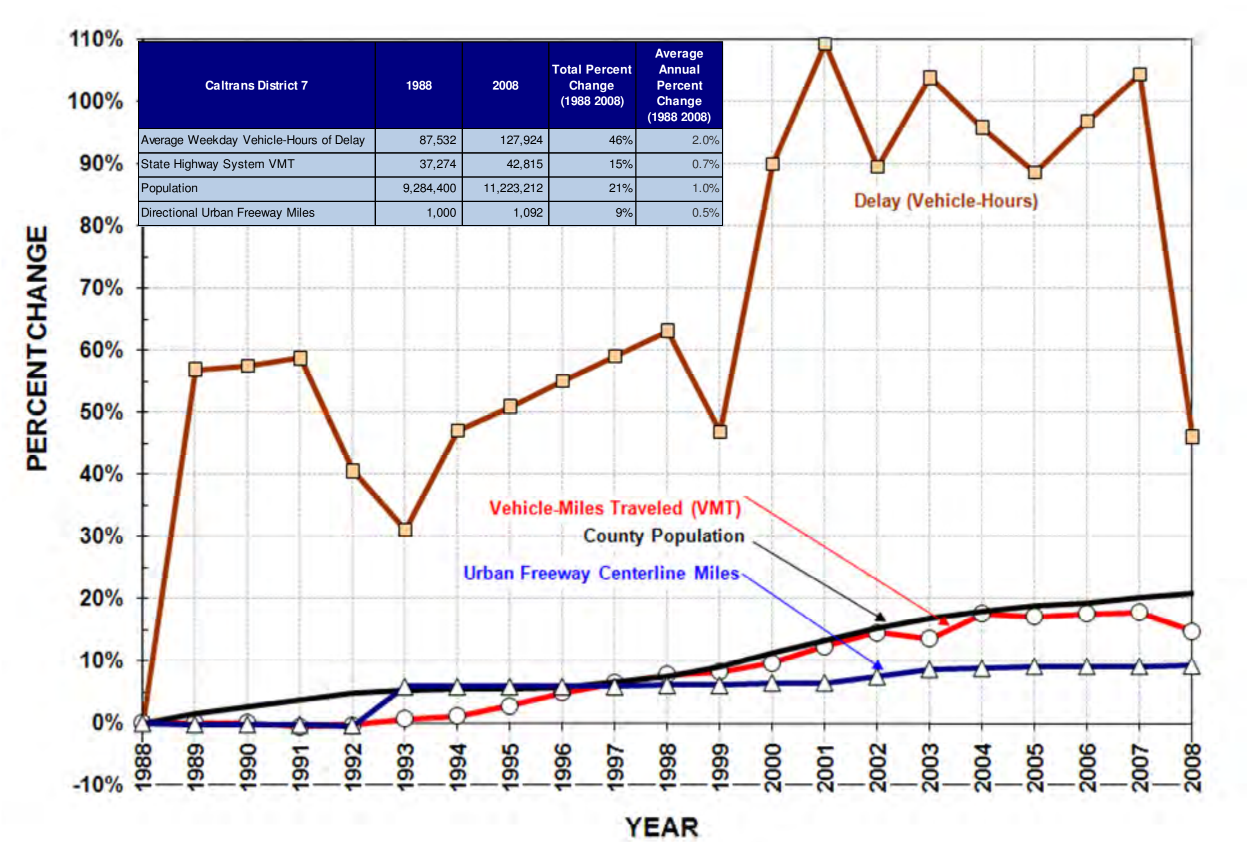
What is System Management?

With the rising cost and complexity of construction and right of way acquisition, the era of large-scale freeway construction is ending. Compared to the growth of vehicle-miles traveled (VMT) and population, congestion is growing at a much higher rate.

Exhibit 1-1 shows District 7 congestion (measured by average weekday recurring vehicle-hours of delay), VMT, and population between 1988 and 2008. Over that 20-year period, congestion increased 50 percent from the 1989 congestion level (just under two percent per year). Over the same period, VMT and population rose by about 20 percent (one percent per year). However, urban freeway miles barely grew at less than one-half a percentage point per year.

Clearly, infrastructure expansion has not kept pace with demographic and travel trends and is not likely to keep pace in the future. Therefore, if conditions are to improve, or at least not deteriorate as fast, a new approach to transportation decision making and investment is needed.

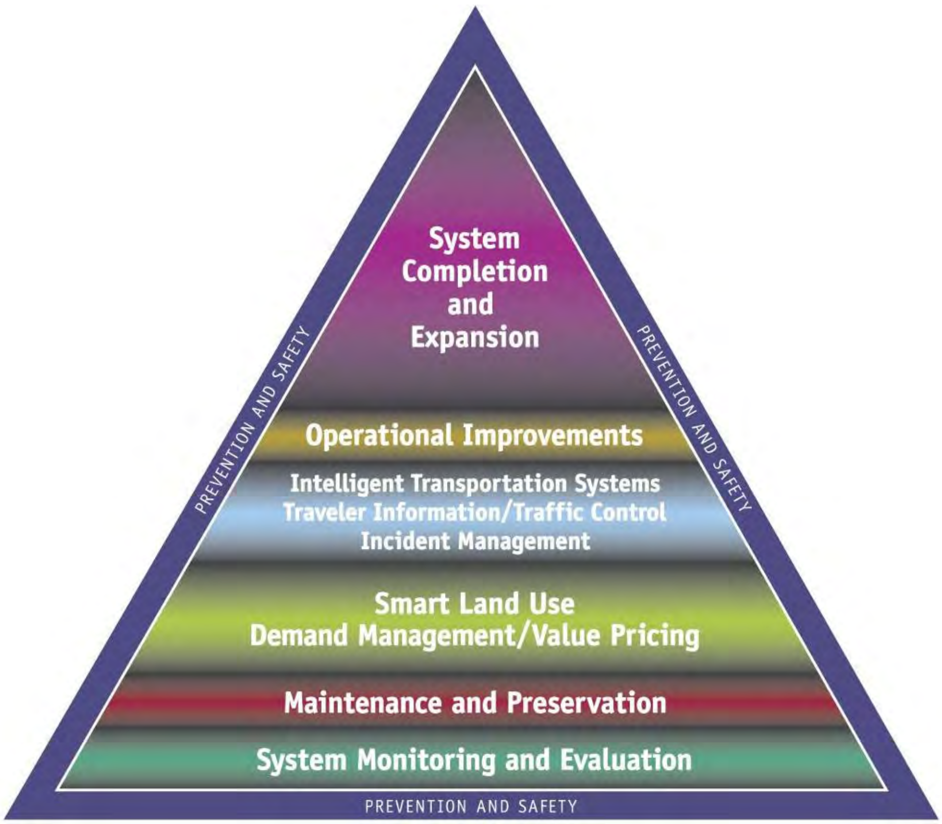
Exhibit 1-1: District 7 Growth Trends (1988-2008)



Caltrans District 7	1988	2008	Total Percent Change (1988 2008)	Average Annual Percent Change (1988 2008)
Average Weekday Vehicle-Hours of Delay	87,532	127,924	46%	2.0%
State Highway System VMT	37,274	42,815	15%	0.7%
Population	9,284,400	11,223,212	21%	1.0%
Directional Urban Freeway Miles	1,000	1,092	9%	0.5%

Caltrans and SCAG recognize this dilemma. Caltrans has adopted a mission statement that embraces the concept of system management. This mission and its goals are supported by the system management approach illustrated in the System Management pyramid shown in Exhibit 1-2.

Exhibit 1-2: System Management Pyramid



System Management is being touted at the federal, state, regional and local levels. It addresses both transportation demand and supply to get the best system performance possible. Ideally, Caltrans would develop a regional system management plan that addresses all components of the pyramid for an entire region comprehensively. However, because the system management approach is relatively new, it is prudent to apply it at the corridor level first.

The foundation of system management is monitoring and evaluation (shown as the base of the pyramid). This monitoring is done by comprehensive performance assessment and evaluation. Understanding how a corridor performs and why it performs the way it does is critical to crafting appropriate strategies. Section 3 is dedicated to performance assessment. It would be desirable for Caltrans to update this performance assessment every two or three years to ensure that future corridor issues can be identified and addressed before breakdown occurs on the corridor.

A critical goal of system management is to “get the most out” of the existing system, or maximize system productivity. One would think that a given freeway is most productive during peak commute times. Yet, this is not true for heavy commute corridors. In fact, for Los Angeles’ urban freeways that have been experiencing growing congestion, the opposite is true. When demand is the highest, the flow breaks down and productivity declines.

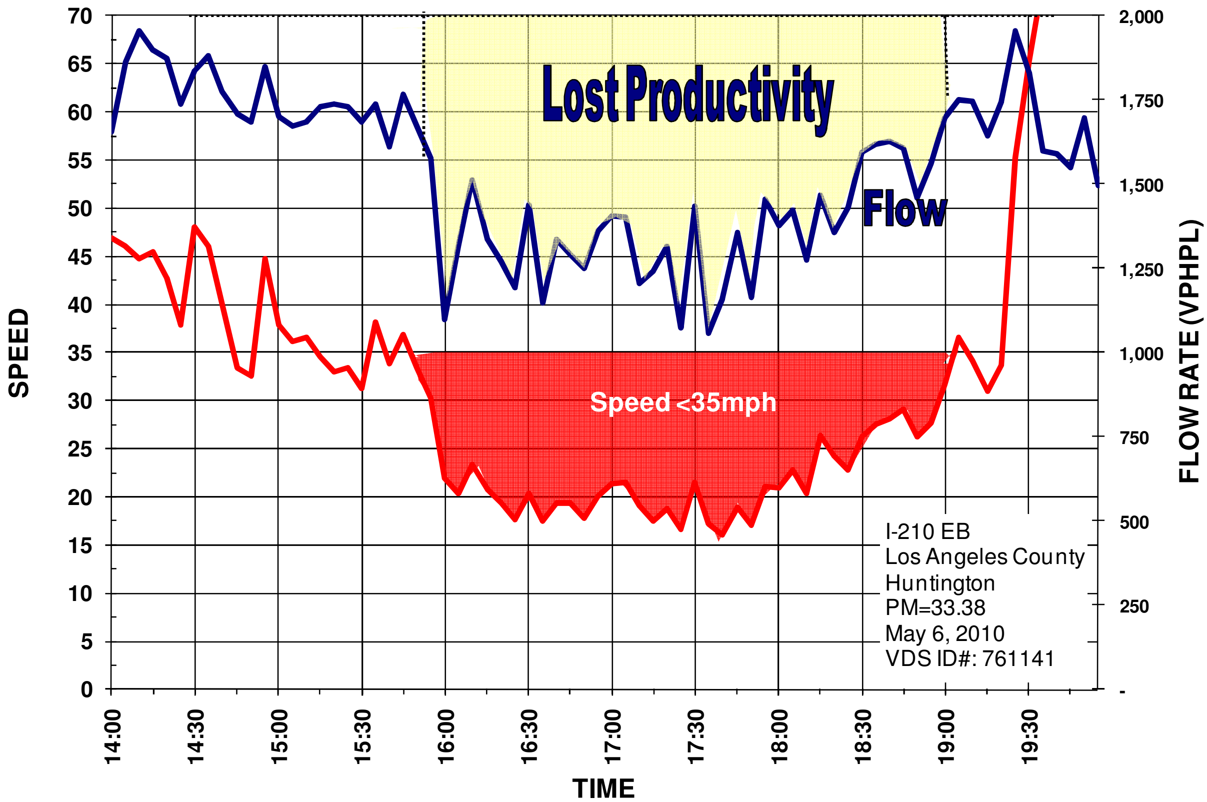
Exhibit 1-3 illustrates how congestion leads to lost productivity. The exhibit was created using observed I-210 data from a non-holiday weekday in May 2010 from Caltrans detector data. It shows speeds (red line) and flow rates (blue line) on eastbound I-210 at Huntington Drive. This location is one of the most congested locations on the corridor.

Flow rates (measured as vehicle-per-hour-per-lane or vphpl) at Huntington Drive average just over 1,700 vphpl between 2:00 PM and 3:30 PM, which is slightly less than a typical peak period maximum flow rate.

Once volumes exceed this maximum flow rate, traffic breaks down and speeds plummet to below 35-45mph. Rather than being able to accommodate the same number of vehicles, flow rates also drop and vehicles back up creating what we know as congestion. In the example in Exhibit 1-3, throughput drops by nearly 25 percent on average during the peak period. Since this is a four-lane road, it is as if one full lane were taken away during rush hour. Stated differently, just when the corridor needed the most capacity, it performed in the least productive manner and effectively lost lanes. This is a major cost of congestion that is rarely discussed or understood.

This is lost productivity. Where there is sufficient automatic detection, this loss in throughput can be quantified and presented as “Equivalent Lost Lane-Miles”. Discussed in more detail later in this report, the productivity losses on eastbound I-210 were almost 12.0 lane-miles during the PM peak period in 2009. Caltrans works hard to recover this lost productivity by investing in improvements that utilize public funds in the most effective manner. By largely implementing operational strategies, Caltrans can leverage past investments and restore productivity.

Exhibit 1-3: Productivity Loss During Severe Congestion



Infrastructure expansion, although still an important strategy (at the top of the pyramid in Exhibit 1-2), cannot be the only strategy for addressing the mobility needs in Los Angeles. System management is needed to get the most out of the current system and must be an important consideration as we evaluate the need for facility expansion investments. Simply stated, the system management philosophy begins by defining how the system is performing, understanding why it is performing that way, and then evaluating different strategies, including operations centric strategies, to address deficiencies. These strategies can then be evaluated using various tools to assess potential benefits to determine if these benefits are worthy of the associated strategy costs.

Stakeholder Involvement

The I-210 CSMP involved corridor stakeholders in two ways. First, a technical committee was formed and met on an almost monthly basis to discuss progress, technical challenges, data needs, and preliminary conclusions. This technical committee comprised of Caltrans, SCAG, and Metro professionals as well as the consulting team members.

Other corridor stakeholders, including representatives from cities bordering I-210 were briefed at critical milestones. Feedback from these 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:

- San Gabriel Valley Council of Governments
- Los Angeles County Department of Public Works
- City of Arcadia
- City of Azusa
- City of Claremont
- City of Duarte
- City of Glendora
- City of Irwindale
- City of LaVerne
- City of Monrovia
- City of Pasadena
- City of San Dimas.

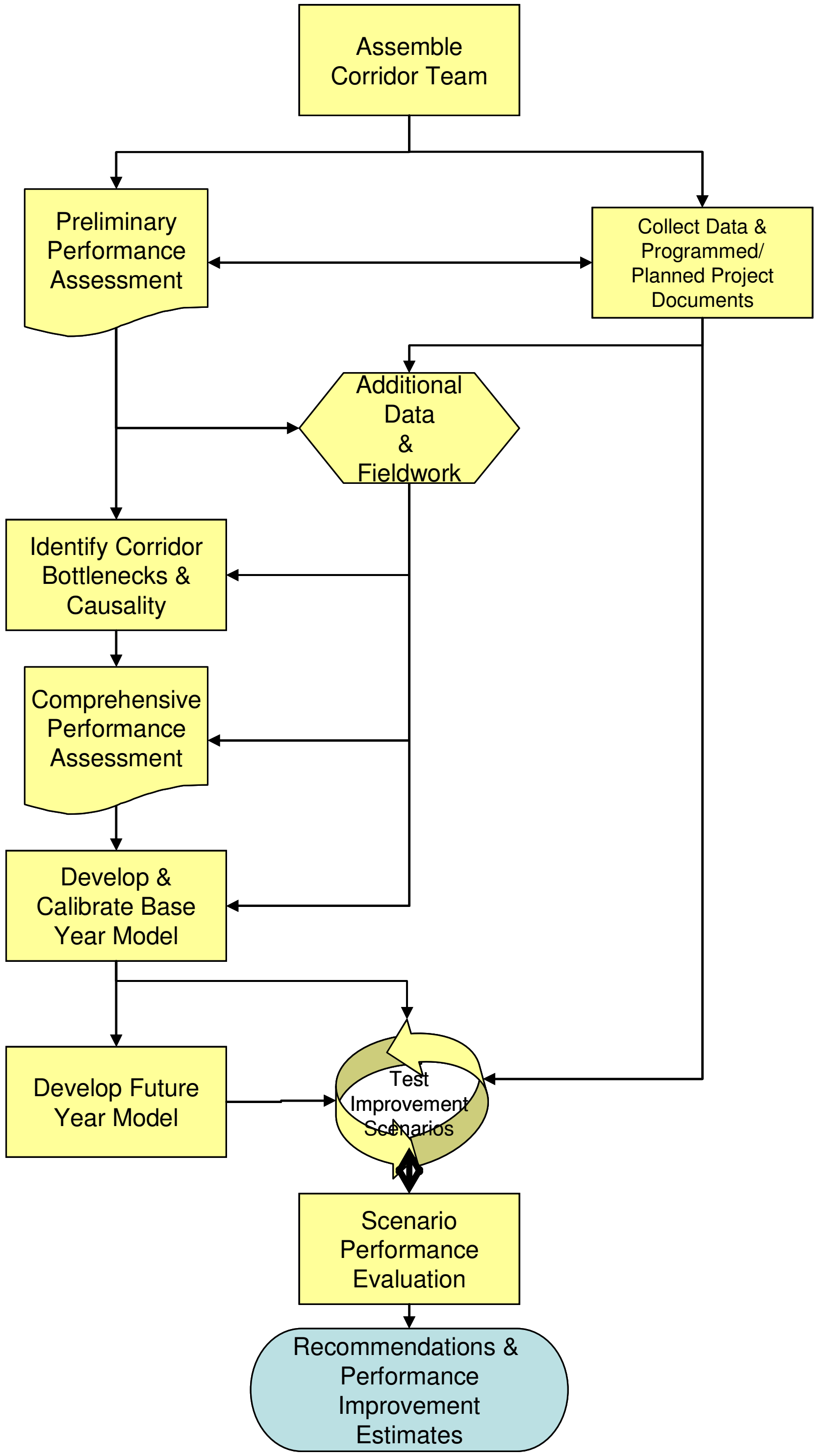
Caltrans and SCAG would like to thank all of its partners for contributing to this CSMP development process. In addition, the CSMP development provided a venue for tighter coordination between Caltrans planning and operations professionals, which is critical to the success of the system management approach.

Study Approach

The I-210 CSMP study approach follows system management principles by placing an emphasis on performance monitoring and evaluation (the base of the pyramid in Exhibit 1-2), and on using lower cost operational improvements to maintain system productivity.

Exhibit 1-4 is a flow chart that illustrates this approach. Each step of the approach is described in the following diagram.

Exhibit 1-4: Study Approach



Assemble Corridor Team

The first task in this effort was undertaken by Caltrans and SCAG with the creation of the I-405/I-210 Technical Advisory Committee (TAC). The TAC met most months to review project progress and to provide feedback to the study team. The TAC reviewed project progress and provided continuous feedback throughout the study. Additionally, Caltrans identified cities and other major stakeholders, whose input would be needed at critical project junctures (e.g., performance assessments, scenario reviews, and final report). The stakeholders group met several times during the study period to receive local feedback on project status updates and "buy off" on project milestones.

Preliminary Performance Assessment

The Preliminary Performance Assessment Report presented a brief description of the corridor and existing projects along on or adjacent to I-210. It included a corridor-wide performance assessment for four key performance areas: mobility, reliability, safety, and productivity. The assessment also included a preliminary bottleneck location assessment based on readily available, existing data and limited field observations.

The results of the Preliminary Performance Assessment were updated and included in the Comprehensive Performance Assessment described below. The results of these two assessments are presented in the Corridor Description and Corridor Performance sections - Sections 2 and 3 of this final report.

For future I-210 CSMP reporting, the Preliminary Performance Assessment should not be necessary, since its main purpose is to identify data gaps – particularly detection gaps. It is anticipated that these gaps will be addressed with improved automatic detection. Future updates to CSMPs can be made directly to this CSMP report.

Collect Data and Programmed/Planned Project Information

In conjunction with the Preliminary Performance Assessment, the study team reviewed existing studies, plans and other programming documents to assess additional data collection needs for modeling and scenario development. One of the key elements of this study was to identify projects that would be implemented in the short- and long-term timeframes to be included in the Vissim micro-simulation model developed by the study team.

Details of the projects included in the scenario analysis are discussed in Section 5: Scenario Development and Evaluation.

Additional Data Collection and Fieldwork

The study team identified locations where additional manual traffic counts would be needed to calibrate the 2006 Base Year micro-simulation model and coordinated the collection of the traffic count data.

The study team conducted several field visits in November and December 2007 and February and May 2008 to observe field conditions during peak periods and to video tape potential bottleneck locations. This fieldwork will be discussed in Section 4: Bottleneck Identification and Causality Analysis.

Identify Corridor Bottlenecks and Causality

Building on the Preliminary Performance Assessment and the fieldwork, the study team identified major AM and PM peak period bottlenecks along the corridor. These bottlenecks will be discussed in detail in Section 4 of this report.

Comprehensive Performance Assessment

Once the bottlenecks were identified and the causality of the bottlenecks determined, the study team prepared the Comprehensive Performance Assessment, which was delivered to Caltrans and SCAG in July 2009. This report builds on the Preliminary Performance Assessment and adds a discussion of bottleneck causality findings – including performance results for each individual bottleneck area. It also included corridor-wide performance results updated to reflect 2008 conditions.

Develop and Calibrate Base Year Model

Using the bottleneck areas as the basis for calibration, the modeling team developed a calibrated base year model for the year 2006. This model was calibrated against California and Federal Highway Administration (FHWA) guidelines for model calibration. In addition, the model was evaluated to ensure that each bottleneck area was represented in the model and that travel times and speeds were consistent with observed data. This process required several review iterations by SMG and the TAC.

Develop Future Year Model

Following the approval of the 2006 Base Year model, the modeling team developed a 2020 Horizon Year model to be used to test the impacts of short-term programmed projects as well as future operational improvements including the impacts of improved incident management on the corridor.

Discussion of the calibrated 2006 Base Year model can be found in Section 5: Scenario Development and Evaluation.

Test Improvement Scenarios

The study team developed scenarios that were evaluated using the micro-simulation model. Short-term scenarios included programmed projects that would likely be completed within the next five years along with other operational improvements, such as improved ramp metering. In addition to the short-term evaluations, short-term projects were tested using the 2020 Horizon Year model to assess their long-term impacts.

The study team also developed and tested other scenarios using only the 2020 model. These scenarios included programmed and planned projects that would not be completed within five years of 2006 and likely experience benefits only in the long-term.

Scenario testing results are presented in Section 5: Scenario Development and Evaluation.

Scenario Performance Evaluations

Once scenarios were developed and fully tested, simulation results for each scenario were subjected to a benefit-cost evaluation to determine how much “bang for the buck” each scenario would deliver. The study team performed a detailed benefit-cost assessment using the California Benefit-Cost model (Cal-B/C).

The results of the Benefit-Cost analysis are presented in Section 5: Scenario Development and Evaluation.

Recommendations and Performance Improvement Estimates

The study team developed final recommendations for future operational improvements that could be reasonably expected to maintain the mobility gains achieved by existing programmed and planned projects. Section 6 summarizes these findings.

This report is organized into six sections (Section 1 is this introduction):

2. *Corridor Description* describes the corridor, including the roadway facility, recent improvements, major interchanges and relative demands at these interchanges, relevant transit services serving freeway travelers, major Intermodal facilities around the corridor, special event facilities/trip generators, and an I-210 origin-destination demand profile from the SCAG regional model.

3. *Corridor Performance Assessment* presents multiple years (2005-09) of performance data for the freeway portion of the I-210 corridor. Statistics are included for the mobility, reliability, safety, and productivity performance measures.

4. *Bottleneck Identification and Causality Analysis* identifies bottlenecks, or choke points, on the I-210. It also diagnoses bottleneck locations and identifies the causes of each location through additional data analysis and field observations. This section has performance results for delay, productivity, and safety by major "bottleneck area", which allows for the relative prioritization of bottlenecks in terms of their contribution to corridor performance degradation. This section provides input to selecting projects to address the critical bottlenecks, and they provide the baseline against which the micro-simulation models were validated.

5. *Scenario Development and Evaluation* discusses the scenario development approach and summarizes the expected future performance based on the Vissim micro-simulation model.

6. *Conclusions and Recommendations* describes the projects and scenarios that were evaluated and recommends a phased implementation of the most promising set of strategies.

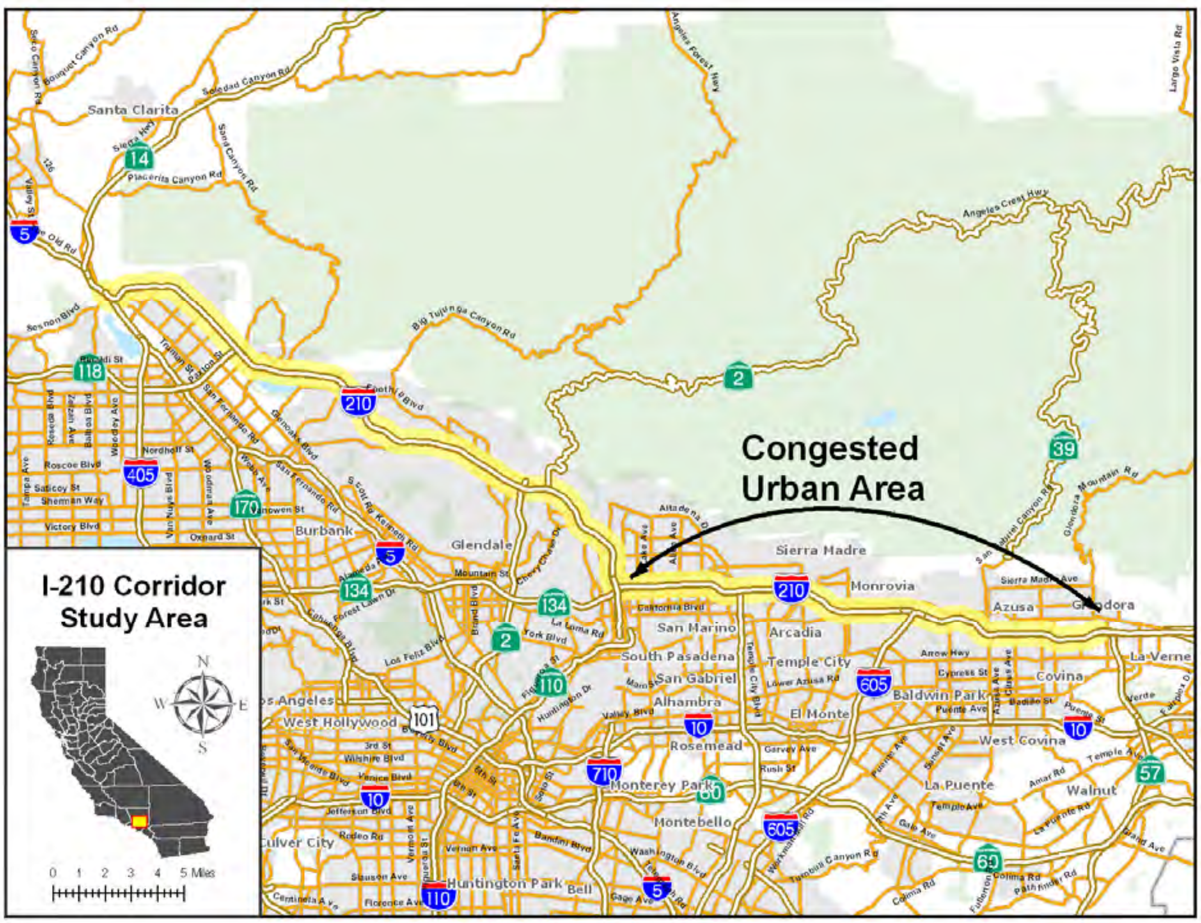
The appendices provide project lists for the micro-simulation scenarios and detailed benefit-cost results.

Note that at the end of each section and at other critical places in this final report, blank pages have been inserted to serve as placeholders for future updates.

2. CORRIDOR DESCRIPTION

The Los Angeles County I-210 Corridor extends approximately 45 miles from the I-5 (Golden State Freeway) interchange in San Fernando to the SR-57 (Orange Freeway) interchange. It traverses through the cities of San Fernando, La Canada Flintridge, Pasadena, Arcadia, Monrovia, Duarte, Azusa, and San Dimas. Since detection data was not available until recently for a large portion of this corridor, the bottleneck identification, causality analysis, and many of the performance trends reported focus on the 20-mile congested urban section between SR-134 and SR-57.

Exhibit 2-1: Map of Study Area



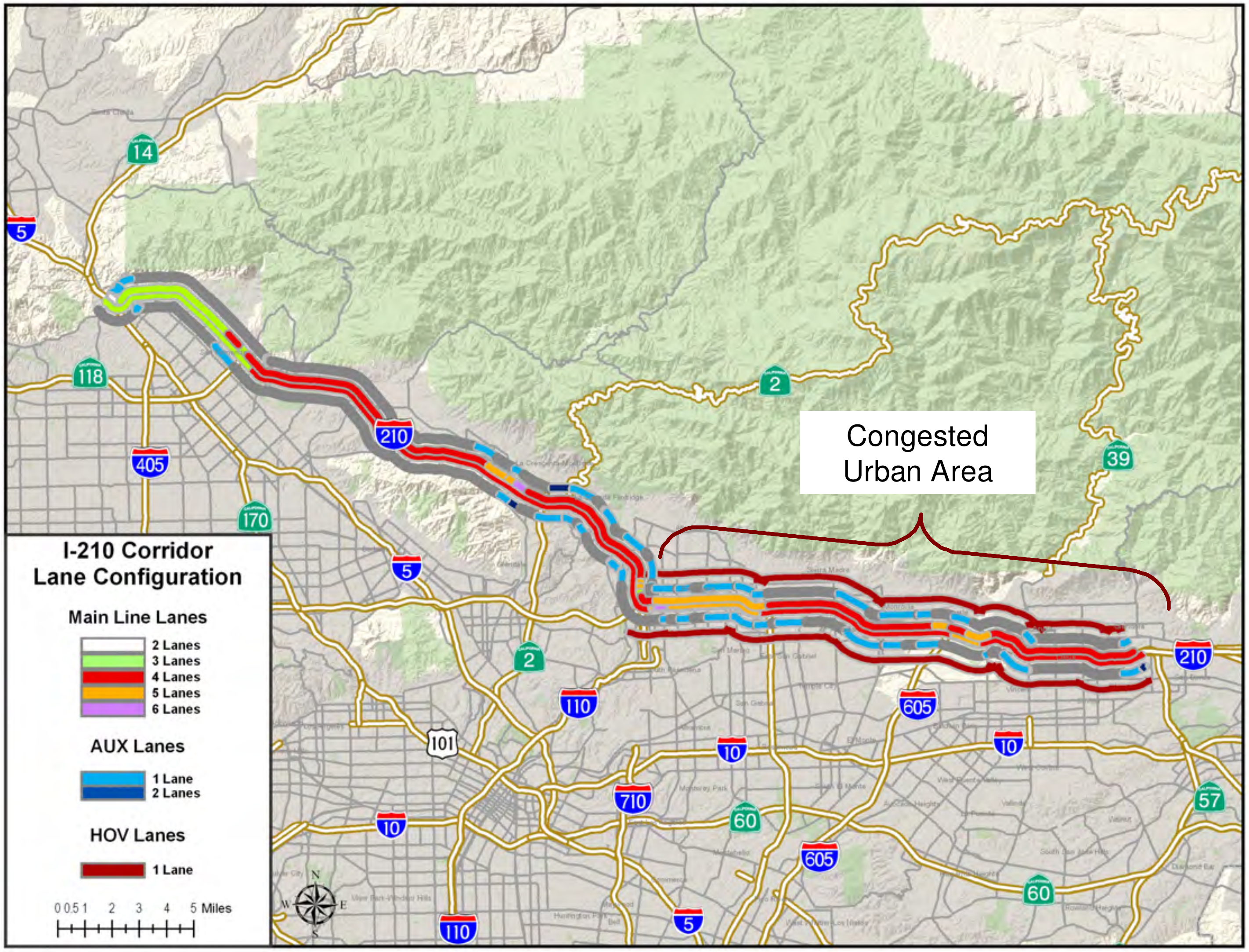
Corridor Roadway Facility

The study corridor traverses a large portion of the northern section of Los Angeles County and connects several of the major communities. The corridor includes 45 miles of I-210 from its beginning at the I-5 junction (postmile R0) in Sylmar through Sunland, Glendale, La Crescenta, La Canada Flintridge, Pasadena, and San Gabriel Valley to SR-57 junction (postmile R45). The I-210 corridor intersects many of the key north-south corridors in Los Angeles County. The major interchanges in the I-210 Corridor include the following:

- I-5, which provides a north-south connection throughout the state as well as Los Angeles County
- SR-118 (Ronald Reagan Freeway), which provides an east-west connection from the I-210 freeway/San Fernando to Ventura County
- SR-2 (Glendale Freeway), which provides north-south access from Foothill Boulevard to the downtown Los Angeles area
- SR-2 (Angeles Crest Highway), which provides access through the Angeles National Forest
- SR-134, which connects to the west with the US-101 freeway and to the south with Long Beach
- Lake Avenue, which is a major north-south arterial traversing through the cities of Altadena, Pasadena, and South Pasadena
- SR-19 (Rosemead Boulevard), which provides access to the San Gabriel Valley and south Los Angeles areas
- Santa Anita Avenue, which is a major north-south arterial traversing through the cities of Arcadia, Temple City, and El Monte
- I-605 (San Gabriel River Freeway), which provides north-south access from Historic Route 66 to Orange County connecting to the I-405 freeway
- SR-57, which provides a north-south connection to Glendora, San Dimas, Pomona, Diamond Bar, and Orange County.

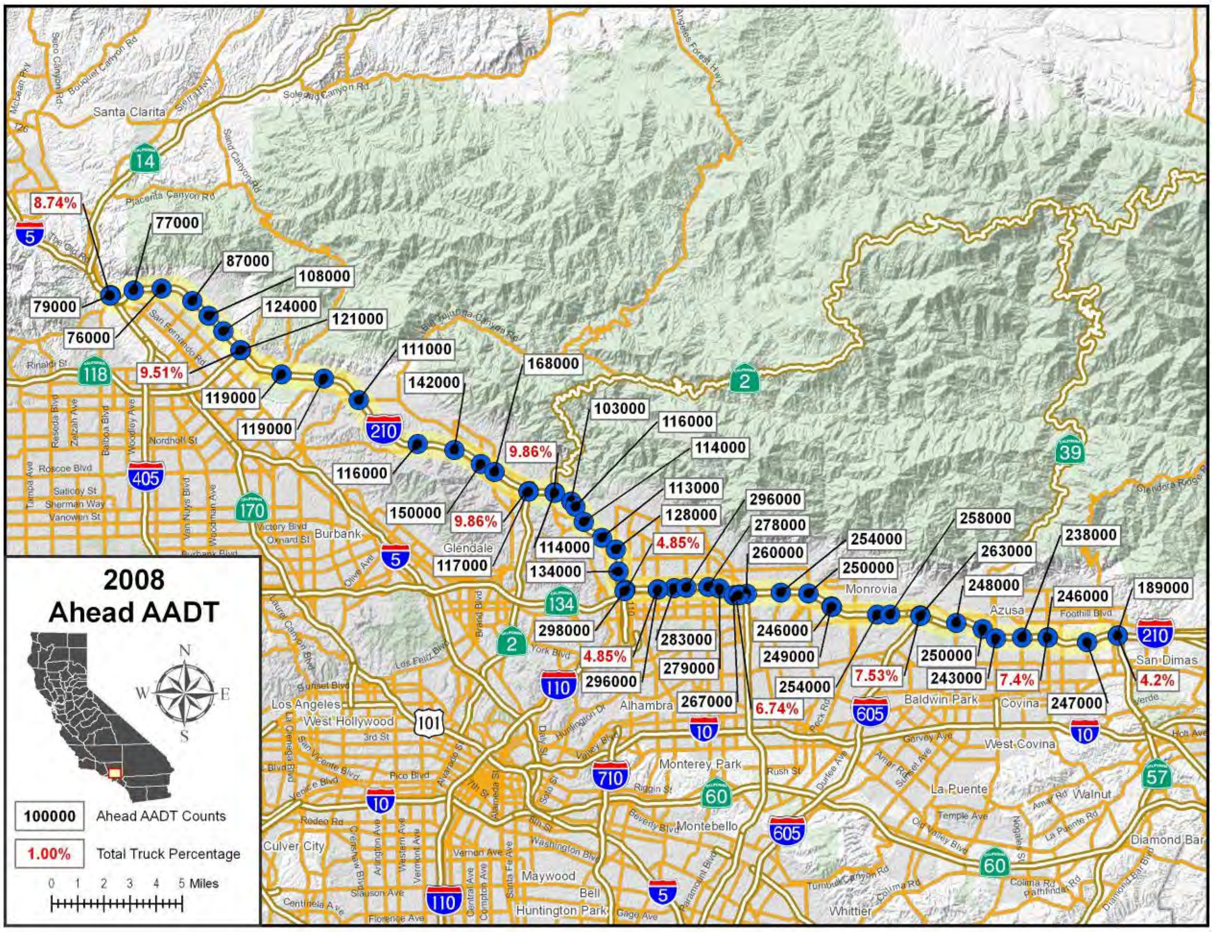
The I-210 Corridor is a divided eight to ten-lane freeway with a concrete median and an additional outside auxiliary lane at various sections throughout most of the corridor. A single High Occupancy Vehicle (HOV) lane is provided in each direction through the congestion urban area, which is the focus of the study corridor (from the SR-134 interchange to the SR-57 interchange). Exhibit 2-2 illustrates the lane configurations along the I-210 Corridor and highlights the congested urban area.

Exhibit 2-2: I-210 Corridor Lane Configuration



The 2008 Caltrans Traffic and Volume Data Systems indicate that the annual average daily traffic (AADT) ranges from 76,000 to 298,000 vehicles per day, as depicted in Exhibit 2-3.

Exhibit 2-3: Major Interchanges and AADT along the I-210 Corridor

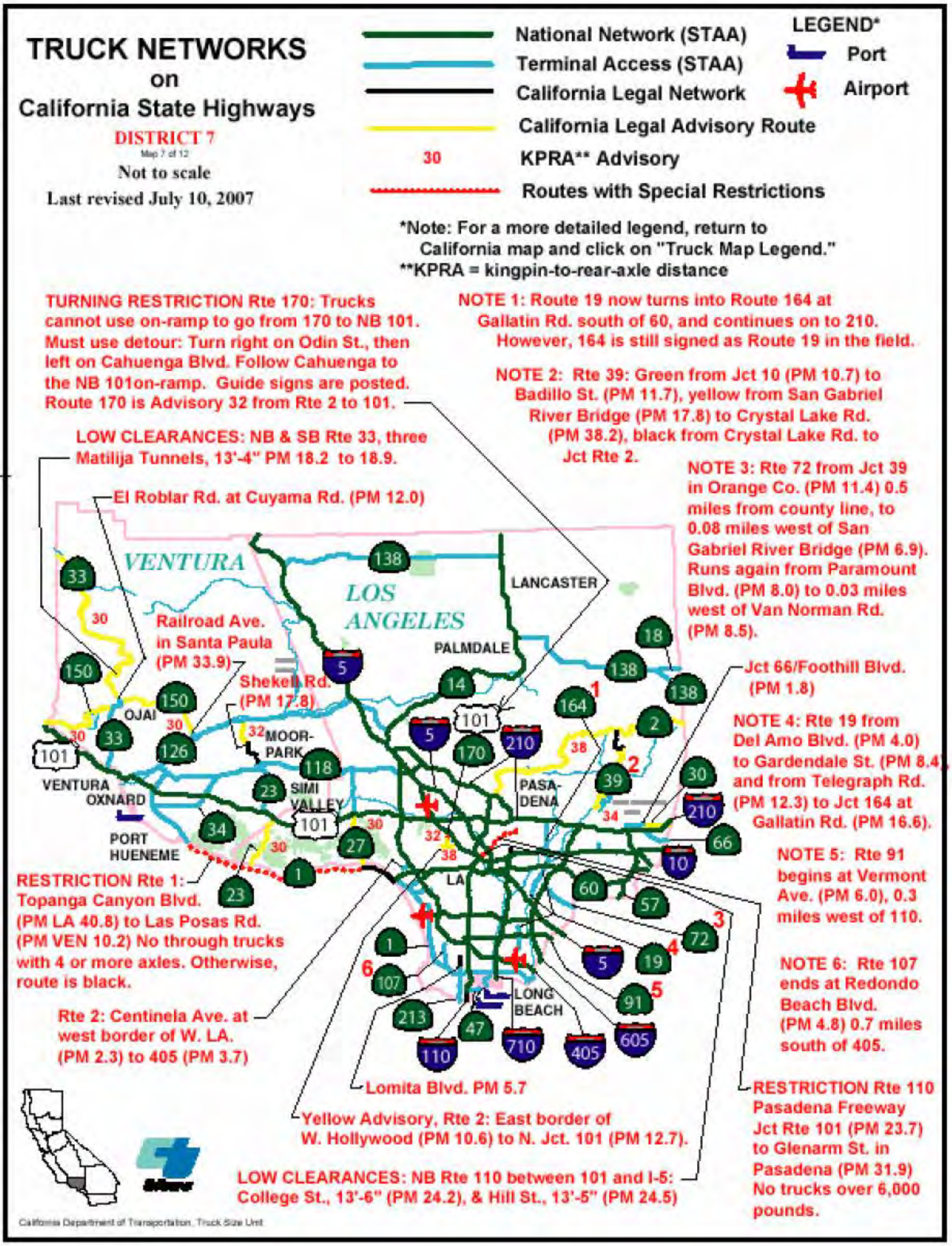


Source: AADT is from the Caltrans Traffic and Vehicle Data Systems Unit[1]

As illustrated in Exhibit 2-4, the I-210 Corridor is part of the Surface Transportation Assistance Act (STAA) National Truck Network. According to the 2008 Annual Average Daily Truck Traffic on the California State Highway System published by Caltrans in September 2009, trucks comprise between four and ten percent of total daily traffic along the corridor. Higher truck percentages occur west of the SR-134. Many of these trucks travel eastbound to the Inland Empire, home to many warehouses and distribution centers. The trucks traveling westbound are typically headed north to connect to the I-5 corridor and beyond.

[1] http://www.dot.ca.gov/hq/traffops/saferesr/trafdata/

Exhibit 2-4: Los Angeles and Ventura County Truck Networks



Transit

Major transit operators within the I-210 Corridor include Los Angeles County Metropolitan Transportation Authority (Metro), Metrolink commuter rail service, Foothill Transit, City of Los Angeles Department of Transportation Commuter Express, and Pasadena Area Rapid Transit System (ARTS).

Metro services 1,433 square miles in Los Angeles County with over 190 bus lines and an average weekday passenger boarding of 1,200,000. It operates bus, bus rapid, and rail service along the I-210 Corridor. Within the corridor, Metro operates Line 236, which runs from the I-5 interchange to a parallel route along Glenoaks Boulevard and Hubbard Street to the San Fernando Metrolink Station. Line 224 operates from the Los Angeles County Olive View-UCLA Medical Center just north of I-210 and runs parallel to the corridor along San Fernando Road. Lines 90 and 91 provide parallel service along the I-210 Corridor from Sunland to downtown Los Angeles. Line 292 services the Glenoaks Boulevard corridor parallel to the I-210 Corridor. Line 290 runs along the corridor and Foothill Boulevard in Sunland. Line 267 operates from La Canada Flintridge to Pasadena along Lincoln Avenue and Del Mar Boulevard and Line 394 operates along San Fernando Road, which is parallel to the I-210 Corridor. Within the study corridor, Lines 177 and 181 also operate on parallel local routes in the Cities of Pasadena and Arcadia. In addition to these bus lines, Metro operates Metro Rapid 780 along Colorado Boulevard terminating at the Hill Street station. Metro Rail Gold Line provides light-rail service from downtown Los Angeles Union Station to the Sierra Madre Villa station. This service runs along the center median of the I-210 freeway and terminates at the Sierra Madre Villa station.

Foothill Transit provides many bus lines servicing 327 square miles of the San Gabriel and Pomona Valley area. It has a weekday ridership of more than 48,000 with an annual ridership of approximately 15 million. Along the I-210 Corridor, some of the major Foothill Transit lines include: Line 690 runs on the I-210 Corridor from Pasadena to past the SR-57 interchange; Line 187 provides parallel service along Colorado Boulevard; Line 184 runs along both northerly and southerly of the corridor and provides service from the City of Arcadia to the City of Duarte; Line 492 provides parallel service along Live Oak Avenue and Arrow Highway, south of the I-210 Corridor.

The City of Los Angeles Department of Transportation also operates two Commuter Service lines that service the San Gabriel Valley. Line 549 runs on the SR-134 (Ventura Freeway) from the Encino and North Hollywood area to the Pasadena area, and Line 409 connects downtown Los Angeles to the Glendale/Montrose area within the vicinity of the study corridor.

Other transit agencies, such as the Pasadena Rapid Transit System and the Glendale Bee, operate local bus service that provides transportation between residential neighborhoods and business centers.

Exhibit 2-5 provides a Metro map of the transit lines servicing the various routes along the I-210 Corridor.

Exhibit 2-5: Metro Area Transit Map Servicing Routes along I-210 Corridor

The Metrolink Antelope Valley Line provides commuter rail service from the Antelope Valley along the I-5 and San Fernando Road to downtown Los Angeles. It runs parallel to the I-210 Corridor from the I-5 and continues in a southwesterly direction to downtown Los Angeles. Exhibit 2-6 provides the system-wide Metrolink map for the Southern California region.

Exhibit 2-6: Metrolink Commuter Rail System Map

Bicycle Facilities

There are bike routes near I-210 as shown in Exhibit 2-7, but none that parallel the study corridor. Most of the bike routes near the corridor are Class III Bike Paths. These routes are concentrated between SR-110 (Arroyo Seco Parkway) and SR-19. Due to the terrain and uphill climb, there are few bike paths west of SR-134.

- Class I bike paths consist of a paved path within an exclusive right of way
- Class II bike lanes consist of signed and striped lanes within a street right of way,
- Class III bike routes are preferred routes on existing streets identified by signs only.

Exhibit 2-7: Bicycle Facilities Near I-210 Corridor

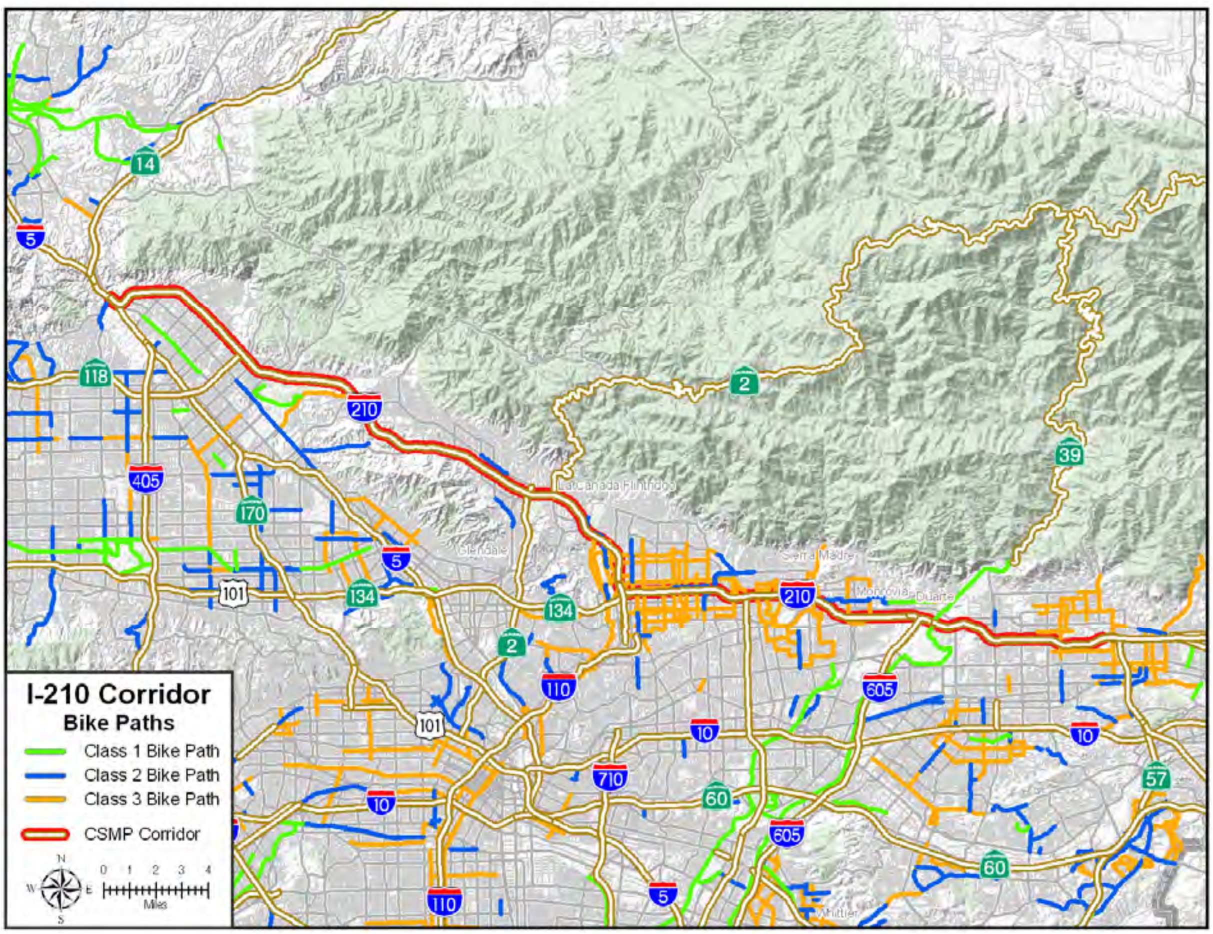
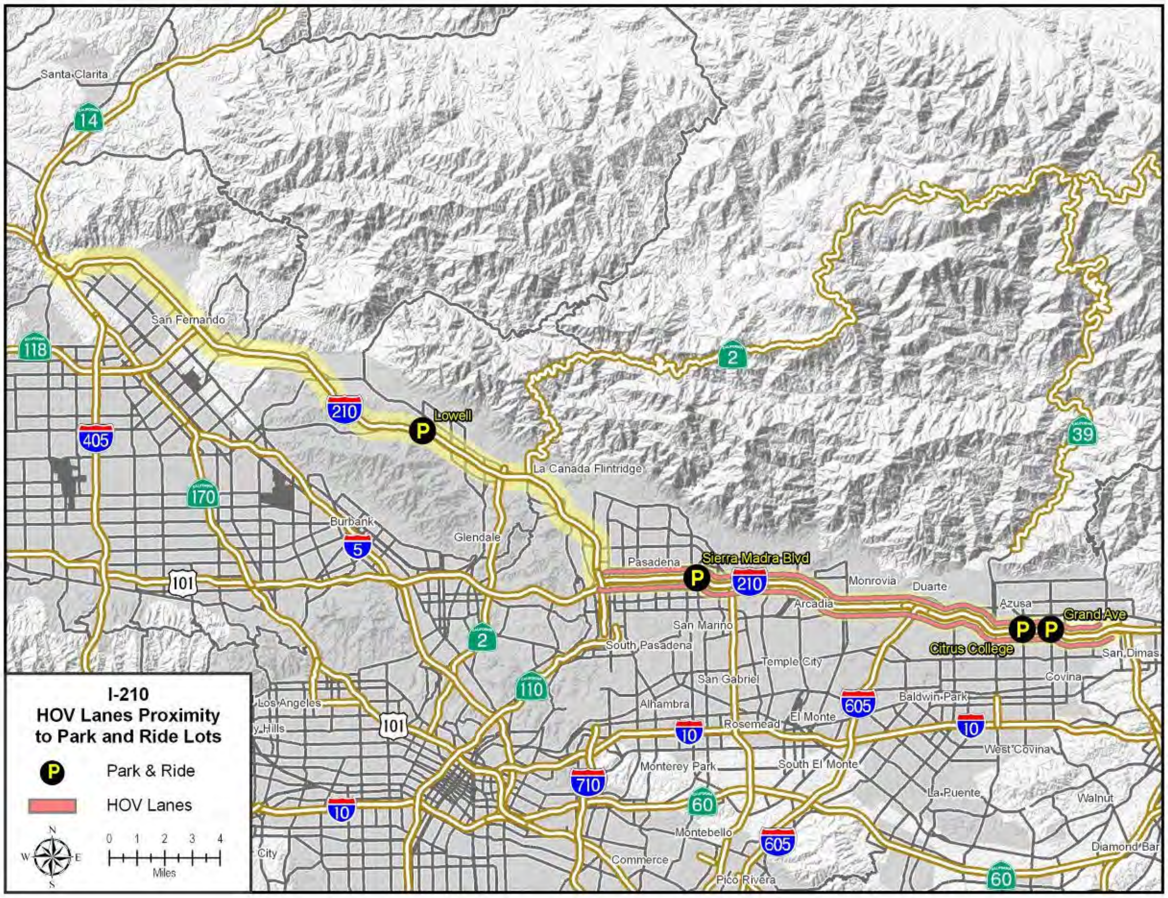


Exhibit 2-8 illustrates the location of the Park and Ride Lots within the vicinity of I-210. Two of these facilities are east of I-605 in Azusa, while one is near Sierra Madre Boulevard and the other is north of La Canada Flintridge.

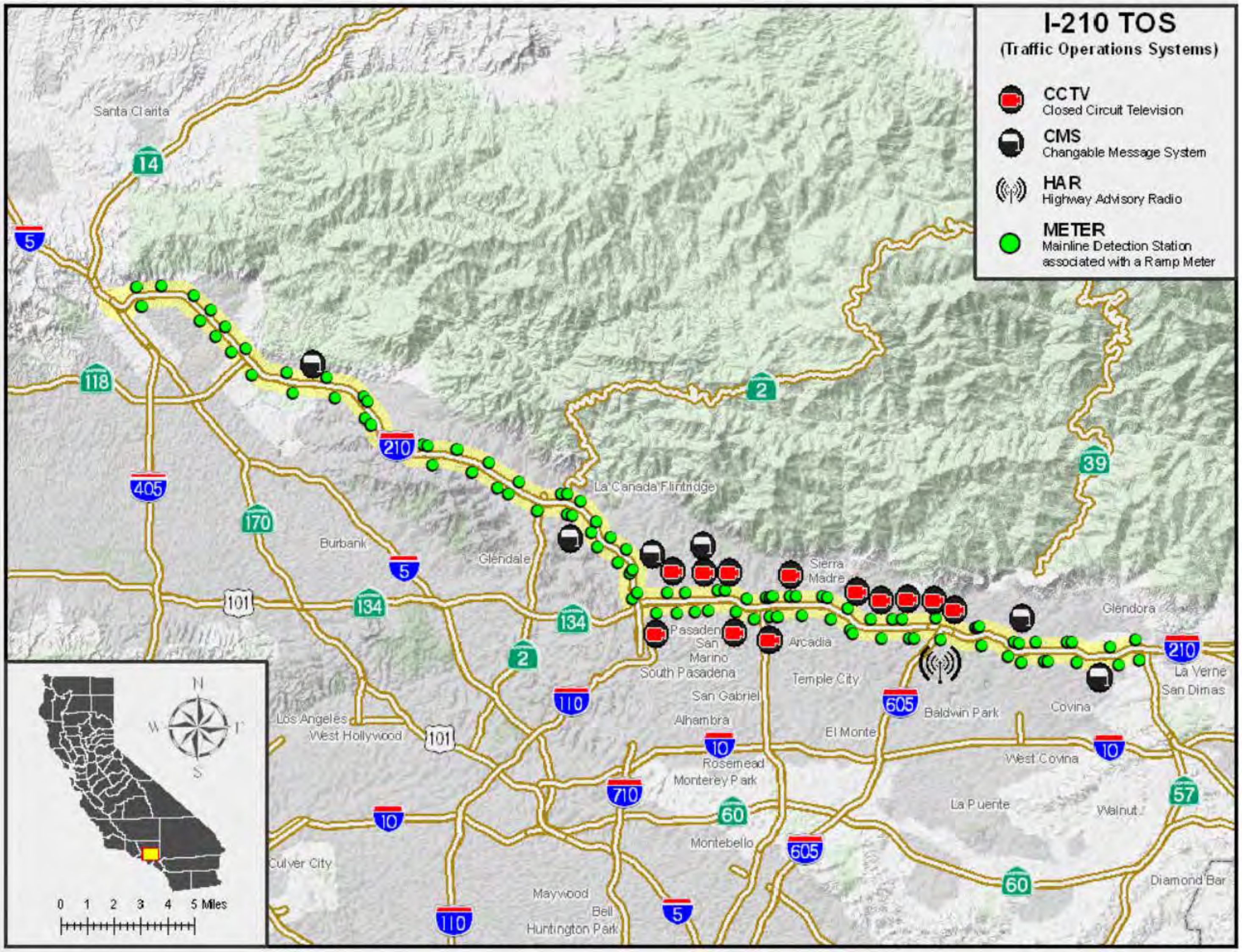
Exhibit 2-8: Park and Ride Facilities



Recent Roadway Improvements

Several roadway improvements have recently been completed and are currently under construction along the corridor. In preparation for System-Wide Adaptive Ramp Metering (SWARM) implementation, various on-ramps between SR-134 and SR-57 were modified to either remove or implement metering with traffic signals on the HOV bypass lanes. Also, freeway connector on-ramps from I-605 and SR-57 have been modified to implement connector metering with traffic signals. Closed-circuit television (CCTV) cameras and fiber optic communications are also being added throughout the corridor. Exhibit 2-9 identifies the traffic operations and management systems that are now part of the corridor.

Exhibit 2-9: Traffic Operations and Management Systems



Special Event Facilities and Trip Generators

Exhibit 2-10 maps some of the major institutions, centers, and facilities that may generate large number of trips along the I-210 Corridor. Most of these facilities are concentrated in the congested urban area.

There are fourteen colleges/universities near the I-210 Corridor. Larger institutions include:

- The California State Polytechnic University Pomona is located south of the I-210 and is a public university with an estimated enrollment of 25,500 students.
- Mount San Antonio College is approximately five miles south of the I-210 in the City of Walnut. It is the largest public two-year community college in the nation with an estimated enrollment of 42,000 students.
- Citrus College is located one mile north of the I-210 and is a public 2-year college with estimated enrollment of 12,000 students.
- Azusa Pacific University is located one mile south of the I-210 and is a private four-year college with an estimated enrollment of 8,200 students offering Bachelors, Masters, and Doctorate Degrees.
- Pasadena City College, one mile south of the I-210, is a public two-year college with an estimated enrollment of 29,000 students.
- Glendale Community College is approximately five miles near the SR-2 freeway. It is a two-year college with an estimated enrollment of 21,000 students.
- The California Institute of Technology (Caltech) is a private research university located in Pasadena. With a strong emphasis on sciences and engineering, Caltech enrolls over 2,000 undergraduate and graduate students and employs over 5,000 employees.
- Los Angeles Mission College is a two-year community college located in Sylmar with a student enrollment of over 8,000 in 2008-2009.

In addition to these educational facilities, many school districts are located along the I-210 Corridor with traffic that could affect corridors in mornings and afternoons.

There are six major medical facilities within proximity of the corridor.

- Foothill Presbyterian Hospital is located one mile north of I-210 in the city of Glendora, west of the SR-57. It provides general acute care services, 24-hour emergency room services and medical/surgical services with 106 hospital beds.

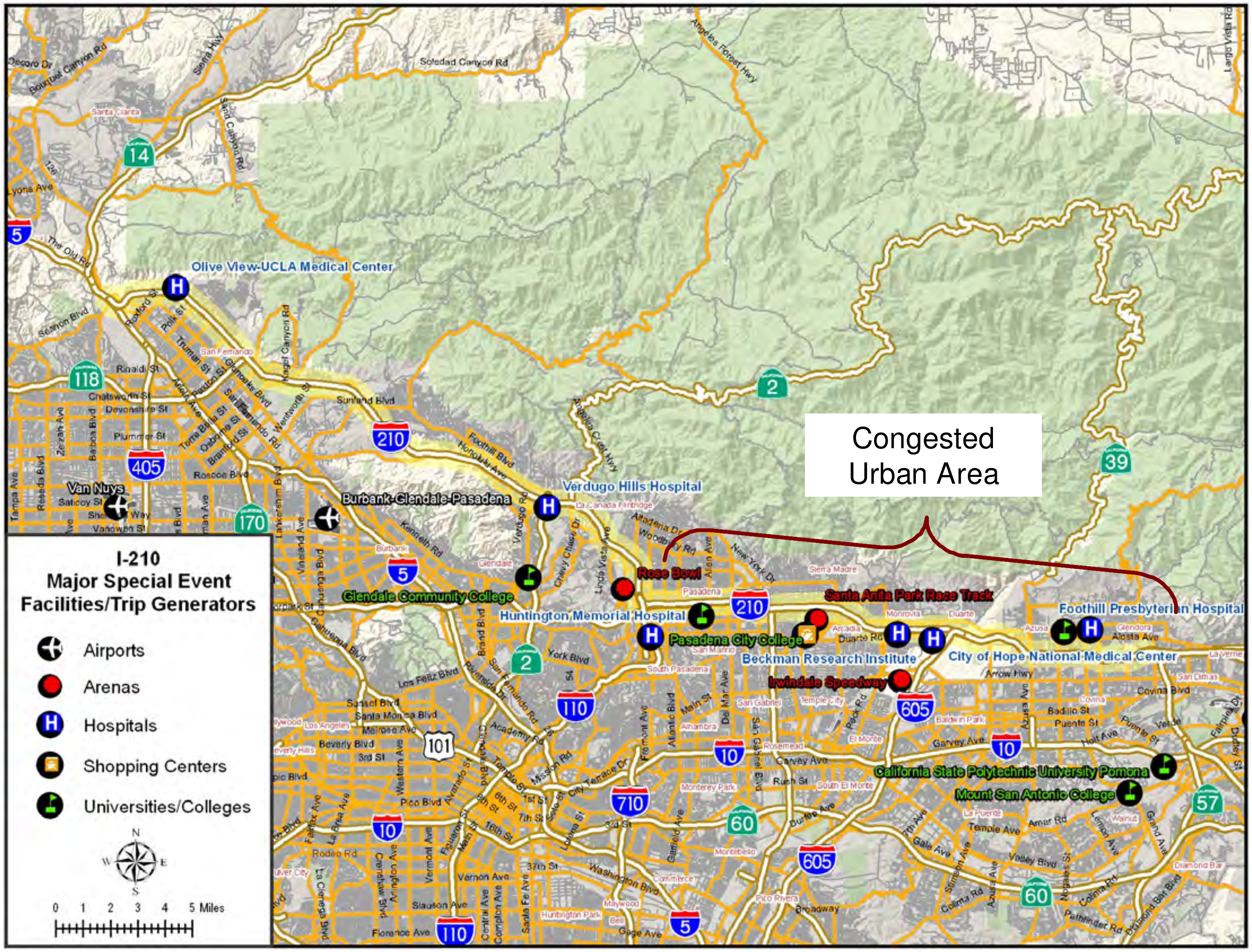
- City of Hope National Medical Center is a non-profit organization and is a designated cancer center. City of Hope comprises an ambulatory and in-patient cancer treatment center as well as a biomedical research facility known as the Beckman Research Institute. It has 158 licensed hospital beds, 84 of which are devoted to bone marrow transplantation patients.
- Verdugo Hills Hospital, located south of the I-210 freeway near the junction of the Glendale Freeway, provides acute care facility with an emergency room and contains 158 beds
- Olive View-UCLA Medical Center is located north of I-210 and three miles east of the I-5 Freeway. It is a teaching hospital affiliated with UCLA School of Medicine with 377 beds
- St. Luke Medical Center is north of the I-210 in the city of Pasadena with an emergency room with 165 beds.
- Huntington Memorial Hospital is a 636-bed hospital in Pasadena, located about a mile south of the I-210/SR-134 junction. Huntington Hospital serves as the regional trauma center for the San Gabriel Valley area and nearby communities.

There are also various parks and garden within close proximity to the corridor.

- The Hansen Dam Recreation Area consists of a nine acre recreation lake and a 1.5-acre swimming lake, a golf course, an equestrian center, and general park amenities. It is located in Lake View Terrace just south of I-210.
- Raging Waters Water Park, located on the north end of the Bonelli Regional Park, is the state's largest water park. It is situated about three miles south of the I-210/SR-57 junction.
- The Huntington comprises a research library, an art gallery, and a botanical garden. It is located about three miles south of I-210 in San Marino.
- Descanso Gardens is a 150 acres botanical garden that is located in La Canada Flintridge just south of I-210.

Another major special event facility is the Rose Bowl Stadium, which is located northwest of the I-210/SR-134 interchange. The stadium is the home of the Tournament of Roses Football Game, UCLA Bruin Football, Fourth of July celebrations, concerts, religious services, filming, and the World's Largest Flea Market. It has a seating capacity of over 90,000 and its parking lots are available for a wide variety of rental uses. Other major special event facilities include the Santa Anita Park Horse Track, Irwindale Speedway, and various large shopping malls. The Bob Hope Airport in Burbank is also a major traffic generator.

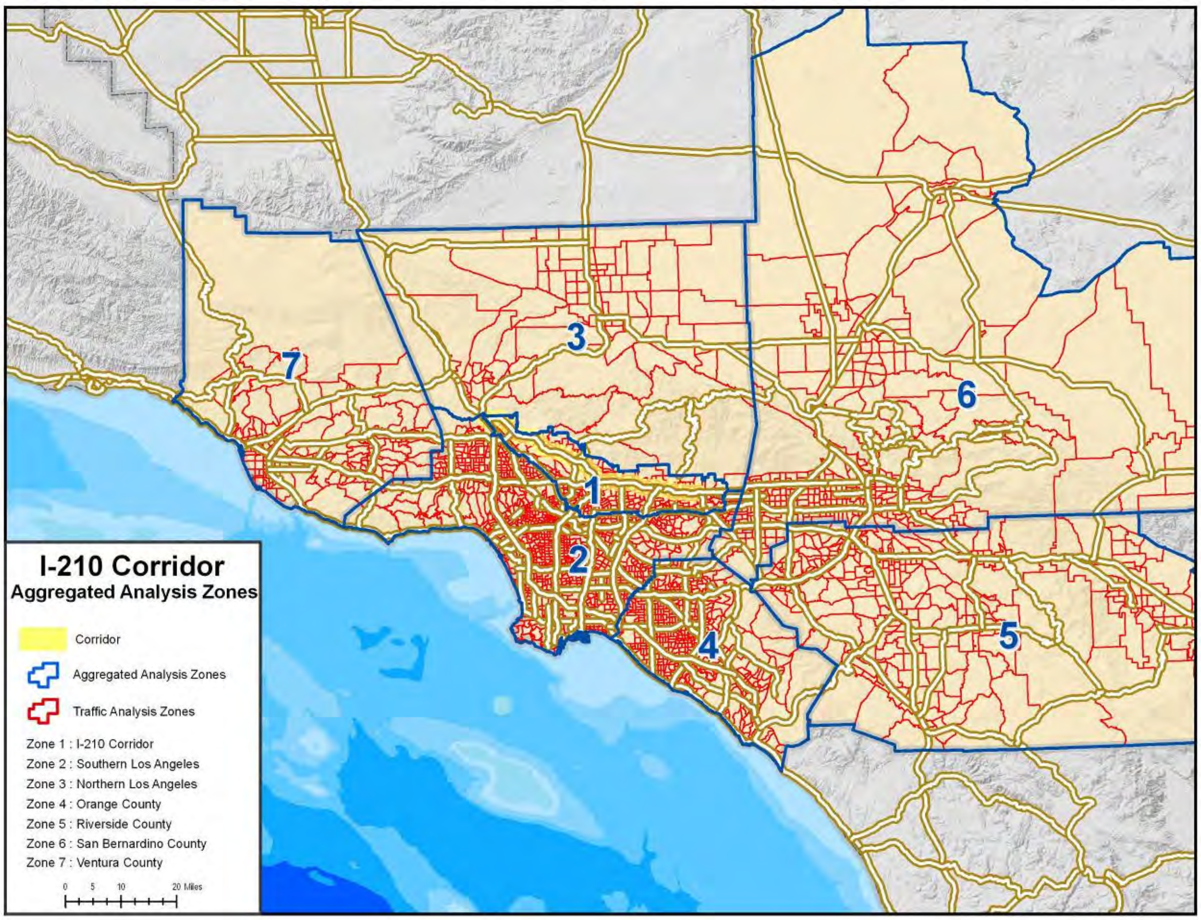
Exhibit 2-10: Major Special Event Facilities/Trip Generators



Demand Profiles

Caltrans' version of SCAG's 2000 travel demand model was used to characterize the travel pattern of trips made on the I-210 Corridor. A "select link analysis" helped to isolate the corridor and identify the origins and destinations of trips along I-210. The origins and destinations were identified by Traffic Analysis Zone (TAZ), which were grouped into the seven aggregate analysis zones mapped in Exhibit 2-11.

Exhibit 2-11: Aggregate Analysis Zones for Demand Profile Analysis



Based on this aggregation, demand on the corridor was summarized by aggregated origin-destination zone as depicted in Exhibits 2-12 and 2-13 for the AM and PM peak periods. This analysis shows that the vast majority (about 86 percent) of travelers along the I-210 study corridor are traveling within Los Angeles County. About 38 percent of the travel is for trips along the corridor and another 41 percent is for travel to and from Zone 2 (Southern Los Angeles County), which includes Downtown Los Angeles and the urban core of the region.

During the AM peak period, 87 percent of all trips originate and terminate in Los Angeles County. Of this percentage, 39 percent represents travel along the corridor, while 41 percent represents travel to and from Southern Los Angeles County and the other 7 percent traveling to other parts of Los Angeles County. As depicted in Exhibit 2-12, the remaining trips originate outside Los Angeles County and terminate in Los Angeles County (8 percent), originate in Los Angeles County and terminate in other counties (5 percent), or originate and terminate outside Los Angeles County (less than 1 percent). This data suggests that a large percentage of traffic in the AM peak period uses I-210 to connect to other freeways headed south to Southern Los Angeles County.

Exhibit 2-12: AM Peak Origin Destination by Aggregated Analysis Zone

		TO ZONE							
	AM Trips	I-210 Corridor	Southern LA	Northern LA	Orange County	Riverside	San Bernardino	Ventura	Outside Zones
FROM ZONE	I-210 Corridor	83,477	49,842	3,872	3,230	622	3,431	884	483
	Southern LA	37,275	1,703	504	31	129	518	22	225
	Northern LA	7,780	1,766	76	61	29	95	150	14
	Orange County	2,852	45	12	0	0	0	0	74
	Riverside	1,678	286	9	0	0	0	6	113
	San Bernardino	7,932	1,652	71	0	0	0	29	99
	Ventura	2,006	103	50	10	45	109	0	33
	Outside Zones	280	180	9	21	85	90	10	336

86.9%	Trips starting and ending in Los Angeles County
4.6%	Trips starting in LA County and ending outside of LA County
8.0%	Trips staring outside of LA County and ending in LA County
0.5%	Trips starting outside of LA County and ending outside of LA County

The same patterns occur during the PM peak period, which experiences roughly 52 percent more demand than the AM. As shown in Exhibit 2-13, roughly 85 percent of all trips originate and terminate in Los Angeles County. Of this percentage, 38 percent represents travel along the corridor, while 41 percent represents travel to and from Southern Los Angeles County with much smaller percentages traveling to other parts of Los Angeles County. The remaining trips originate outside Los Angeles County and terminate in Los Angeles County (8 percent), originate in Los Angeles County and terminate in other counties (6 percent), or originate and terminate outside Los Angeles County (about 1 percent).

Exhibit 2-13: PM Peak Origin Destination by Aggregated Analysis Zone

		TO ZONE							
	PM Trips	I-210 Corridor	Southern LA	Northern LA	Orange County	Riverside	San Bernardino	Ventura	Outside Zones
FROM ZONE	I-210 Corridor	122,552	58,306	10,380	4,747	2,271	11,035	2,886	597
	Southern LA	74,797	2,809	1,617	122	409	2,048	154	363
	Northern LA	7,297	1,092	133	53	43	155	76	16
	Orange County	5,735	55	96	0	0	1	13	111
	Riverside	1,306	248	27	0	0	0	23	135
	San Bernardino	7,103	1,275	167	3	0	0	105	125
	Ventura	2,056	103	55	14	46	134	0	46
	Outside Zones	1,062	546	23	284	341	278	15	1,164

85.4%	Trips starting and ending in LA County
7.6%	Trips starting in LA County and ending outside of LA County
6.1%	Trips staring outside of LA County and ending in LA County
0.9%	Trips starting outside of LA County and ending outside of LA County

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3. CORRIDOR PERFORMANCE ASSESSMENT

This section summarizes existing conditions on the I-210 corridor. The primary objectives of the performance measures are to provide a sound technical basis for describing traffic performance on the corridor.

A. Data Sources and Detection

Various data sources were used to analyze the performance of the corridor, including:

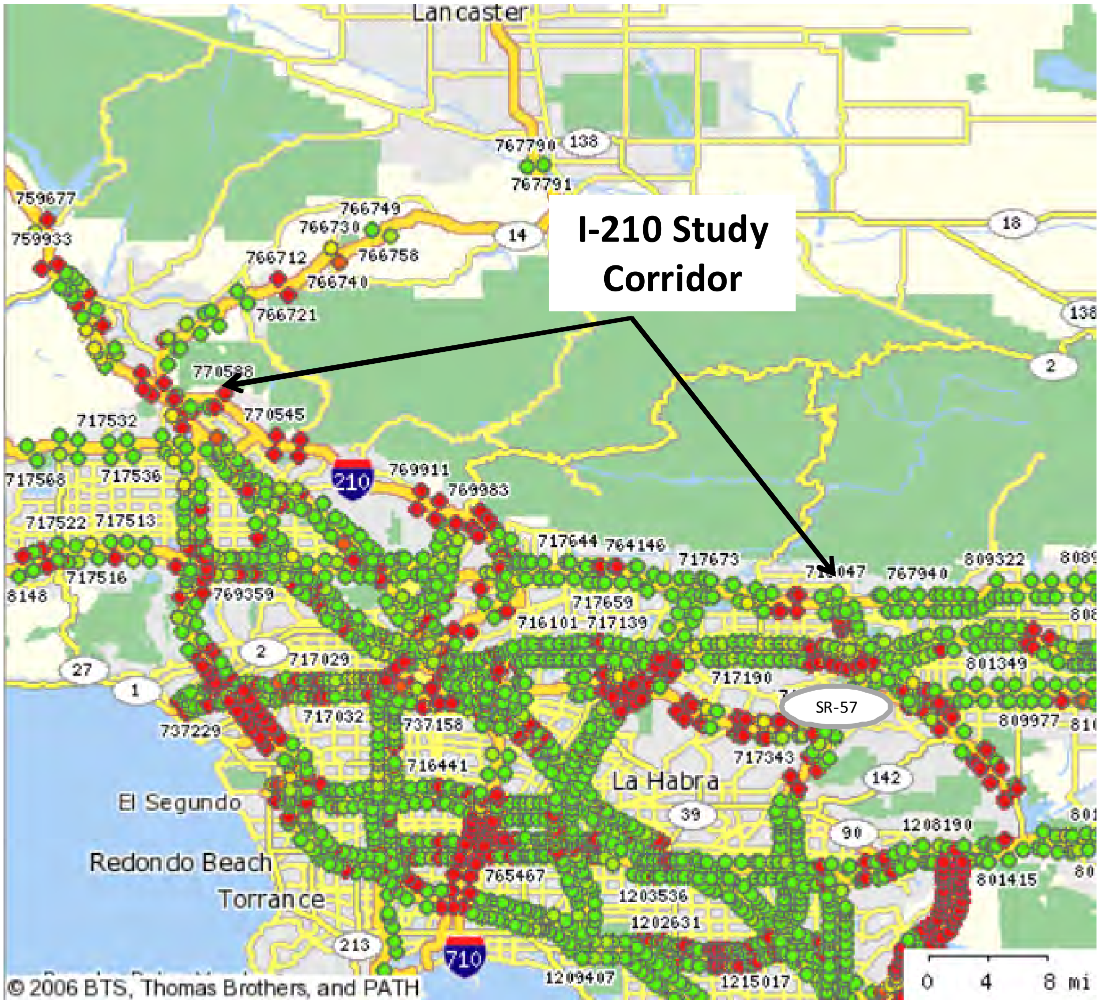
- Caltrans HICOMP report and data files (2004 to 2007)
- Caltrans Freeway detector data
- Caltrans District 7 probe vehicle runs (electronic tachometer data)
- Caltrans Traffic Accident Surveillance and Analysis System (TASAS)
- Traffic study reports (various)
- Aerial photographs (Google Earth) and Caltrans photologs
- Internet (i.e. Metro website, Metrolink website, Foothill Transit website, etc.).

Details for each data source are provided in applicable sections of this report. However, given the need for comprehensive and continuous monitoring and evaluation, detection coverage and quality are discussed in more detail below.

Freeway Detection Status

Exhibit 3A-1 depicts the corridor freeway facility with the detectors in place as of December 30, 2008. This date was chosen randomly to provide a snapshot of the detection status. The exhibit shows that there are many detectors on the mainline and the majority functioning well (based on the green color) in the eastern portion of the corridor. These are the 20 miles in the congested urban area between the SR-134 junction and the SR-57 junction. The western portion of the corridor has large gaps in detection and the data was not available on the illustrated date.

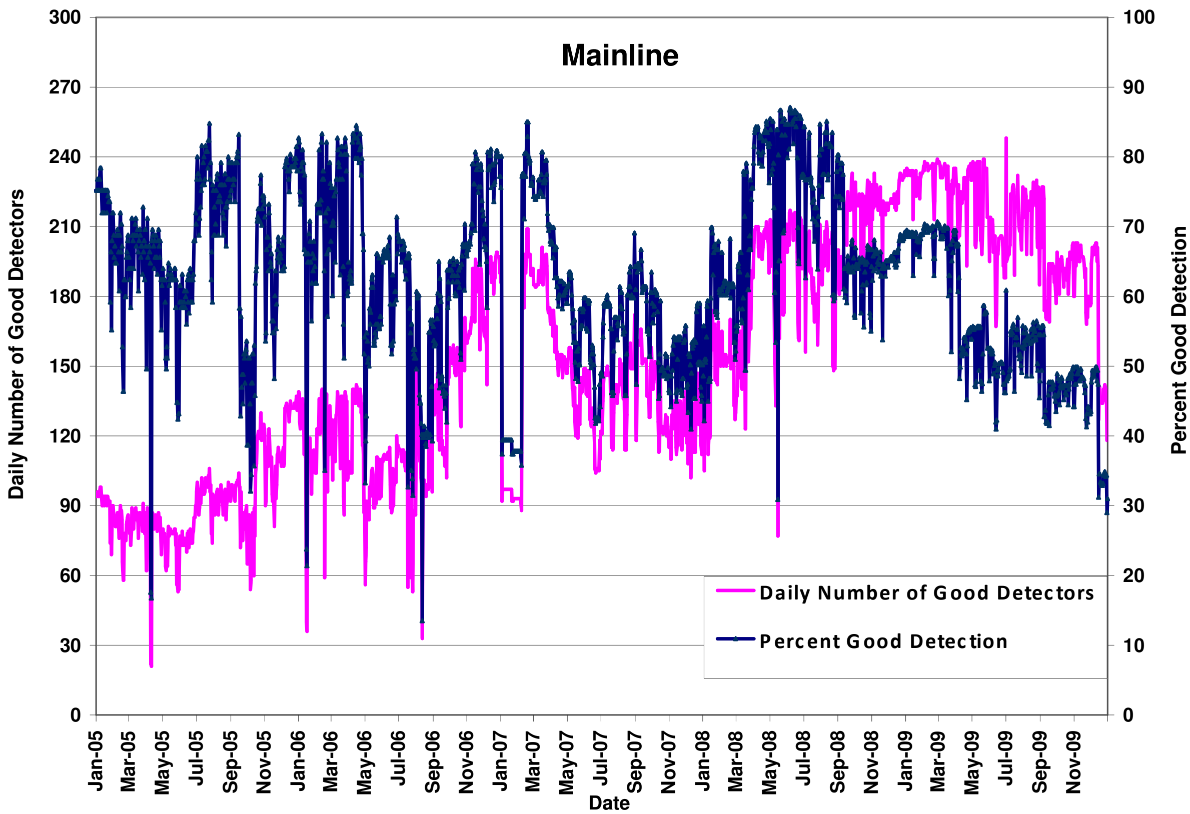
Exhibit 3A-1: I-210 Sensor Data Quality (December 2008)



The following exhibits provide a better picture of how the detectors on the corridor performed over a longer period from January 2005 to December 2009. Exhibits 3A-2 and 3A-3 report the number and percentage of daily "good" detectors on the mainline (ML) facility (including ramps) of the study corridor. Exhibits 3A-4 and 3A-5 report the same information for the HOV facility. The left y-axis shows the scale used for the number of detectors, while the right y-axis shows the scale used for the percent good detectors.

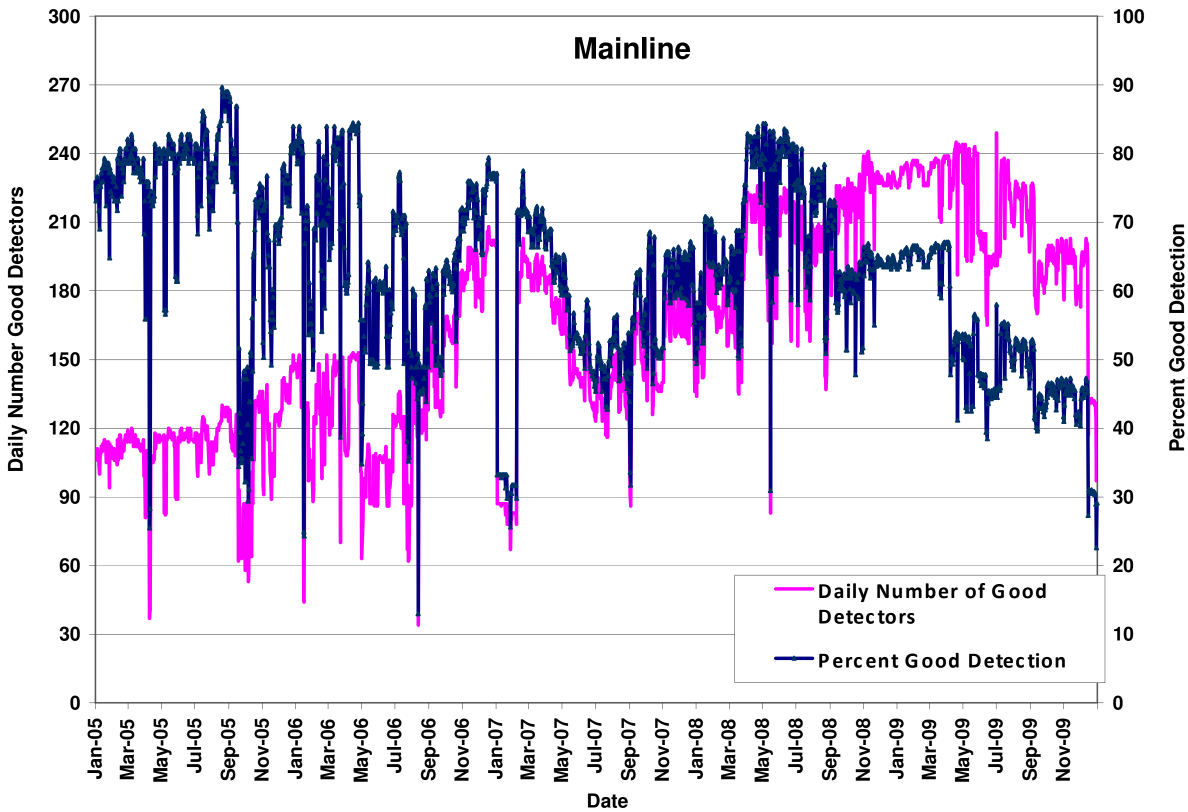
The first two exhibits (Exhibits 3A-2 and 3A-3) suggest that the available detection coverage is roughly the same in the two directions. The number of good detectors increased from 2005 through 2007, particularly during the last half of 2006. In percentage terms, the available detection generally ranged from 60 to 80 percent during this period. In 2007, the available detection dropped in both percent and number of detectors. In 2008, the number of good detectors has increased to about 240 detectors in each direction. In percentage terms, the amount of good direction has decreased from highs of over 80 percent, but good detection still represents 65 to 70 percent of total detection in both directions. In 2009, both directions experienced a slight drop in the number of good detectors and percent of good detection, especially in the second half of the year. During this period, the number of good detectors decreased to around 200 detectors and the percentage dropped to below 50 percent. In 2009, detectors became active in the western section of the corridor, but were not providing good data.

Exhibit 3A-2: I-210 Eastbound Mainline Level of Good Detection (2005-09)



Source: Caltrans detector data

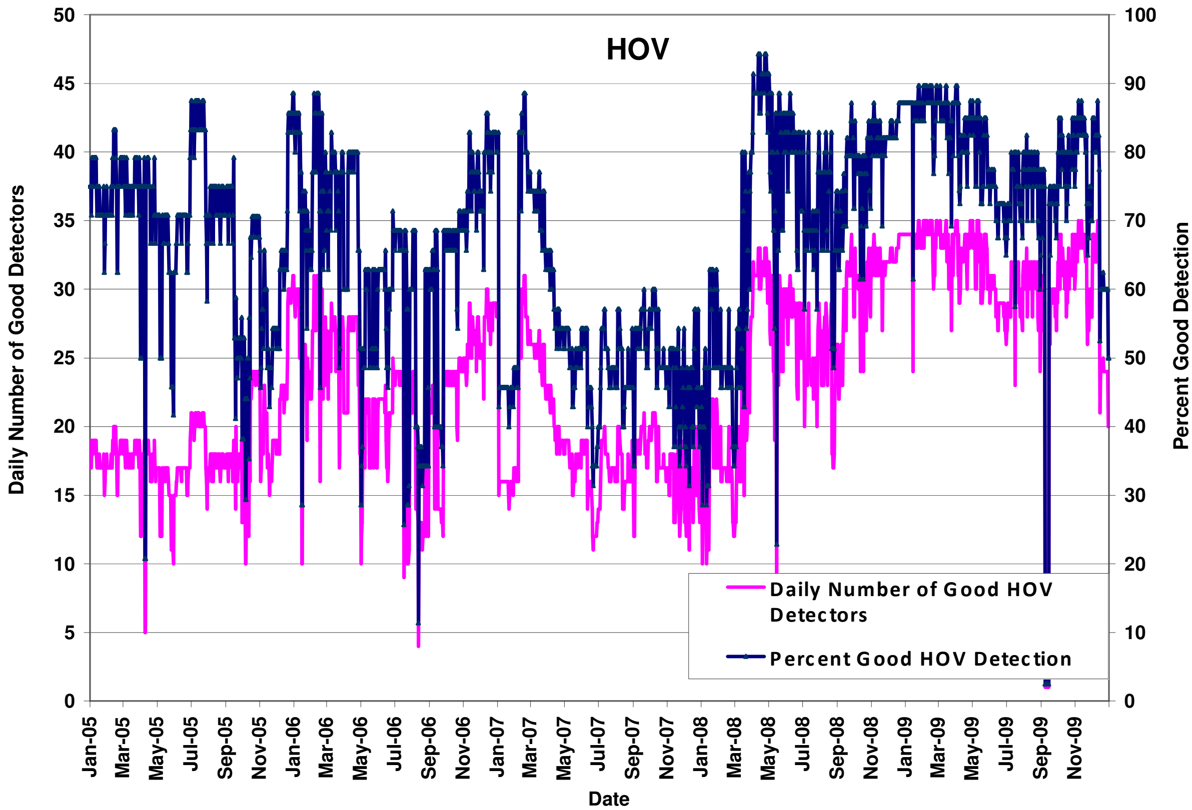
Exhibit 3A-3: I-210 Westbound Mainline Level of Good Detection (2005-09)



Source: Caltrans detector data

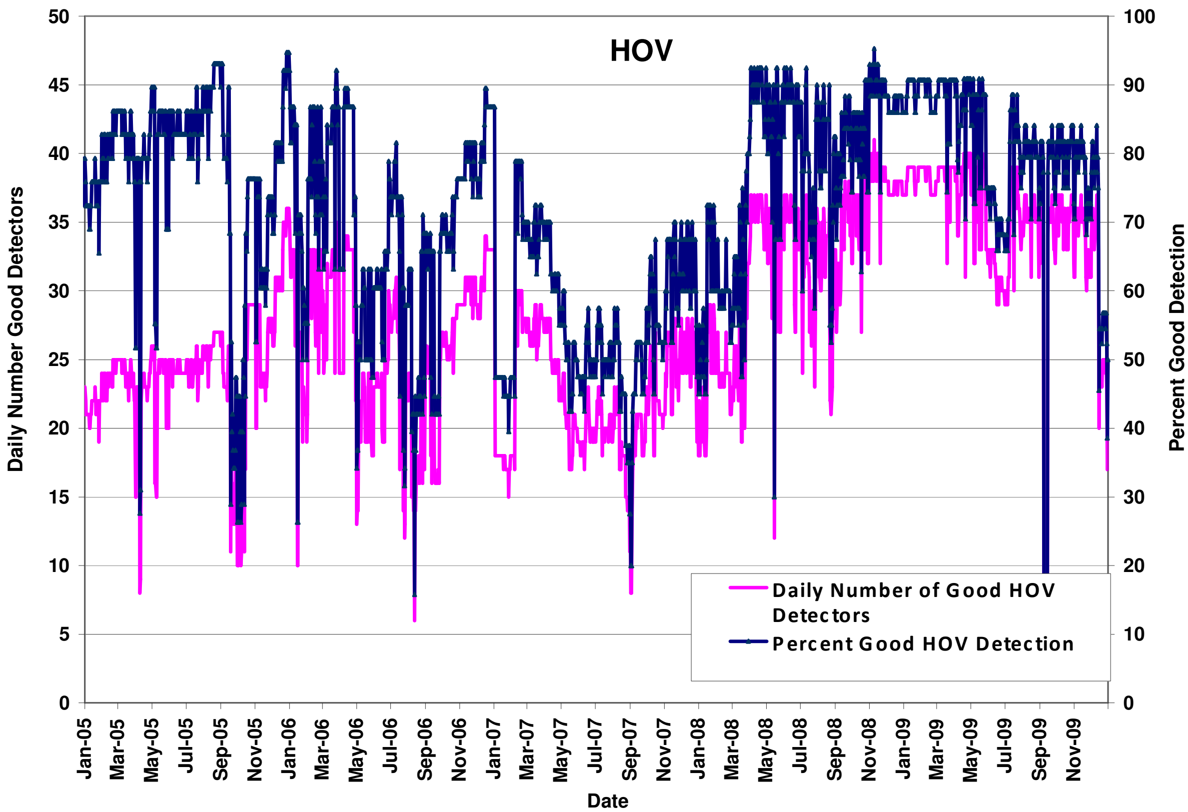
As Exhibits 3A-4 and 3A-5 show, detection quality on the HOV-lanes (HOVL) roughly mirrored that of the mainline. Like the mainline, HOV detection quality dropped in 2007, but has since recovered. By the end of 2009, the number of good detectors as a percent of total detection stood at roughly 80 percent in both directions. A comparison of Exhibits 3A-4 and 3A-5 shows that detection quality is fairly even between the two directions.

Exhibit 3A-4: I-210 Eastbound HOV Level of Good Detection (2005-09)



Source: Caltrans detector data

Exhibit 3A-5: I-210 Westbound HOV Level of Good Detection (2005-09)



Source: Caltrans detector data

Part of the increase in detection quality may be attributed to improved maintenance of existing detectors. However, further deployment has also played a part. Exhibits 3A-6 through 3A-9 show the detection added to the corridor in 2009 and 2010. Numerous detectors were added to the mainline and ramps as part of the traffic management system improvement that was completed in 2009. This project added detectors to the western section of the corridor from I-5 to SR-134.

Exhibits 3A-10 and 3A-11 show an analysis of gaps in mainline and HOV detection coverage. While there are several segments extending over 0.75 miles without detection in either direction, the larger gaps are in the western part of the corridor (indicated by smaller postmiles). Much of the analysis in this corridor performance assessment focuses on the eastern congested urban area because of the detection gap.

Exhibit 3A-11 shows that the gaps in HOV detection coverage mirror those for mainline detection.

Exhibit 3A-6: I-210 Eastbound ML and Ramp Detectors Added (2009-10)

VDS	CA PM	Abs PM	Name	Type	Date Online
769895	R15.7	15.7	LOWELL / HONOLULU	Mainline	4/8/2009
769866	R17.4	17.4	LA CRESCENTA	Mainline	4/8/2009
769831	R19.8	19.8	ANGELES CREST HWY SB	Mainline	4/8/2009
769819	R20	20.0	ANGELES CREST HWY NB	Mainline	4/8/2009
771603	R45.66	45.9	SAN DIMAS AVE	Mainline	4/8/2009
769897	R15.7	15.7	LOWELL / HONOLULU	Off Ramp	4/8/2009
769898	R15.7	15.7	LOWELL / HONOLULU	Off Ramp	4/8/2009
769833	R19.8	19.8	ANGELES CREST HWY SB	Off Ramp	4/8/2009
771605	R45.66	45.9	SAN DIMAS AVE	Off Ramp	4/8/2009
769896	R15.7	15.7	LOWELL / HONOLULU	On Ramp	4/8/2009
769868	R17.4	17.4	LA CRESCENTA	On Ramp	4/8/2009
769832	R19.8	19.8	ANGELES CREST HWY SB	On Ramp	4/8/2009
769820	R20	20.0	ANGELES CREST HWY NB	On Ramp	4/8/2009
771604	R45.66	45.9	SAN DIMAS AVE	On Ramp	4/8/2009
770170	R24.51	24.5	EB 210 TO WB 134 #1	Fwy-Fwy	1/8/2010
770385	R19.1	19.1	EB/NB 2 TO EB 210 CN	Mainline	1/8/2010
770169	R24.51	24.5	EB 134 TO WB 210 CON	Mainline	1/8/2010
770419	R24.51	24.5	EB 210 TO COLORADO	Off Ramp	1/8/2010
770387	R19.1	19.1	EB/NB 2 TO EB 210 CN	On Ramp	1/8/2010
770356	R5.51	5.5	EB 118 TO WB 210 CON	Fwy-Fwy	1/12/2010
770012	R3.4	3.4	POLK	Mainline	1/12/2010
770024	R4.2	4.2	HUBBARD	Mainline	1/12/2010
770036	R5.1	5.1	MACLAY	Mainline	1/12/2010
770354	R5.51	5.5	EB 118 TO WB 210 CON	Mainline	1/12/2010
770048	R6.2	6.2	PAXTON	Mainline	1/12/2010
770331	R6.5	6.5	EB 118 TO EB 210 CON	Mainline	1/12/2010
770061	R8	8.0	OSBORNE / FOOTHILL	Mainline	1/12/2010
770076	R9.5	9.5	WHEATLAND	Mainline	1/12/2010
770089	R11	11.0	SUNLAND SB	Mainline	1/12/2010
770103	R11.3	11.3	SUNLAND NB	Mainline	1/12/2010
770116	R14.41	14.4	LA TUNA CANYON	Mainline	1/12/2010
770014	R3.4	3.4	POLK	Off Ramp	1/12/2010
770026	R4.2	4.2	HUBBARD	Off Ramp	1/12/2010
770038	R5.1	5.1	MACLAY	Off Ramp	1/12/2010
770050	R6.2	6.2	PAXTON	Off Ramp	1/12/2010
770063	R8	8.0	OSBORNE / FOOTHILL	Off Ramp	1/12/2010
770078	R9.5	9.5	WHEATLAND	Off Ramp	1/12/2010
770091	R11	11.0	SUNLAND SB	Off Ramp	1/12/2010
770118	R14.41	14.4	LA TUNA CANYON	Off Ramp	1/12/2010
770013	R3.4	3.4	POLK	On Ramp	1/12/2010
770025	R4.2	4.2	HUBBARD	On Ramp	1/12/2010
770037	R5.1	5.1	MACLAY	On Ramp	1/12/2010
770049	R6.2	6.2	PAXTON	On Ramp	1/12/2010
770333	R6.5	6.5	EB 118 TO EB 210 CON	On Ramp	1/12/2010
770062	R8	8.0	OSBORNE / FOOTHILL	On Ramp	1/12/2010
770077	R9.5	9.5	WHEATLAND	On Ramp	1/12/2010
770090	R11	11.0	SUNLAND SB	On Ramp	1/12/2010
770104	R11.3	11.3	SUNLAND NB	On Ramp	1/12/2010
770117	R14.41	14.4	LA TUNA CANYON	On Ramp	1/12/2010
772857	R37.1	37.4	SAN GABRIEL RIVER	Mainline	2/24/2010
772872	R37.5	37.8	W/O IRWINDALE	Mainline	2/24/2010
772887	R38.5	38.8	ZACHARY PADILLA	Mainline	2/24/2010
772903	R39.9	40.2	PASADENA AVE	Mainline	2/24/2010
772917	R41.1	41.4	E/B 210-W/O BARRANCA	Mainline	2/24/2010
772932	R42.3	42.6	E/O GLENDORA	Mainline	2/24/2010
772953	R42.6	42.9	BONNIE COVE	Mainline	2/24/2010
772966	R44.2	44.5	AMELIA	Mainline	2/24/2010

Source: Caltrans detector data

Exhibit 3A-7: I-210 Westbound ML and Ramp Detectors Added (2009-10)

VDS	CA PM	Abs PM	Name	Type	Date Online
770317	R.8	0.8	YARNELL	Off Ramp	4/8/2009
770316	R.8	0.8	YARNELL	On Ramp	4/8/2009
770315	R.8	0.8	YARNELL	Mainline	1/12/2010
770303	R1.75	1.8	ROXFORD	Mainline	4/8/2009
770305	R1.75	1.8	ROXFORD	Off Ramp	4/8/2009
770304	R1.75	1.8	ROXFORD	On Ramp	4/8/2009
770215	R3.1	3.1	POLK	Mainline	4/8/2009
770218	R3.1	3.1	POLK	Off Ramp	4/8/2009
770216	R3.1	3.1	POLK	On Ramp	4/8/2009
770229	R3.5	3.5	HUBBARD	Mainline	1/12/2010
770231	R3.5	3.5	HUBBARD	Off Ramp	1/12/2010
770230	R3.5	3.5	HUBBARD	On Ramp	1/12/2010
770243	R4.7	4.7	MACLAY	Mainline	1/12/2010
770246	R4.7	4.7	MACLAY	Off Ramp	1/12/2010
770244	R4.7	4.7	MACLAY	On Ramp	1/12/2010
770353	R5.51	5.5	EB 118 TO WB 210 CON	Mainline	1/12/2010
770355	R5.51	5.5	EB 118 TO WB 210 CON	On Ramp	1/12/2010
770259	R5.92	5.9	PAXTON	Mainline	1/12/2010
770261	R5.92	5.9	PAXTON	Off Ramp	1/12/2010
770260	R5.92	5.9	PAXTON	On Ramp	1/12/2010
770336	R6.5	6.5	EB 118 TO EB 210 CON	Fwy-Fwy	1/12/2010
770332	R6.5	6.5	EB 118 TO EB 210 CON	Mainline	1/12/2010
770545	R7.19	7.2	TERRA BELLA	Mainline	1/12/2010
770275	R7.73	7.7	OSBORNE / FOOTHILL	Mainline	1/12/2010
770277	R7.73	7.7	OSBORNE / FOOTHILL	Off Ramp	1/12/2010
770276	R7.73	7.7	OSBORNE / FOOTHILL	On Ramp	1/12/2010
770290	R9.3	9.3	WHEATLAND	Mainline	1/12/2010
770292	R9.3	9.3	WHEATLAND	Off Ramp	1/12/2010
770291	R9.3	9.3	WHEATLAND	On Ramp	1/12/2010
770200	R10.9	10.9	SUNLAND SB	Mainline	1/12/2010
770201	R10.9	10.9	SUNLAND SB	On Ramp	1/12/2010
770187	R11.1	11.1	SUNLAND NB	Mainline	1/12/2010
770189	R11.1	11.1	SUNLAND NB	Off Ramp	1/12/2010
770188	R11.1	11.1	SUNLAND NB	On Ramp	1/12/2010
770141	R14	14.0	LA TUNA CANYON SB	Mainline	1/12/2010
770142	R14	14.0	LA TUNA CANYON SB	On Ramp	1/12/2010
770129	R14.2	14.2	LA TUNA CANYON NB	Mainline	1/12/2010
770131	R14.2	14.2	LA TUNA CANYON NB	Off Ramp	1/12/2010
770130	R14.2	14.2	LA TUNA CANYON NB	On Ramp	1/12/2010
769965	R15.3	15.3	HONOLULU	Mainline	4/8/2009
769966	R15.3	15.3	HONOLULU	On Ramp	4/8/2009
769867	R17.4	17.4	LA CRESCENTA	Mainline	4/8/2009
769869	R17.4	17.4	LA CRESCENTA	Off Ramp	4/8/2009
770401	R18.34	18.3	EB/NB 2 TO WB 210 CN	Mainline	1/8/2010
770402	R18.34	18.3	EB/NB 2 TO WB 210 CN	On Ramp	1/8/2010
770388	R19.1	19.1	EB/NB 2 TO EB 210	Fwy-Fwy	1/8/2010
770386	R19.1	19.1	EB/NB 2 TO EB 210 CN	Mainline	1/8/2010
769941	R19.6	19.6	ANGELES CREST HWY SB	Mainline	4/8/2009
769953	R19.8	19.8	ANGELES CREST HWY NB	Mainline	4/8/2009
769955	R19.8	19.8	ANGELES CREST HWY NB	Off Ramp	4/8/2009
769954	R19.8	19.8	ANGELES CREST HWY NB	On Ramp	4/8/2009
769998	R21.41	21.4	BERKSHIRE	Off Ramp	1/12/2010
769999	R21.41	21.4	BERKSHIRE	On Ramp	1/12/2010
770165	R24.51	24.5	EB 134 TO WB 210 CON	On Ramp	1/8/2010
770157	R24.51	24.5	EB 134 TO WB 210 CON	Mainline	1/12/2010
772858	R37.1	37.4	SAN GABRIEL RIVER	Mainline	2/24/2010
772873	R37.5	37.8	W/O IRWINDALE	Mainline	2/24/2010
772888	R38.5	38.8	ZACHARY PADILLA	Mainline	2/24/2010
772902	R39.9	40.2	PASADENA AVE	Mainline	2/24/2010
772918	R41.1	41.4	E/B 210-W/O BARRANCA	Mainline	2/24/2010
769638	R41.466	41.8	GRAND 1	Coll/Dist	5/20/2009
772933	R42.3	42.6	E/O GLENDORA	Mainline	2/24/2010
772954	R42.6	42.9	BONNIE COVE	Mainline	2/24/2010
772967	R44.2	44.5	AMELIA	Mainline	2/24/2010
771618	R45.31	45.6	SAN DIMAS AVE	Mainline	4/8/2009
771620	R45.31	45.6	SAN DIMAS AVE	Off Ramp	4/8/2009
771619	R45.31	45.6	SAN DIMAS AVE	On Ramp	4/8/2009

Exhibit 3A-8: I-210 HOV Detectors Added (2009-10)

VDS	CA PM	Abs PM	Name	Type	Date Online
Eastbound					
772859	R37.1	37.4	SAN GABRIEL RIVER	HOV	2/24/2010
772874	R37.5	37.8	W/O IRWINDALE	HOV	2/24/2010
772889	R38.5	38.8	ZACHARY PADILLA	HOV	2/24/2010
772890	R38.5	38.8	ZACHARY PADILLA	HOV	2/24/2010
772905	R39.9	40.2	PASADENA AVE	HOV	2/24/2010
772919	R41.1	41.4	E/B 210-W/O BARRANCA	HOV	2/24/2010
772934	R42.3	42.6	E/O GLENDORA	HOV	2/24/2010
772955	R42.6	42.9	BONNIE COVE	HOV	2/24/2010
772968	R44.2	44.5	AMELIA	HOV	2/24/2010
769759	R44.6	44.9	NB 57 TO EB 210 CON	HOV	9/11/2008
771606	R45.66	45.9	SAN DIMAS AVE	HOV	4/8/2009
Westbound					
772860	R37.1	37.4	SAN GABRIEL RIVER	HOV	2/24/2010
772875	R37.5	37.8	W/O IRWINDALE	HOV	2/24/2010
772904	R39.9	40.2	PASADENA AVE	HOV	2/24/2010
772920	R41.1	41.4	E/B 210-W/O BARRANCA	HOV	2/24/2010
772935	R42.3	42.6	E/O GLENDORA	HOV	2/24/2010
772956	R42.6	42.9	BONNIE COVE	HOV	2/24/2010
772969	R44.2	44.5	AMELIA	HOV	2/24/2010
771621	R45.31	45.6	SAN DIMAS AVE	HOV	4/8/2009

Exhibit 3A-9: EB I-210 Gaps In Mainline Detection (May 2010)

Location		Abs PM		Length (Miles)
From	To	From	To	
YARNELL	ROXFORD	1.0	2.1	**1.1**
POLK	HUBBARD	3.4	4.2	**0.8**
HUBBARD	MACLAY	4.2	5.1	**0.9**
TERRA BELLA	OSBORNE/FOOTHILL	7.2	8.0	**0.8**
ORCAS AVE	WHEATLAND	8.6	9.5	**0.9**
WHEATLAND	SUNLAND SB	9.5	11.0	**1.5**
SUNLAND NB	LA TUNA CANYON	11.3	14.4	**3.1**
LA TUNA CANYON	LOWELL/HONOLULU	14.4	15.7	**1.3**
LOWELL/HONOLULU	PENNSYLVANIA	15.7	17.0	**1.3**
LA CRENSCENTA	OCEAN VIEW	17.4	18.2	**0.8**
OCEAN VIEW	EB/NB 2 TO EB 210 CN	18.2	19.1	**0.9**
BERKSHIRE	ARROYO	21.6	22.6	**1.0**
ALLEN	SAN GABRIEL	27.6	28.7	**1.1**
SAN GABRIEL	SIERRA MADRE V2	28.7	29.4	**0.8**
MICHILLINDA	BALDWIN	30.3	31.2	**0.9**
BALDWIN	SANTA ANITA 2	31.2	32.3	**1.1**
SANTA ANITA 2	HUNTINGTON 1	32.3	33.1	**0.8**
HUNTINGTON 2	MYRTLE AV	33.4	34.4	**1.1**
MYRTLE AV	MOUNTAIN	34.4	35.4	**1.0**
SUNFLOWER AV	LONE HILL AV	43.6	44.5	**0.9**
NB 57 TO EB 210 CON	SAN DIMAS AV	44.9	45.9	**1.1**
SAN DIMAS AVE	FOOTHILL BL	45.9	47.3	**1.3**
LIVE OAK CANYON	TOWNE AV	49.1	50.0	**0.9**

Exhibit 3A-10: WB I-210 Gaps in Mainline Detection (May 2010)

Location		Abs PM		Length (Miles)
From	To	From	To	
YARNELL	ROXFORD	0.8	1.8	**1.0**
ROXFORD	BLEDSOE ST.	1.8	2.8	**1.0**
HUBBARD	MACLAY	3.5	4.7	**1.2**
MACLAY	EB 118 TO WB 210 CON	4.7	5.5	**0.8**
OSBORNE / FOOTHILL	ORCAS AVE	7.7	8.6	**0.9**
WHEATLAND	SUNLAND SB	9.3	10.9	**1.6**
SUNLAND NB	LA TUNA CANYON SB	11.1	14.0	**2.9**
LA TUNA CANYON NB	HONOLULU	14.2	15.3	**1.1**
HONOLULU	PENNSYLVANIA	15.3	16.6	**1.3**
PENNSYLVANIA	LA CRESCENTA	16.6	17.4	**0.8**
EB/NB 2 TO WB 210 CN	EB/NB 2 TO EB 210 CN	18.3	19.1	**0.8**
BERKSHIRE	ARROYO 1	21.4	22.3	**0.9**
LINCOLN 1	HAMMOND ST.	23.0	23.8	**0.8**
HILL	ALTADENA	26.8	28.0	**1.2**
SAN GABRIEL	SIERRA MADRE V1	28.3	29.2	**0.9**
BALDWIN 2	SANTA ANITA 1	31.0	32.0	**1.0**
SANTA ANITA 2	HUNTINGTON 1	32.2	33.0	**0.9**
HUNTINGTON 1	MYRTLE AV	33.0	34.0	**1.0**
MYRTLE AV	MOUNTAIN AV	34.0	34.9	**0.9**
MOUNT OLIVE DR / 605	SAN GABRIEL RIVER	36.6	37.4	**0.8**
CITRUS	E/B 210-W/O BARRANCA	40.5	41.4	**0.8**
SUNFLOWER AV	NB 57 TO WB 210 CONN	43.4	44.2	**0.8**
AMELIA	SAN DIMAS AVE	44.5	45.6	**1.1**
SAN DIMAS AVE	FOOTHILL BLVD SB	45.6	46.7	**1.2**
FOOTHILL BLVD NB	BIXBY DR	46.9	47.8	**0.9**
FRUIT ST	LIVE OAK CANYON	48.2	49.1	**0.9**
LIVE OAK CANYON	TOWNE AV	49.1	49.9	**0.8**

Exhibit 3A-11: I-210 Gaps In HOV Detection (2010)

Location		Abs PM		Length (Miles)
From	To	From	To	
Eastbound				
ALLEN	SAN GABRIEL	27.6	28.7	**1.1**
SAN GABRIEL	SIERRA MADRE V2	28.7	29.4	**0.8**
MICHILLINDA	BALDWIN	30.3	31.2	**0.9**
BALDWIN	SANTA ANITA 2	31.2	32.3	**1.1**
SANTA ANITA 2	HUNTINGTON 1	32.3	33.1	**0.8**
HUNTINGTON	MYRTLE AV	33.4	34.4	**1.1**
MYRTLE AV	MOUNTAIN	34.4	35.4	**1.0**
SUNFLOWER AV	LONE HILL AV	43.6	44.5	**0.9**
NB 57 TO EB 210 CON	SAN DIMAS AV	44.9	45.9	**1.1**
SAN DIMAS AVE	FOOTHILL BL	45.9	47.3	**1.3**
LIVE OAK CANYON	TOWNE AV	49.1	50.0	**0.9**
Westbound				
HILL	ALTADENA	26.8	28.0	**1.2**
SAN GABRIEL	SIERRA MADRE V1	28.3	29.2	**0.9**
BALDWIN 2	SANTA ANITA 1	31.0	32.0	**1.0**
SANTA ANITA 2	HUNTINGTON 1	32.2	33.0	**0.9**
HUNTINGTON 1	MYRTLE AV	33.0	34.0	**1.0**
MYRTLE AV	MOUNTAIN AV	34.0	34.9	**0.9**
MOUNT OLIVE DR / 605	SAN GABRIEL RIVER	36.6	37.4	**0.8**
IRWINDALE 2	VERNON	38.2	39.2	**1.0**
CITRUS	E/B 210-W/O BARRANCA	40.5	41.4	**0.8**
SUNFLOWER AV	NB 57 TO WB 210 CONN	43.4	44.2	**0.8**
AMELIA	SAN DIMAS AVE	44.5	45.6	**1.1**
SAN DIMAS AVE	FOOTHILL BLVD SB	45.6	46.7	**1.2**
FOOTHILL BLVD NB	BIXBY DR	46.9	47.8	**0.9**
FRUIT ST	LIVE OAK CANYON	48.2	49.1	**0.9**
LIVE OAK CANYON	TOWNE AV	49.1	49.9	**0.8**

B. Corridor Performance Assessment

This section summarizes the analysis results of the performance measures used to evaluate the existing conditions of the I-210 Corridor. The primary objectives of the measures are to provide a sound technical basis for describing traffic performance on the corridor. Data from the mainline (ML) and high-occupancy vehicle (HOV) facilities are analyzed separately under each performance measure. The base year for the analysis and subsequent simulation modeling to test CSMP scenarios is 2006.

The performance measures focus on four key areas:

- *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

The mobility performance measures are both measurable and straightforward for documenting current conditions. They can also be forecasted, which makes them useful for future comparisons. Two primary measures are typically used to quantify mobility: delay and travel time.

Delay

Delay is defined as the observed travel time less the travel time under non-congested conditions, and is reported as vehicle-hours of delay. Delay can be computed for severely congested conditions using the following formula:

$$(\text{Vehicles Affected per Hour})\times(\text{SegmentLength})\times(\text{Duration})\times\left[\frac{1}{(\text{Congested Speed})}-\frac{1}{(\text{Threshold Speed})}\right]$$

In the formula above, the *Vehicles Affected per Hour* value depends on the methodology used. Some methods assume a fixed flow rate (e.g., 2000 vehicles per hour per lane), while others use a measured or estimated flow rate. The segment length is the distance under which the congested speed prevails. The duration is how long the congested period lasts (measured in hours), with the congested period being the amount of time spent below the threshold speed. The threshold speed is the speed under which congestion is considered to occur. Any speed can be used, but two commonly used threshold speeds are 35 mph and 60 mph.

Caltrans defines the threshold speed as 35 mph and assumes a fixed 2,000 vehicles per hour per lane are experiencing the delay to estimate severe delay for reporting congestion for the statewide Highway Congestion Monitoring Report (HICOMP).

In calculating total delay, Caltrans detector data uses the 60 mph threshold speed and the observed number of vehicles reported by detection systems. The congestion results of HICOMP and detector data are difficult to compare due to these methodological differences, so they are discussed separately in this assessment.

Caltrans Highway Congestion Monitoring Program (HICOMP)

The HICOMP report has been published by Caltrans annually since 1987.[2] Delay is presented as average daily vehicle-hours of delay (DVHD). In HICOMP, Caltrans attempts to capture recurrent congestion during “typical” incident-free weekday peak periods. Recurrent delay is defined in HICOMP as a condition where speeds drop below 35 mph for a period of 15-minutes or longer during weekday AM or PM commute periods.

For the HICOMP report, probe vehicle runs are performed at most only two to four days during the entire year. Ideally, two days of data collection in the spring and two in the fall of the year, but resource constraints may affect the number of runs performed during a given year. As discussed later in this section when using automatic detector data, congestion levels vary from day to day and depend on any number of factors including accidents, weather, and special events.

Exhibits 3B-1 shows yearly delay trends from 2005 to 2007 for the AM and PM peak travel period for both directions along the corridor. As indicated, the westbound direction had the most significant congestion during the AM peak period while the eastbound direction experienced the most congestion during the PM peak period. There was a small amount of congestion in the eastbound direction during the AM peak period in 2006 and 2007. However, westbound congestion was insignificant during the PM peak period.

[2] Located at <www.dot.ca.gov/hq/traffops/sysmgtpl/HICOMP/index.htm>

Exhibit 3B-1: Average Daily Vehicle-Hours of Delay (2005-07)

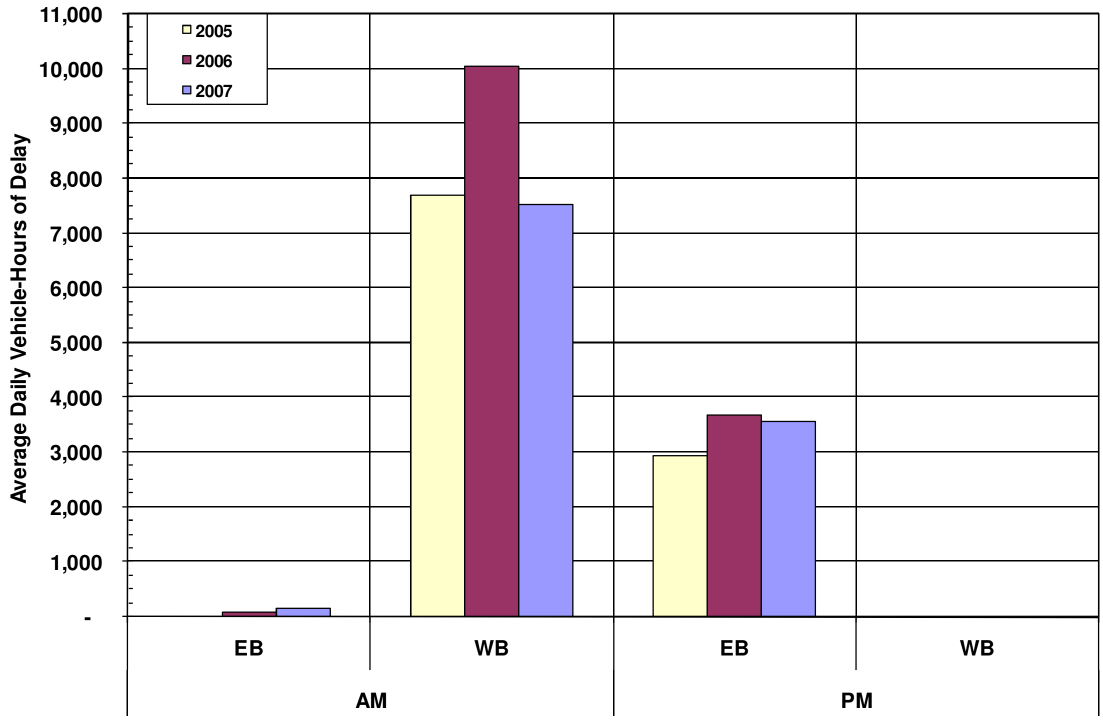


Exhibit 3B-2 shows the complete list of congested segments reported in the HICOMP report for the I-210 Corridor. A congested segment may vary in distance or size from one year to the next as well as from day to day.

The most congested segment on the I-210 Corridor in 2007 was in the westbound direction in the AM peak period between Fifth Avenue and Vernon Avenue, where delay experienced in this segment totaled over 2,200 vehicle-hours.

Exhibits 3B-3 and 3B-4 provide maps illustrating the 2007 congested segments during the AM and PM peak commute periods for the I-210. The approximate locations of the congested segments, the duration of that congestion, and the reported recurrent daily delay are also shown.

Exhibit 3B-2: HICOMP Congested Segments (2005-07)

Period	Dir	Generalized Congested Area	Generalized Area Congested – Hours of Delay 2005	2006	2007
AM	EB	Lincoln Bl to Fair Oaks Ave		78	
		SR134/I210 to Arroyo Blvd			149
	WB	Fruit St to Lone Hill Ave	177		
		Lone Hill Ave to Azusa Ave	2,155	3,143	
		Irwindale Ave to Mountain Ave	3,951	2,007	
		Mountain Ave (Monrovia) to Rosemead Bl		2,015	
		Mountain Ave (Monrovia) to Lake Ave	1,395		
		Mountain Ave (Monrovia) to Rosemead Bl		2,015	
		Foothill Bl to west of Lake Ave		866	
		Hill Ave to Fifth Ave			1,342
		Fifth Ave to Vernon Ave			2,253
		Vernon Ave to Galanto Ave			1,327
		Galanto Ave to Sunflower Ave			1,051
		Sunflower Ave to Walnut Cr			1,547
AM PEAK PERIOD SUMMARY			7,678	10,124	7,669
PM	EB	SR-134 to Baldwin Ave	743		
		JCT SR-164 to El Molino Av			287
		East Banch Arcadia to JCT SR-164			414
		West of Lake Ave to Sierra Madre Bl		431	
		Magnolia Ave to East Branch Arcadia			1,129
		Citrus Ave to Magnolia			1,734
		Sierra Madre Bl to Mountain Ave (Monrovia)		2,771	
		Baldwin Ave to I-605	1,849		
		Irwindale Ave to Citrus Ave	328	469	
PM PEAK PERIOD SUMMARY			2,920	3,671	3,564
TOTAL CORRIDOR CONGESTION			**10,598**	**13,795**	**11,233**

Exhibit 3B-3: 2007 AM Peak Period HICOMP Congested Segments Map

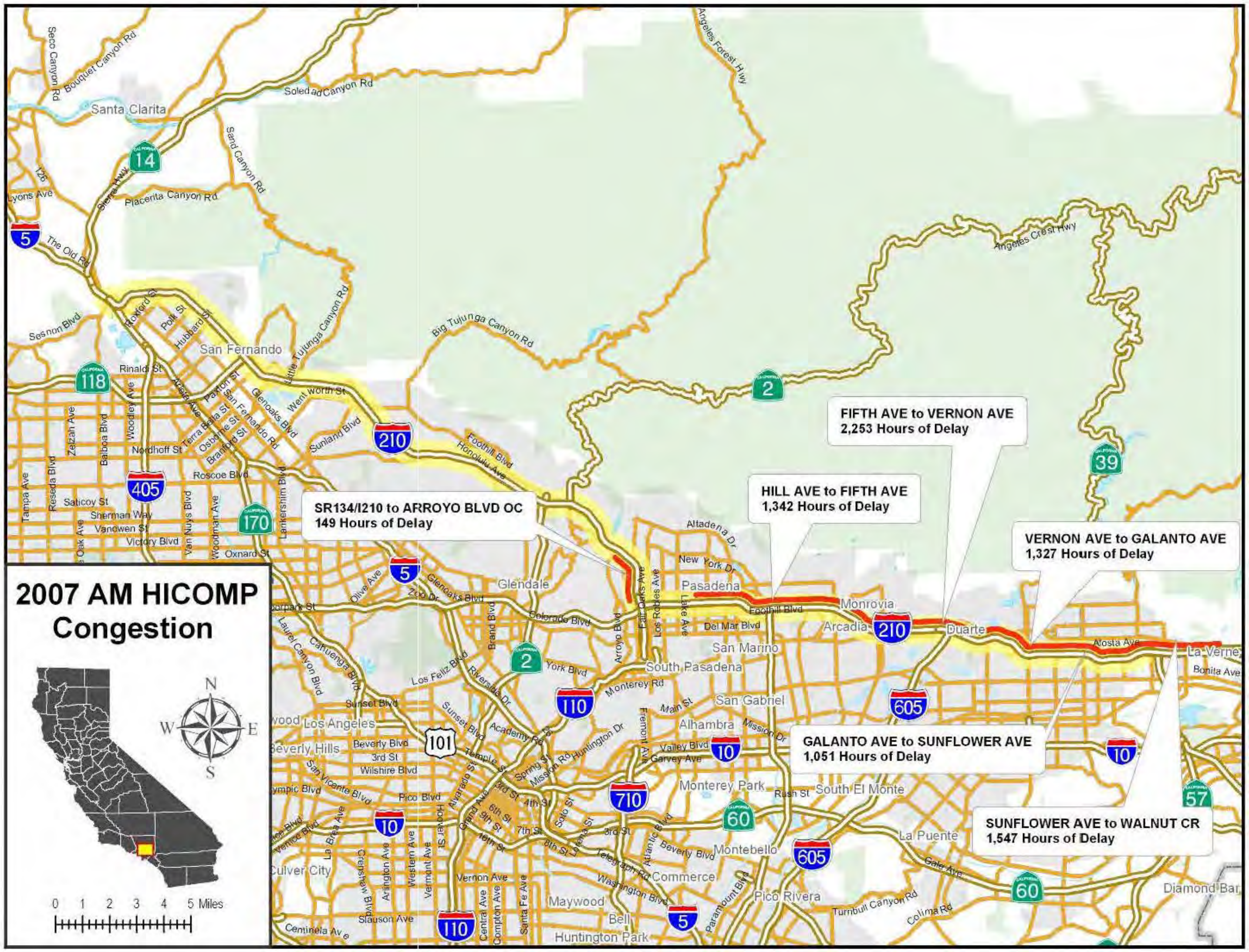
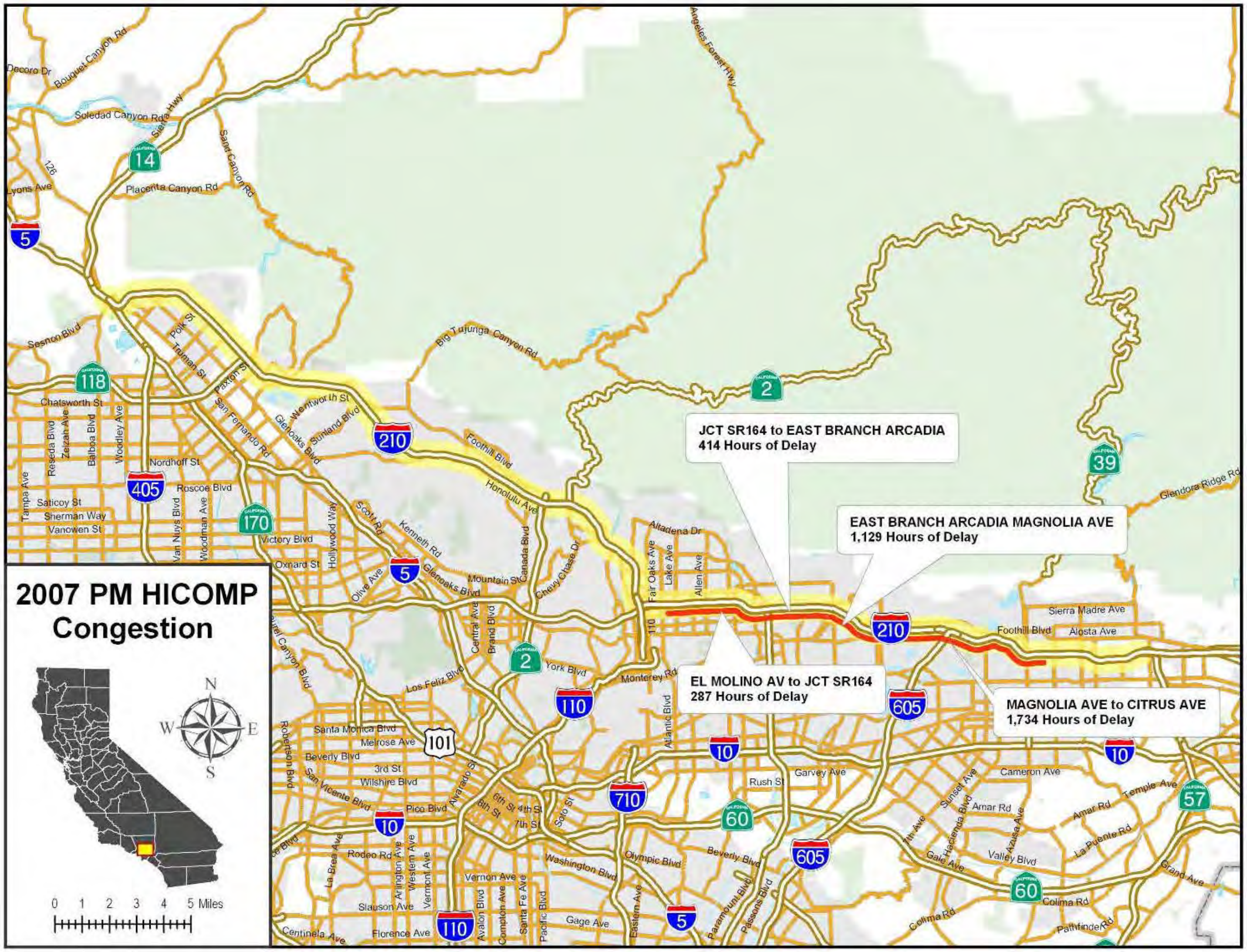


Exhibit 3B-4: 2007 PM Peak Period HICOMP Congested Segments Map



Automatic Detector Data

Using freeway detector data in the previous section, delay is computed for every day and summarized in different ways, which is not possible when using probe vehicle data.

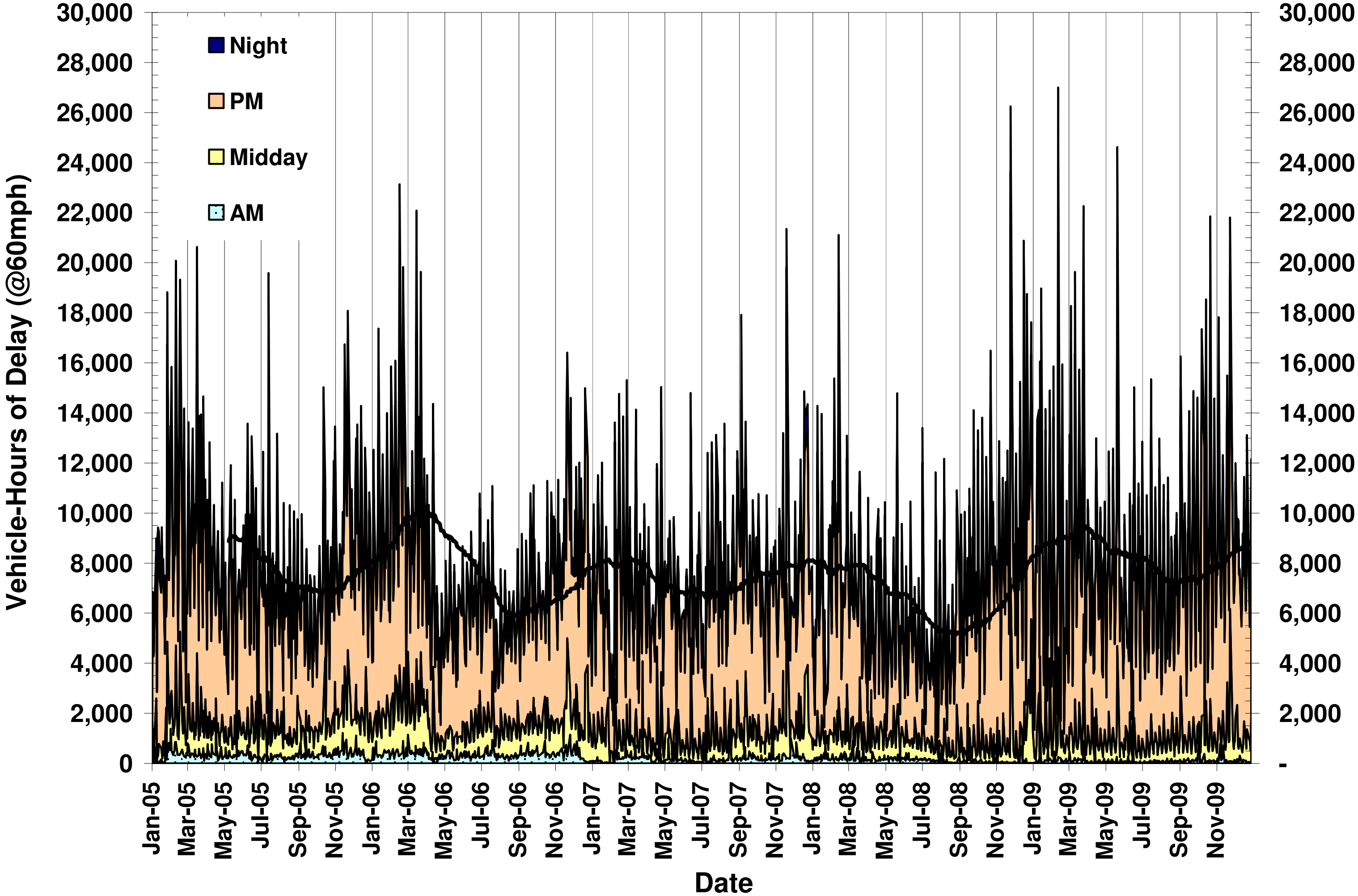
The study compiled five years of automatic detector data from 2005 to 2009. The HICOMP report calculates delay when speeds drop below 35 miles per hour, and assumes an output volume of 2000 vehicles per hour per lane. The automatic detector data in contrast, calculates delay when speeds drop below "free flow" conditions at 60 miles per hour, using the measured output flow volume. The total delay by time period for the corridor for each direction is shown in Exhibits 3B-5 and 3B-6.

Total delay along the I-210 Corridor was computed for four time periods: AM peak (6:00 AM to 9:00 AM), Midday (9:00 AM to 3:00 PM), PM peak (3:00 PM to 7:00 PM), and evening/early AM (7:00 PM to 6:00 AM). Delay is computed as the difference in estimated travel time and a hypothetical travel time at a threshold speed of 60 miles per hour. This is different from the HICOMP reporting methodology, which uses a "severe" threshold speed of 35 mph.

Weekday delay for the mainline facility is presented in Exhibits 3B-5 and 3B-6 during the five-year period from 2005 to 2009. There is also a 90-day moving average to "smooth" out the day-to-day variations and better illustrate the seasonal and annual changes in congestion over time. I-210 eastbound experiences the highest levels of congestion during PM peak period, while I-210 westbound experiences the highest levels of congestion during the AM peak period. Eastbound PM peak delay averages approximately 5,700 vehicle-hours while westbound AM peak delay averages approximately 4,100 vehicle-hours.

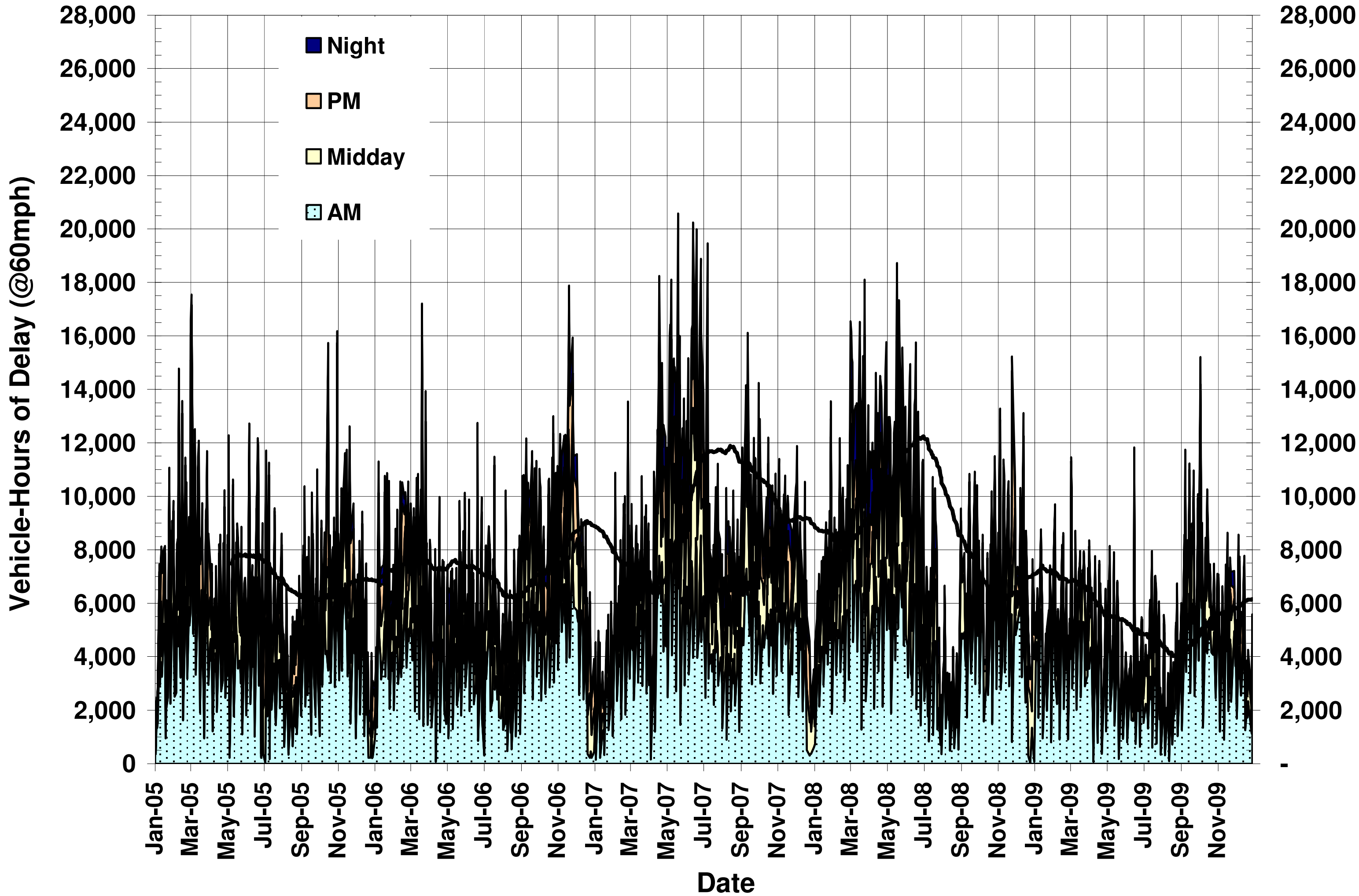
Exhibits 3B-7 and 3B-8 show that delay on the HOV facility followed the same pattern as the mainline facility with more congestion occurring in the PM peak for the eastbound direction and in the AM peak for the westbound direction. Between 2005 and 2009, the average daily delay on the eastbound HOV lanes was around 1,600 hours with the highest delay occurring in November 2008. Similar to the mainline trend, the westbound HOV facility experienced less delay than did the eastbound facility with an average delay around 1,200 hours during the same five-year period.

Exhibit 3B-5: I-210 Eastbound Mainline Average Daily Delay by Time Period (2005-09)



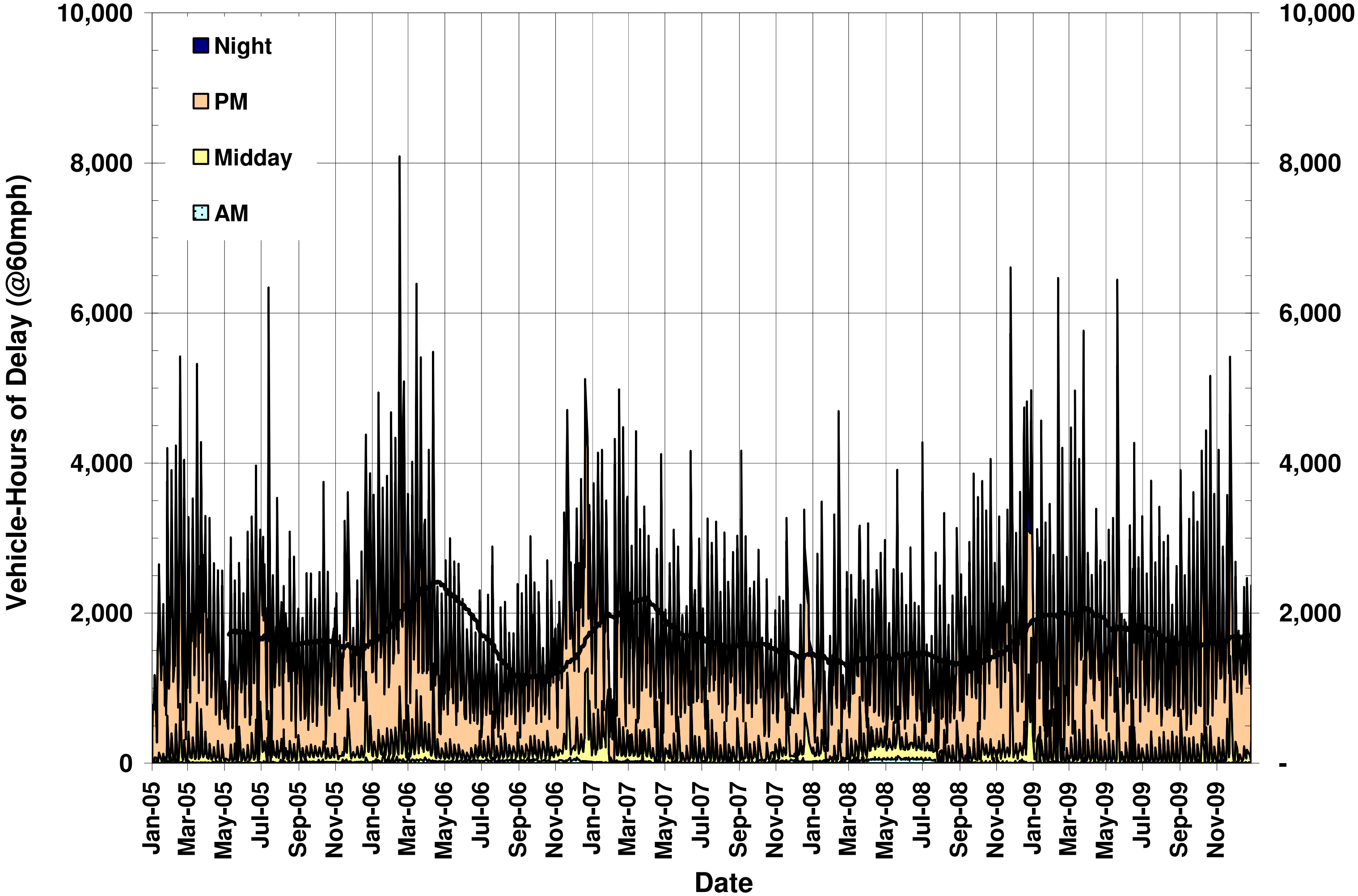
Source: Caltrans detector data

Exhibit 3B-6: I-210 Westbound Mainline Average Daily Delay by Time Period (2005-09)



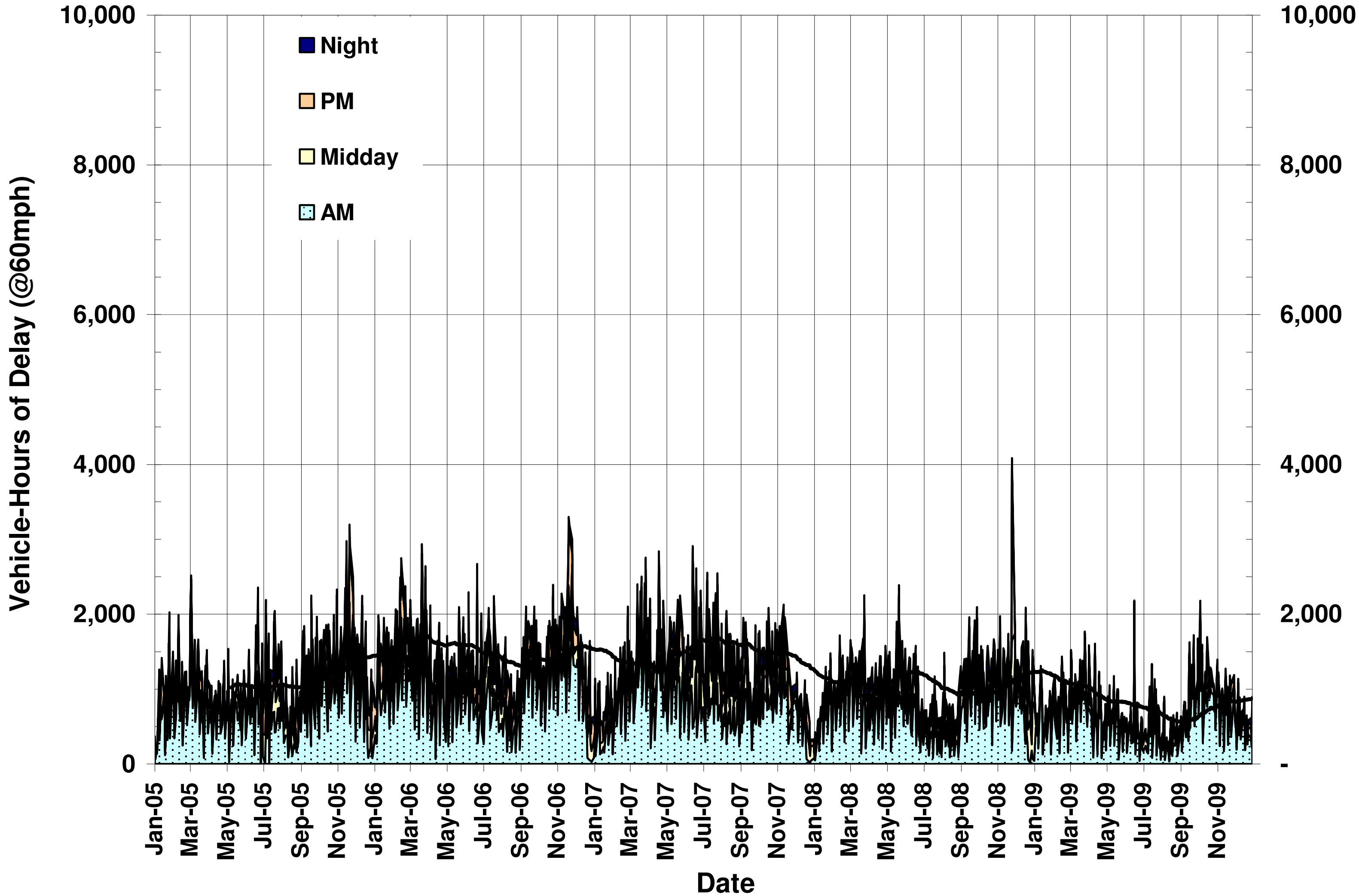
Source: Caltrans detector data

Exhibit 3B-7: I-210 Eastbound HOV Average Daily Delay by Time Period (2005-09)



Source: Caltrans detector data

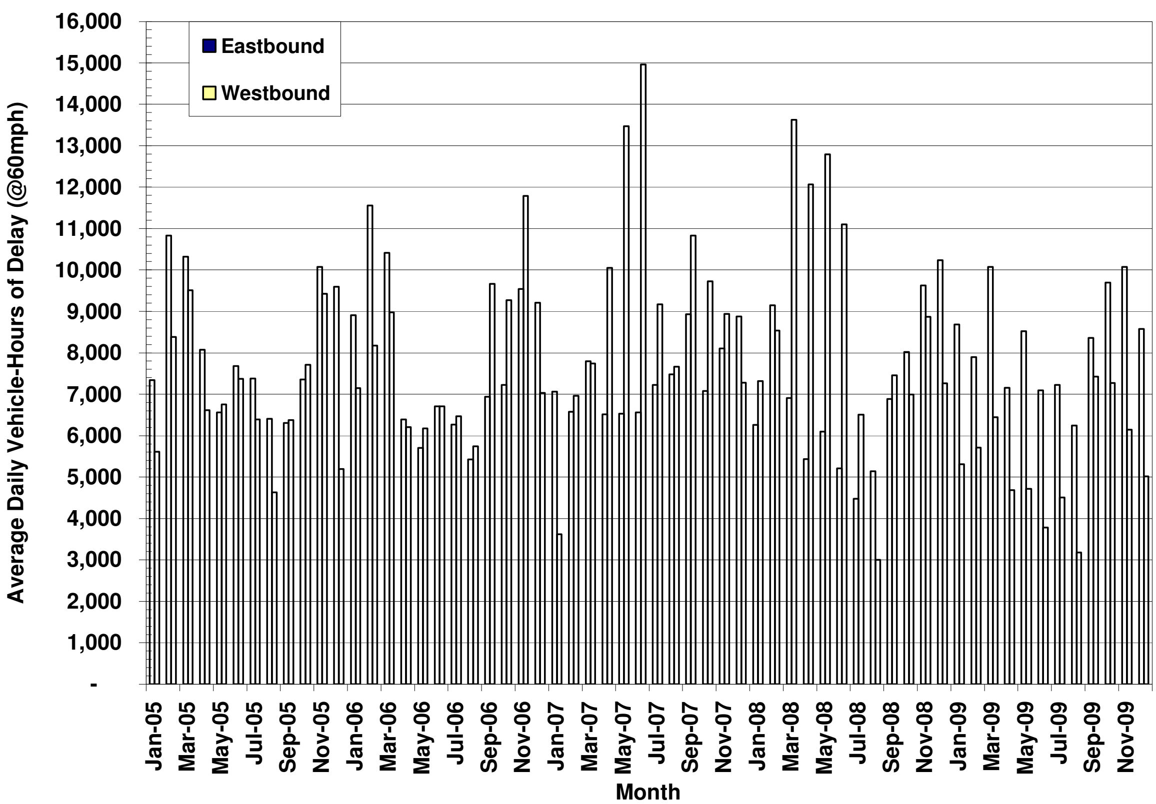
Exhibit 3B-8: I-210 Westbound HOV Average Daily Delay by Time Period (2005-09)



Source: Caltrans detector data

Exhibits 3B-9 and 3B-10 depict the average daily weekday delay by month for the mainline and HOV facilities. As indicated in Exhibit 3B-9, the average weekday delay on the mainline facility varies from month to month. Average weekday delays range from approximately 4,500 vehicle-hours to 11,600 vehicle-hours in the eastbound direction and from approximately 3,000 vehicle-hours to 15,000 vehicle-hours in the westbound direction.

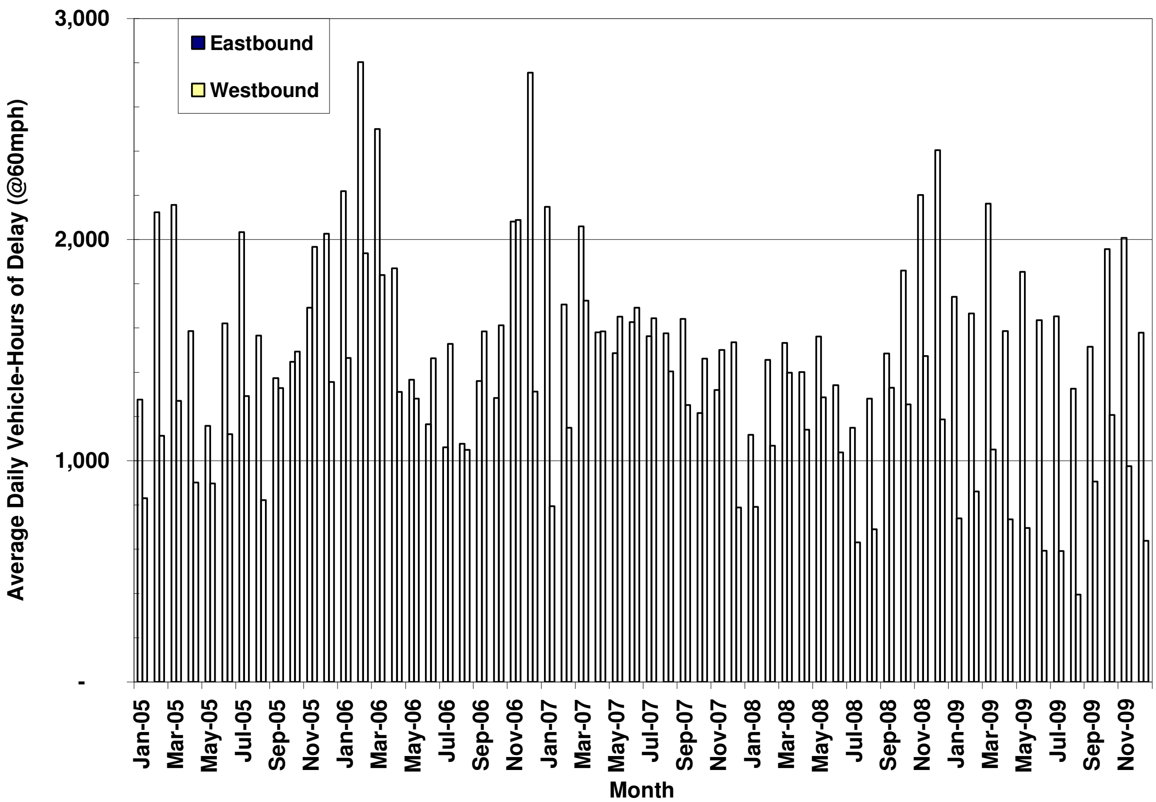
Exhibit 3B-9: I-210 Mainline Average Weekday Delay by Month (2005-09)



Source: Caltrans detector data

Exhibit 3B-10 shows that the HOV lanes exhibit similar variations. The delays on the eastbound HOV lanes range from 1,060 daily vehicle-hours to 2,800. Like the mainline facility, the westbound HOV lanes exhibit greater variation in delay, ranging from 400 daily vehicle-hours to 2,100 daily vehicle-hours.

Exhibit 3B-10: I-210 HOV Average Weekday Delay by Month (2005-09)



Source: Caltrans detector data

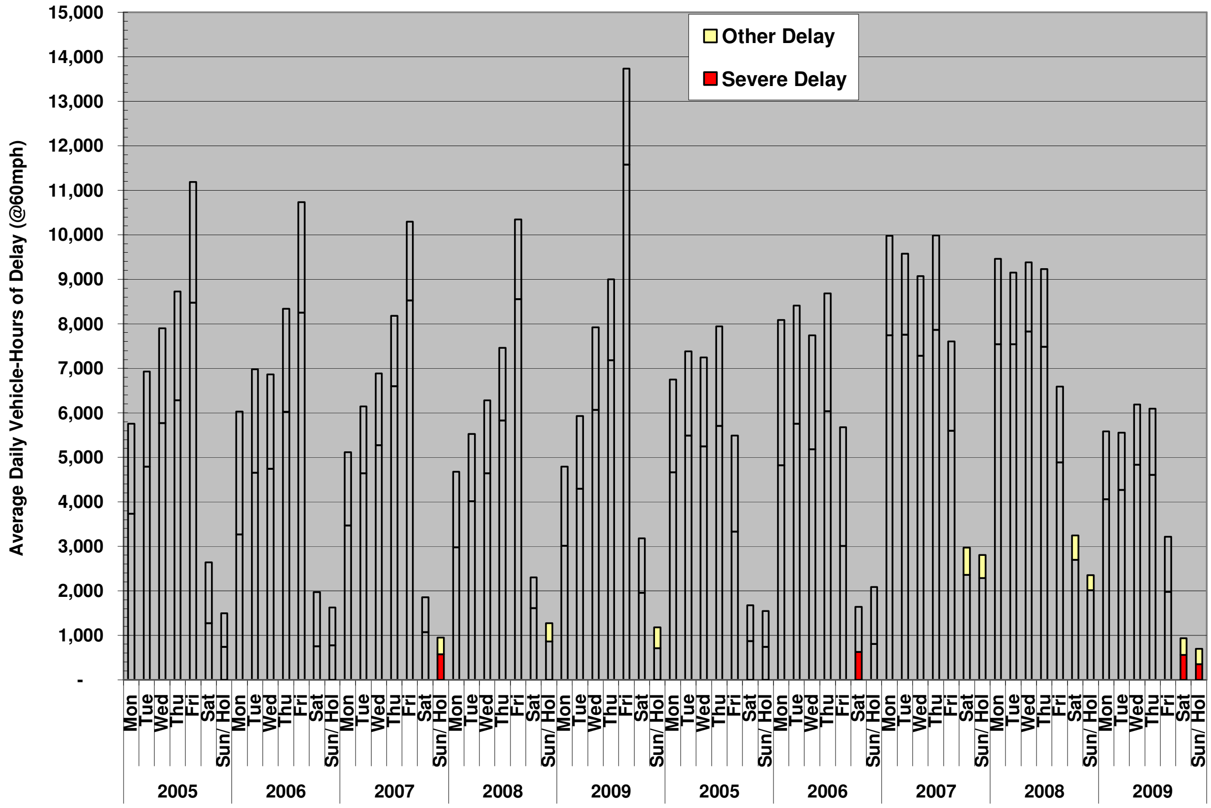
Delays presented to this point represent the difference in travel time between “actual” conditions and free-flow conditions at 60 miles per hour. This delay can be segmented into two components as shown in Exhibits 3B-11 and 3B-12:

- Severe delay – delay occurring when speeds are below 35 miles per hour
- Other delay – delay occurring when speeds are between 35 and 60 miles per hour.

Severe delay represents breakdown conditions and is generally the focus of congestion mitigation strategies. “Other” delay represents conditions approaching the breakdown congestion, leaving the breakdown conditions, or areas that cause temporary slowdowns rather than widespread breakdowns. Although combating congestion requires the focus on severe congestion, it is important to review “other” congestion and understand its trends. This could allow for pro-active intervention before the “other” congestion turns into severe congestion.

As indicated in Exhibit 3B-11, the eastbound direction experienced the highest severe delays on Fridays, peaking at nearly 14,000 vehicle-hours in 2009. In the westbound direction, severe delays do not vary as drastically among the weekdays. These delays have been increasing since 2004, although 2007 and 2008 delays are of roughly similar magnitude. However, in 2009 the westbound direction showed a significant decrease in delays.

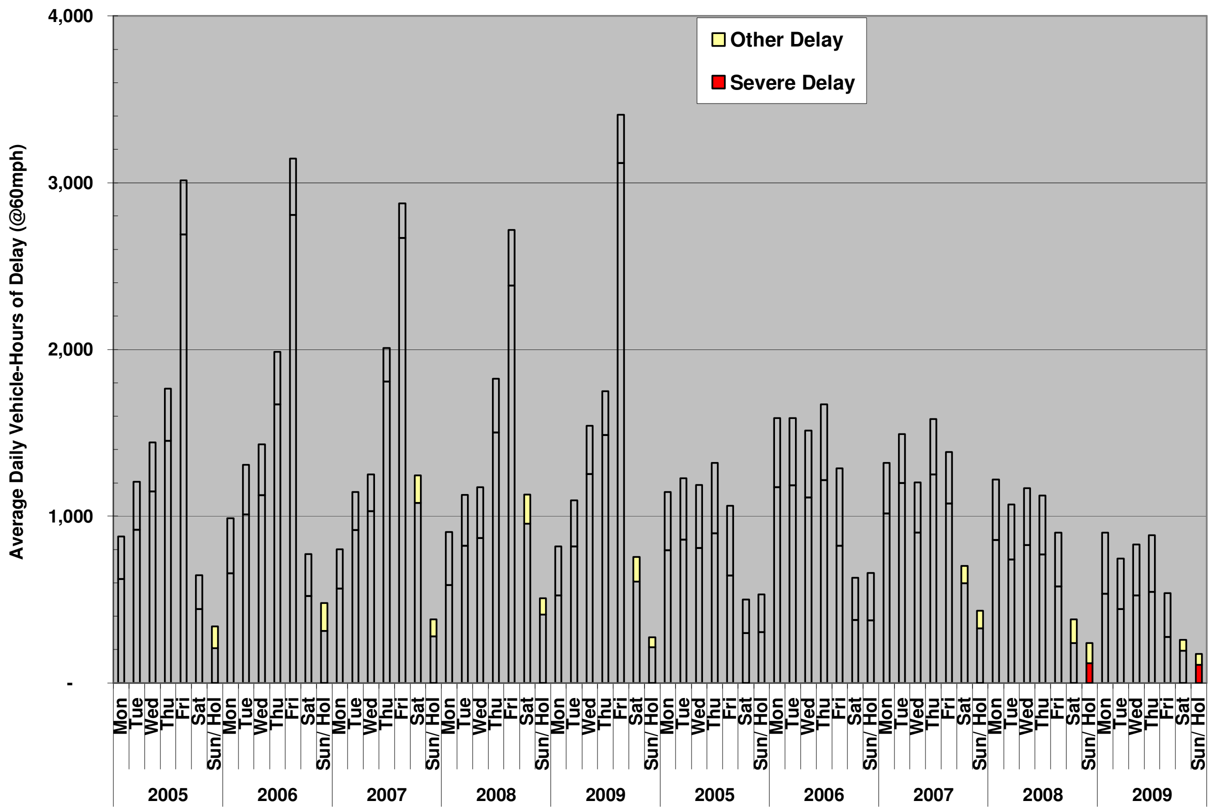
Exhibit 3B-11: I-210 Mainline Average Delay by Day of Week by Severity (2005-09)



Source: Caltrans detector data

Exhibit 3B-12 shows comparable data for the HOV facility. In the eastbound direction, the variation by day of the week appears to be more pronounced for the HOV facility than for the mainline. Much larger delays occur on Fridays than any other day by a large margin (50 to 70 percent greater delays than on Thursdays). Like the mainline facilities, the HOV lanes exhibit fewer daily vehicle-hours of delay in the westbound direction than in the eastbound direction. The variation among days of the week is also less in the westbound direction, where the highest delays tend to occur on Thursdays.

Exhibit 3B-12: I-210 HOV Average Delay by Day of Week by Severity (2005-09)



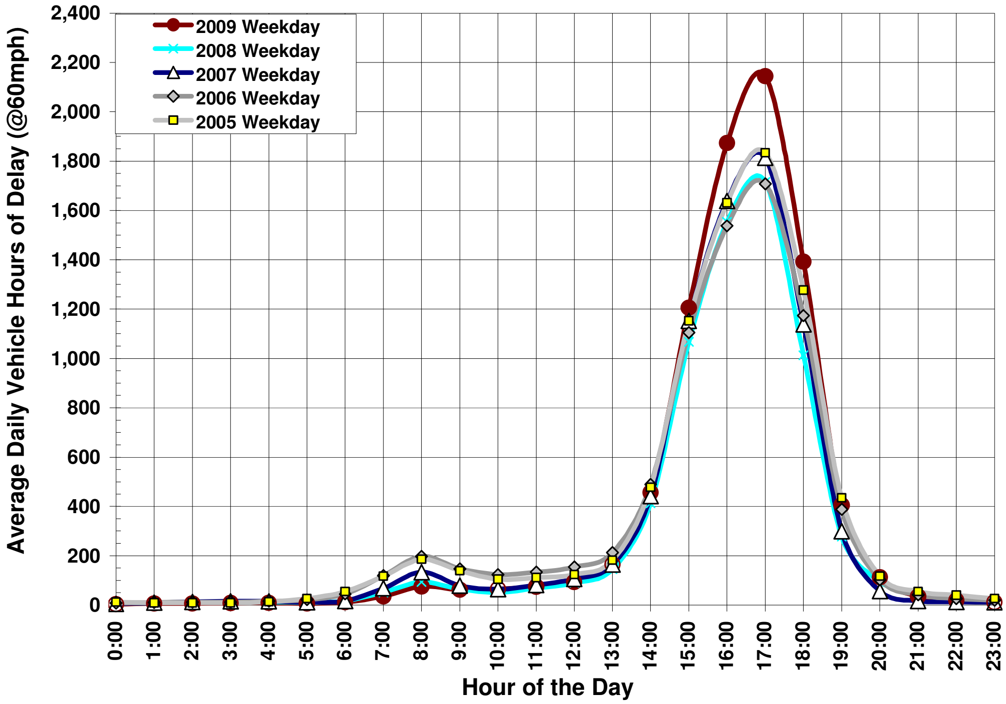
Source: Caltrans detector data

Another way to understand the characteristics of congestion and related delays is shown in Exhibits 3B-13 through 3B-16, which summarize average weekday delay by hour for the five years analyzed (2005 to 2009) for both the mainline and the HOV lanes. These exhibits show corridor peaking characteristics, and how the peak period is changing over time.

Exhibit 3B-13 summarizes the average weekday hourly delay for the mainline in the eastbound direction. The eastbound direction peaks in the PM peak period, while the AM is the westbound peak. AM peak hour is 7:00 AM, while the PM peak period is 5:00

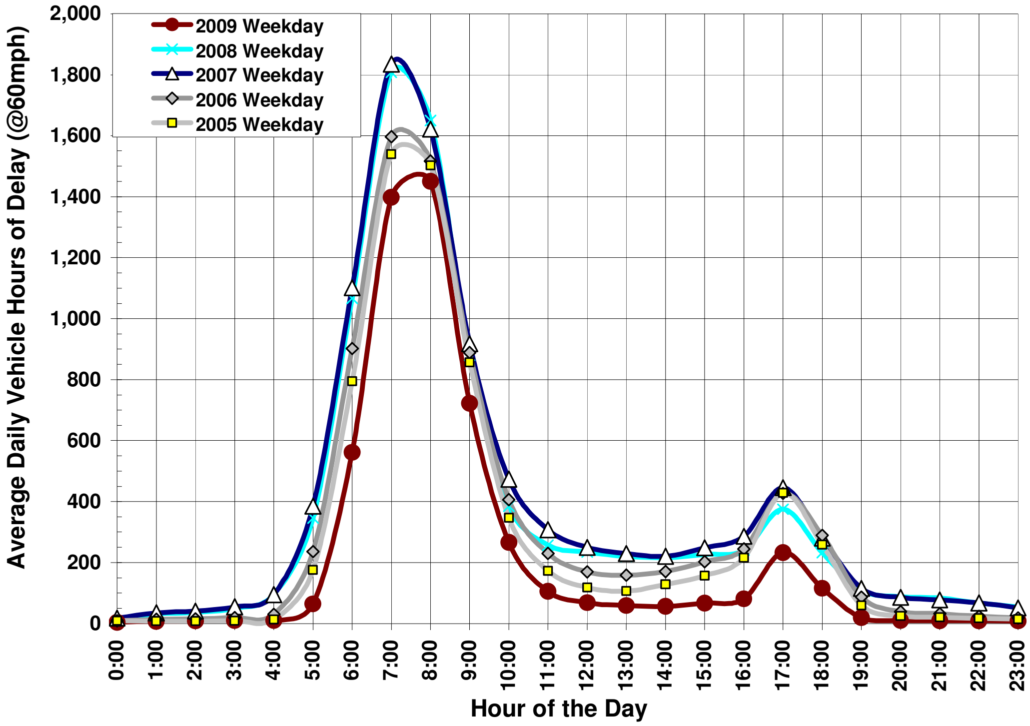
PM. In the eastbound PM direction, congestion grew dramatically in 2009, while westbound AM congestion declined. Eastbound delay between 2005 and 2008 remained relatively constant at about 1,750 vehicle-hours during the 5:00 PM peak hour before increasing in 2009 to about 2,100 vehicle-hours. Westbound AM congestion declined in 2009, after two years of dramatic growth between 2007 and 2008. In 2009, the AM peak period also shrank by approximately one-half hour and started at approximately 5:30 AM whereas from 2005 to 2008, the peak period started around 5:00 AM.

Exhibit 3B-13: Eastbound Mainline Average Weekday Hourly Delay (2005-09)



Source: Caltrans detector data

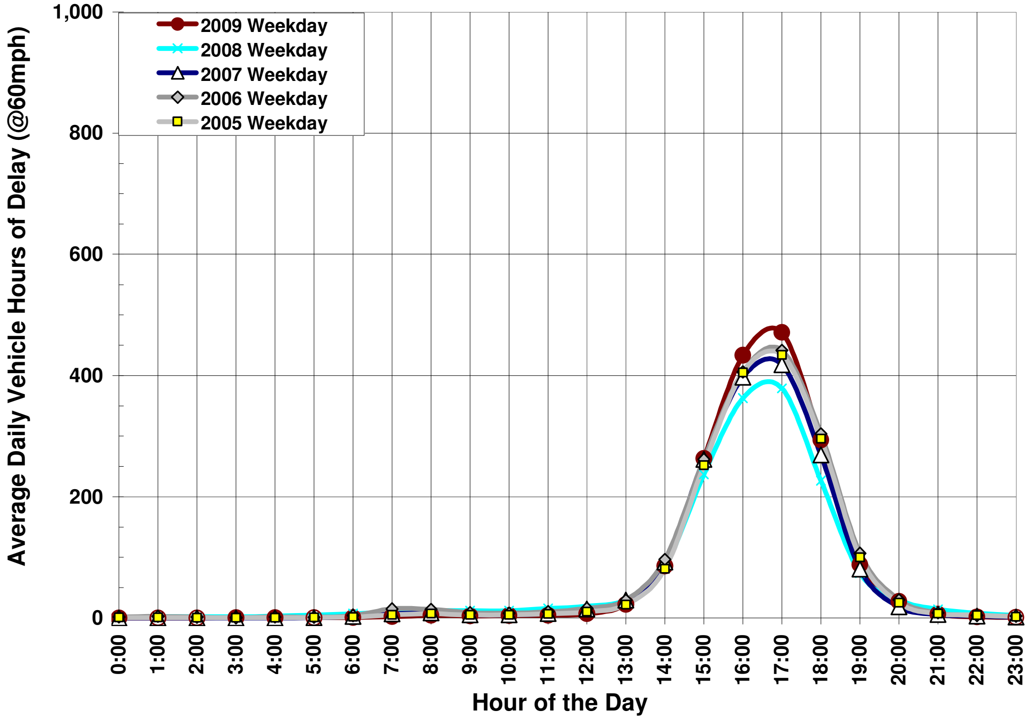
Exhibit 3B-14: Westbound Mainline Average Weekday Hourly Delay (2005-09)



Source: Caltrans detector data

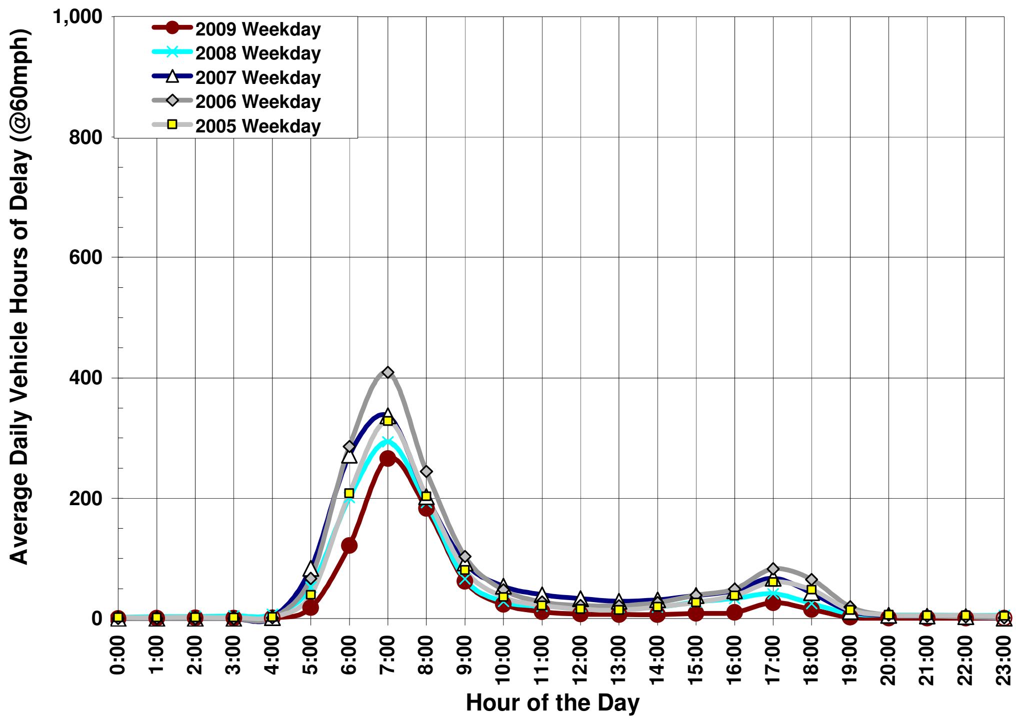
As shown in Exhibits 3B-15 and 3B-16, delays on the HOV lanes roughly mirror those on the mainline facilities. The HOV westbound direction (Exhibit 3B-16) shows two humps with the larger delays in the morning just like the mainline (Exhibit 3B-14). In the eastbound direction, the HOV lanes have the largest delays at 4:00 PM and 5:00 PM (Exhibit 3B-15). Unlike the mainline facilities, the HOV facilities do not show much (if any) delay in the eastbound direction during the morning.

Exhibit 3B-15: Eastbound HOV Average Weekday Hourly Delay (2005-09)



Source: Caltrans detector data

Exhibit 3B-16: Westbound HOV Average Weekday Hourly Delay (2005-09)



Source: Caltrans detector data

Travel Time

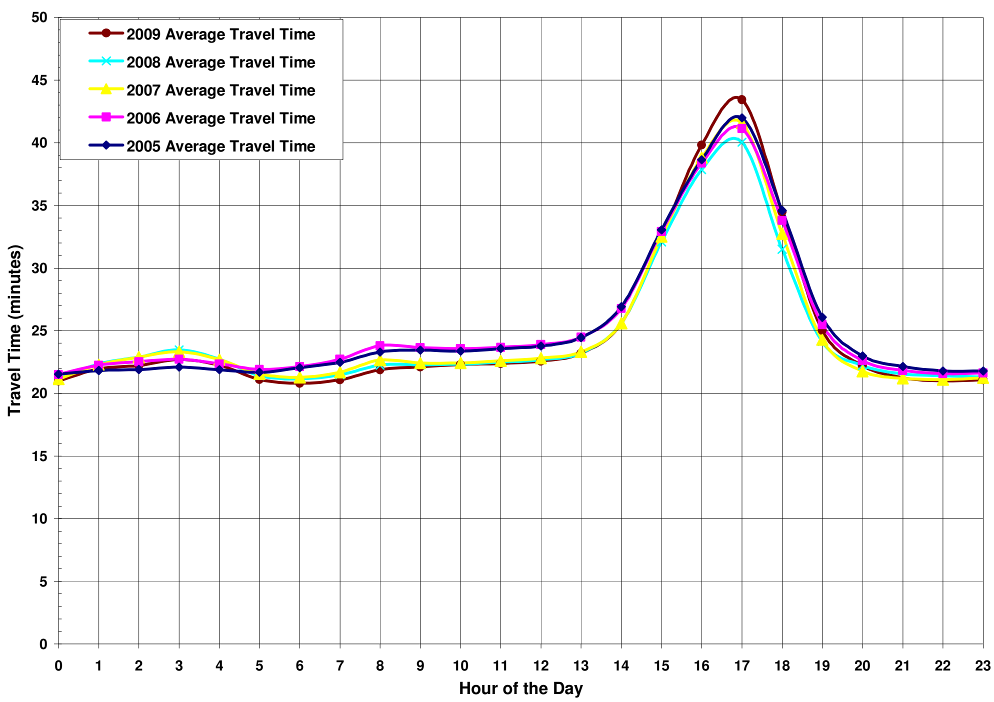
Travel time is reported as the amount of time for a vehicle to traverse the distance between two points on a corridor. In this section, travel time is estimated using automatic detector data for the 20-mile urban area of the I-210 Corridor from west of SR-134 to east of SR-57. Travel time on parallel arterials was not included for this analysis.

Exhibits 3B-17 through 3B-20 summarize the travel times estimated for the mainline and HOV facilities using automatic detector data. As shown in Exhibits 3B-17 and 3B-18, travel along the mainline takes about 21 to 22 minutes during the off-peak periods. This corresponds to a speed of about 65 mph. As shown in Exhibits 3B-19 and 3B-20, travel times are comparable, although slightly less, on the HOV lanes.

In the mainline lanes, the eastbound PM peak hour (5:00 PM), travel time grew from 40 minutes in 2008 to 44 minutes in 2009. In the westbound AM peak hour (7:00 AM), the opposite trend occurred with travel times dropping from a 41 minute average in 2008 to around 36 minutes in 2009.

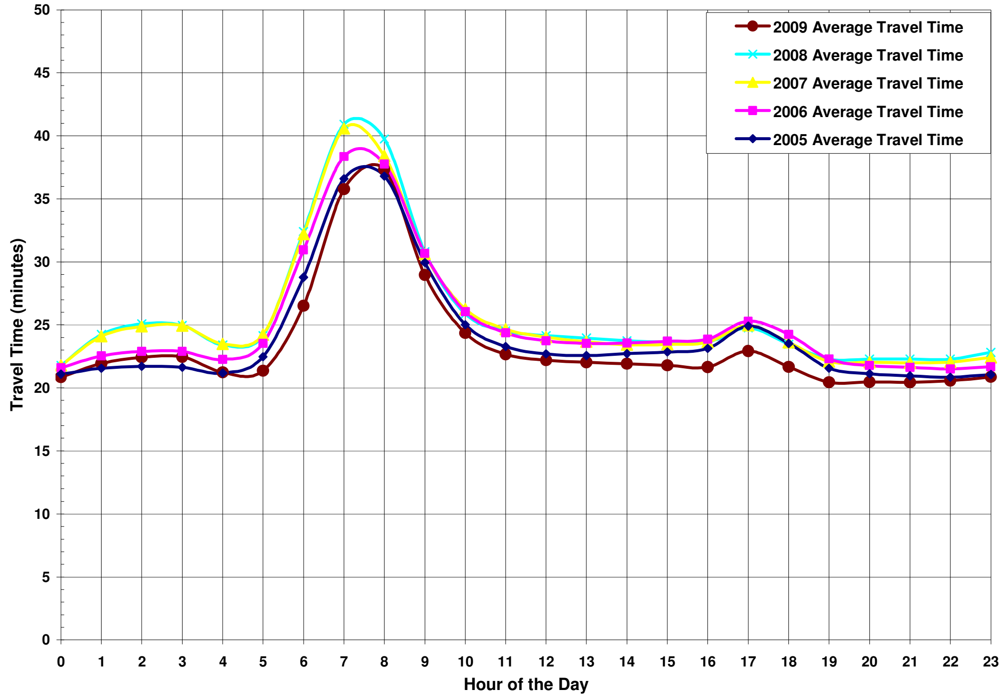
A similar trend occurred for the HOV lanes, except that 2005 was the worst year in terms of travel times.

Exhibit 3B-17: Eastbound Mainline Travel Time by Time of Day (2005-09)



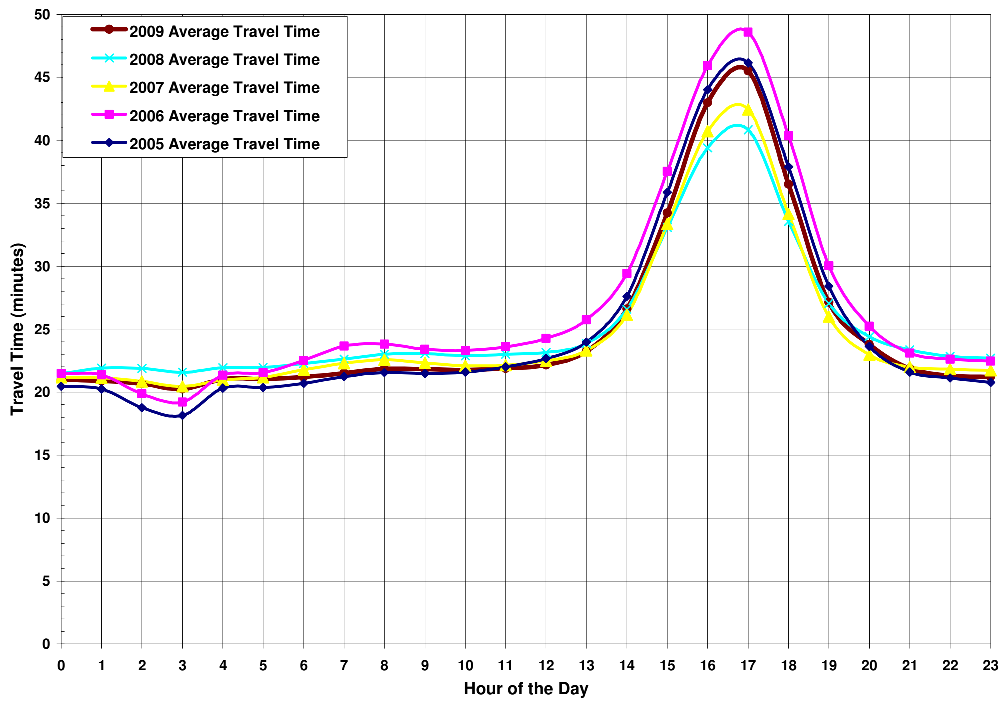
Source: Caltrans detector data

Exhibit 3B-18: Westbound Mainline Travel Time by Time of Day (2005-09)



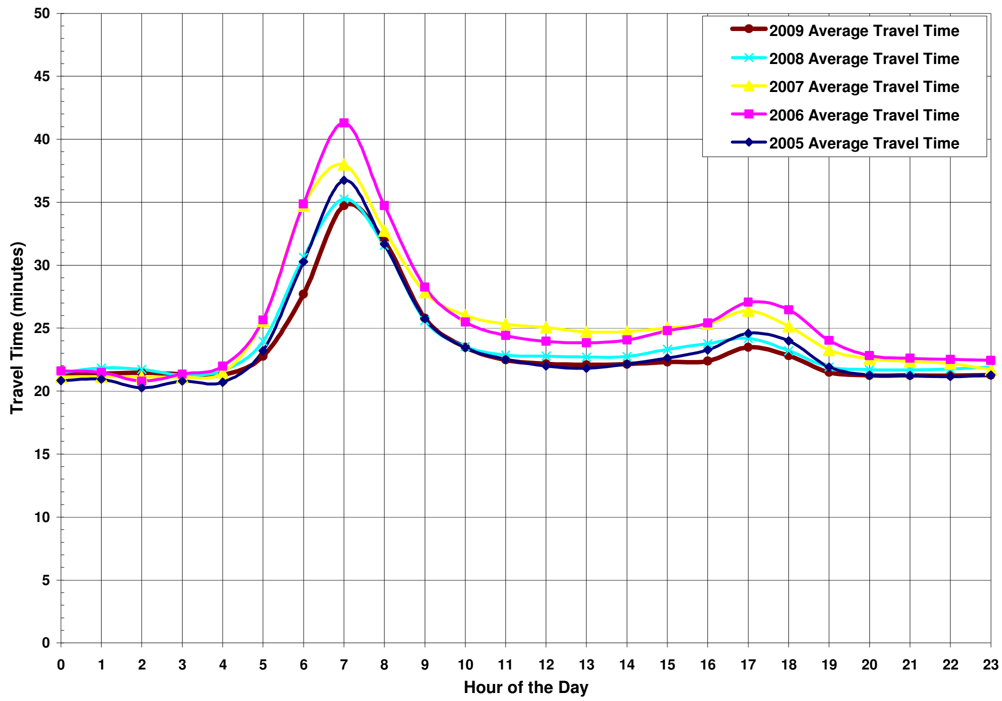
Source: Caltrans detector data

Exhibit 3B-19: Eastbound HOV Travel Time by Time of Day (2005-09)



Source: Caltrans detector data

Exhibit 3B-20: Westbound HOV Travel Time by Time of Day (2005-09)



Source: Caltrans detector data

Reliability

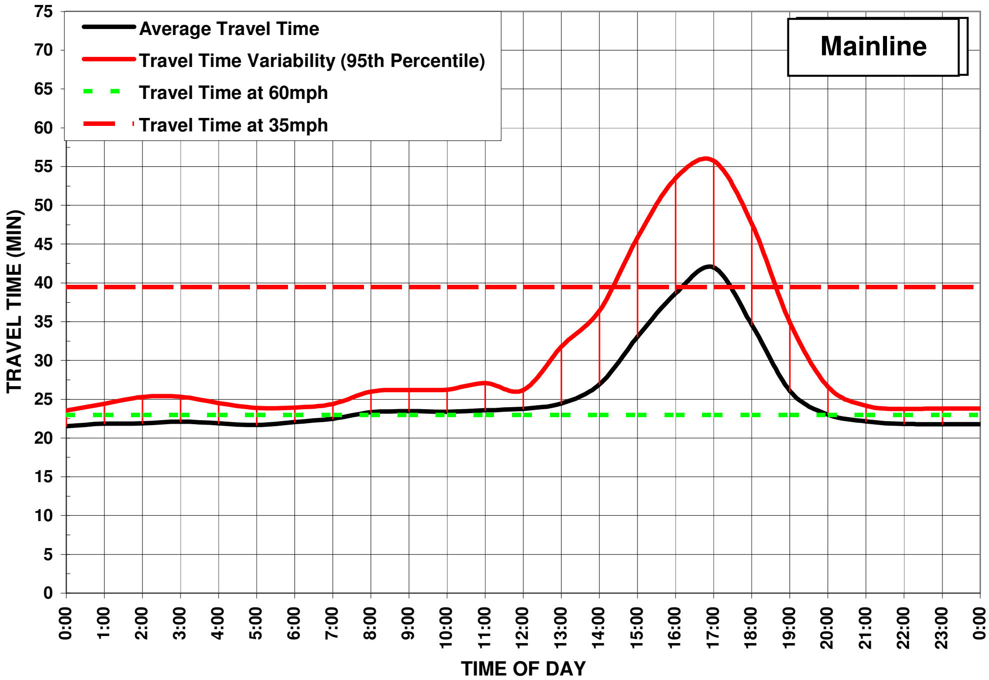
Reliability captures the degree of predictability in the public's travel time. Unlike mobility, which measures the rate of travel, the reliability measure focuses on how travel time varies from day to day. To measure reliability, the study team used statistical measures of variability on the travel times estimated from automatic detector data. The 95th percentile was chosen to represent the maximum travel time that most people would experienced on the corridor. Severe events, such as fatal collisions, could cause longer travel times, but the 95th percentile was chosen as a balance between extreme events and a "typical" travel day.

Exhibits 3B-21 to 3B-30 illustrate the variability of travel time along I-210 from SR-134 to SR-57 for weekdays averaged throughout the indicated year. As evident in the exhibits, travel times can range considerably more than the mean travel time during the peak hours. Daily reliability will vary within this range (mean to maximum) depending on the number and extent of incidents occurring during travel. Travel times of less than the mean are infrequent, typically occurring during the day preceding or following a holiday weekend. The exhibits demonstrate that travel time reliability has been fairly constant over the five years. The greatest reliability occurs during the peak periods – often with travel times reflecting congested conditions (travel at speeds under 35 mph).

Similarly, Exhibits 3B-31 through 3B-40 show travel time variability on the HOV facility for both the eastbound and westbound direction between the years 2005 and 2009. Unlike the mainline facility, the HOV lanes appear to have had improved reliability over the last three years (2007-2009).

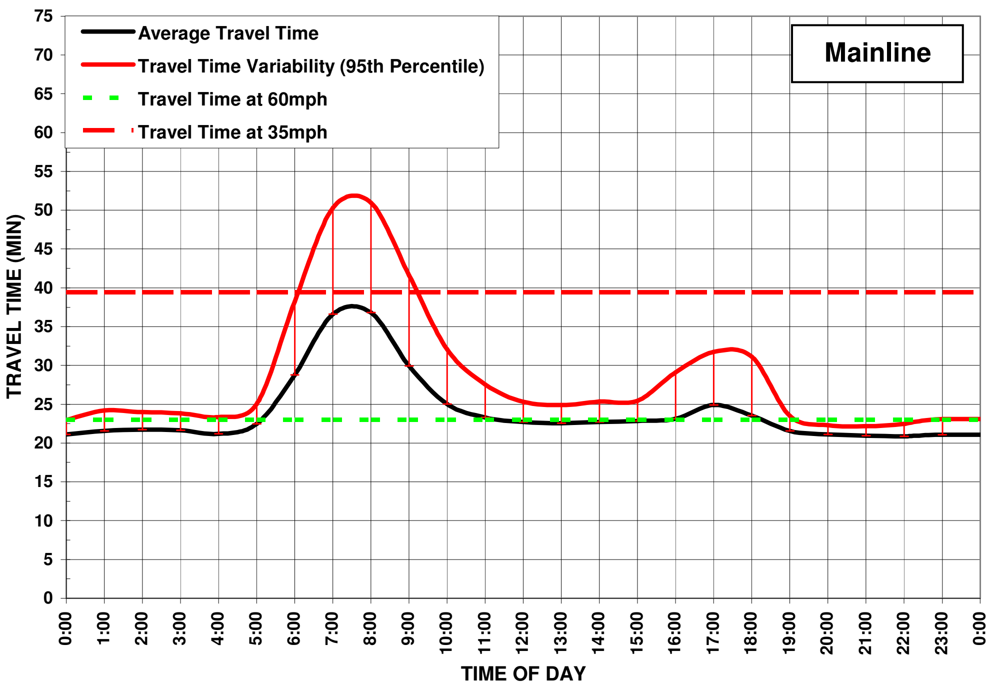
In 2006 in the eastbound direction, 5:00 PM had the highest estimated average travel time at approximately 41 minutes and the highest estimated buffer index time of 15 minutes for a buffer index of 33 percent. In other words, to arrive on time 95 percent of the time, a commuter would need to leave for work 56 minutes before the start time to travel the length of the I-210 study corridor from SR-134 to SR-57. The westbound direction the 7:00 AM had the estimated average travel time of 39 minutes in 2006 with a buffer time of 15 minutes for a buffer index of 38 percent.

Exhibit 3B-21: Eastbound Mainline Travel Time Variability (2005)



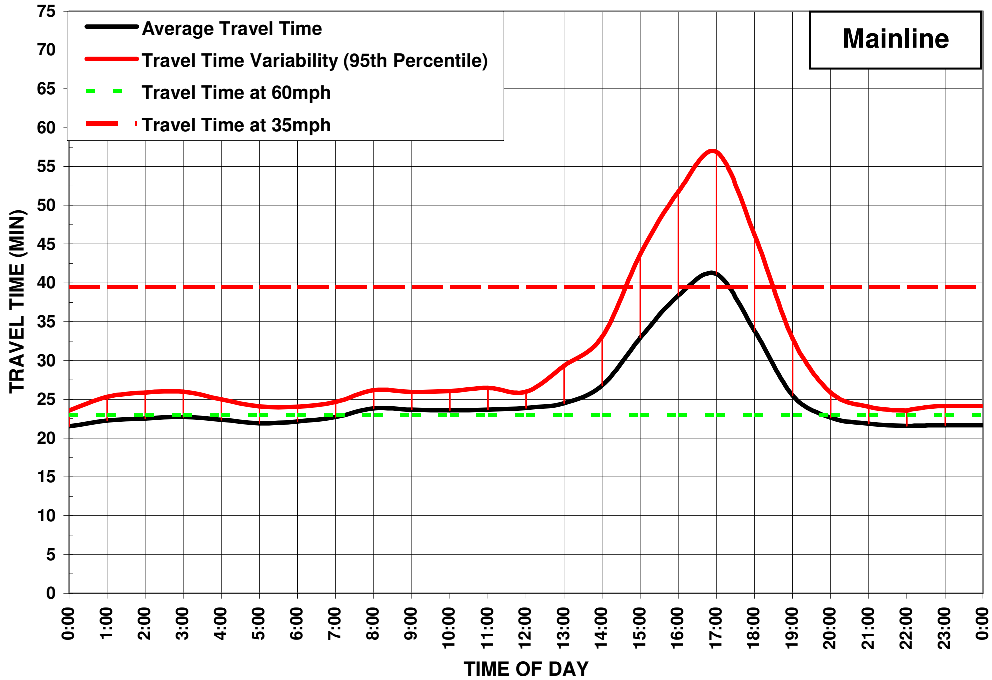
Source: Caltrans detector data

Exhibit 3B-22: Westbound Mainline Travel Time Variability (2005)



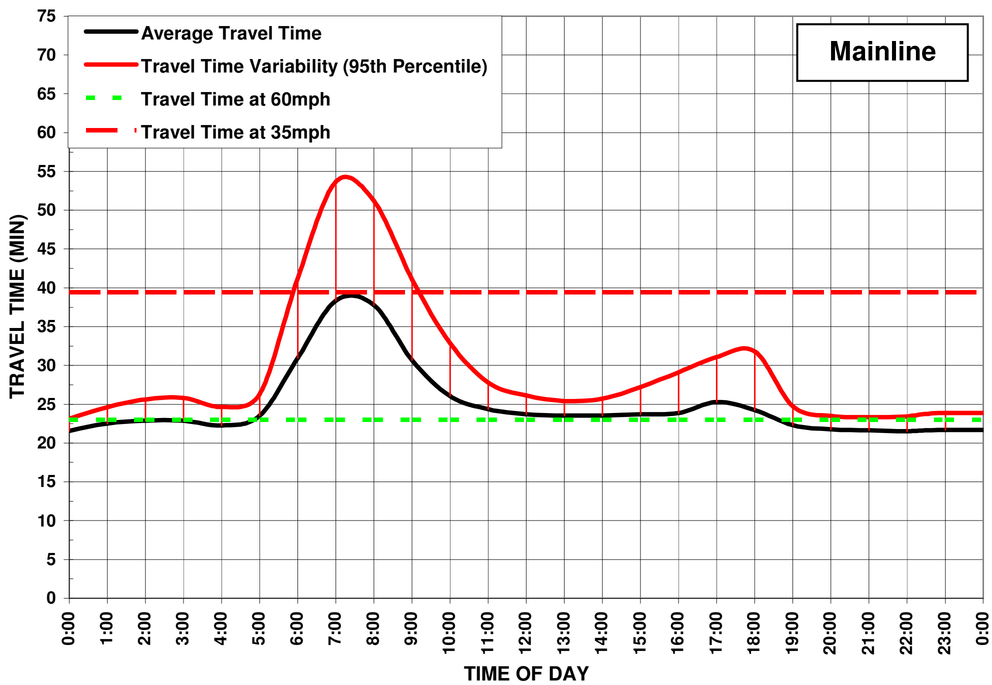
Source: Caltrans detector data

Exhibit 3B-23: Eastbound Mainline Travel Time Variability (2006)



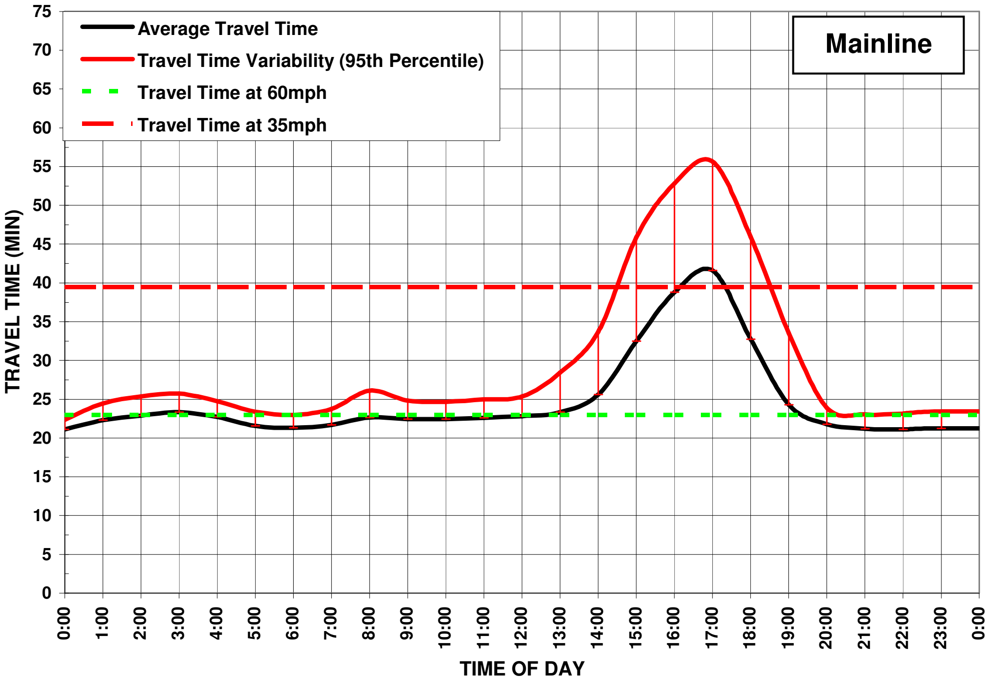
Source: Caltrans detector data

Exhibit 3B-24: Westbound Mainline Travel Time Variability (2006)



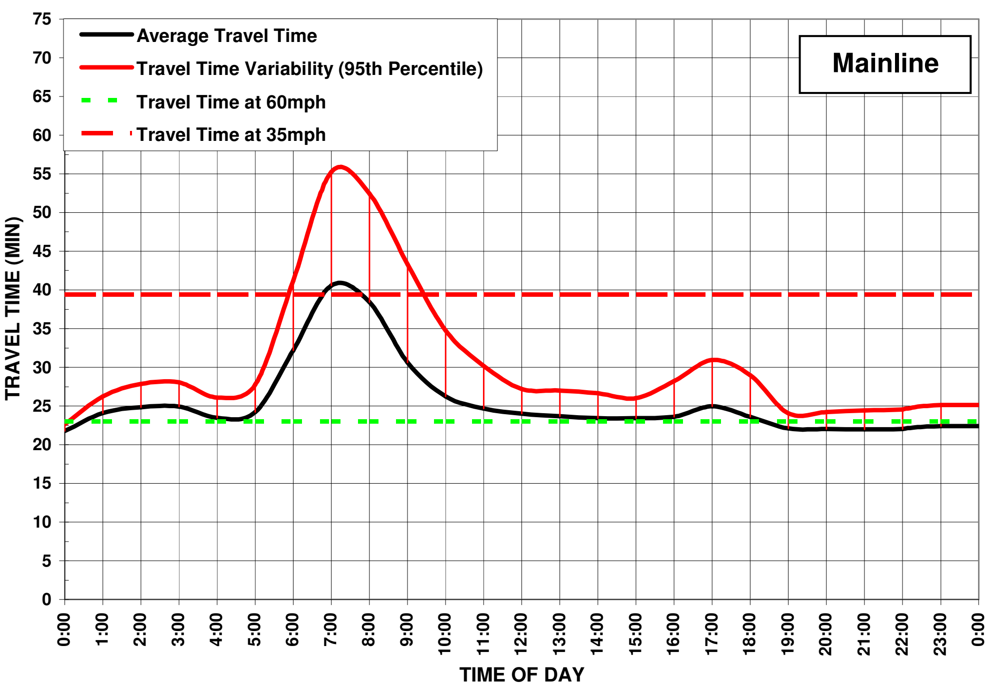
Source: Caltrans detector data

Exhibit 3B-25: Eastbound Mainline Travel Time Variability (2007)



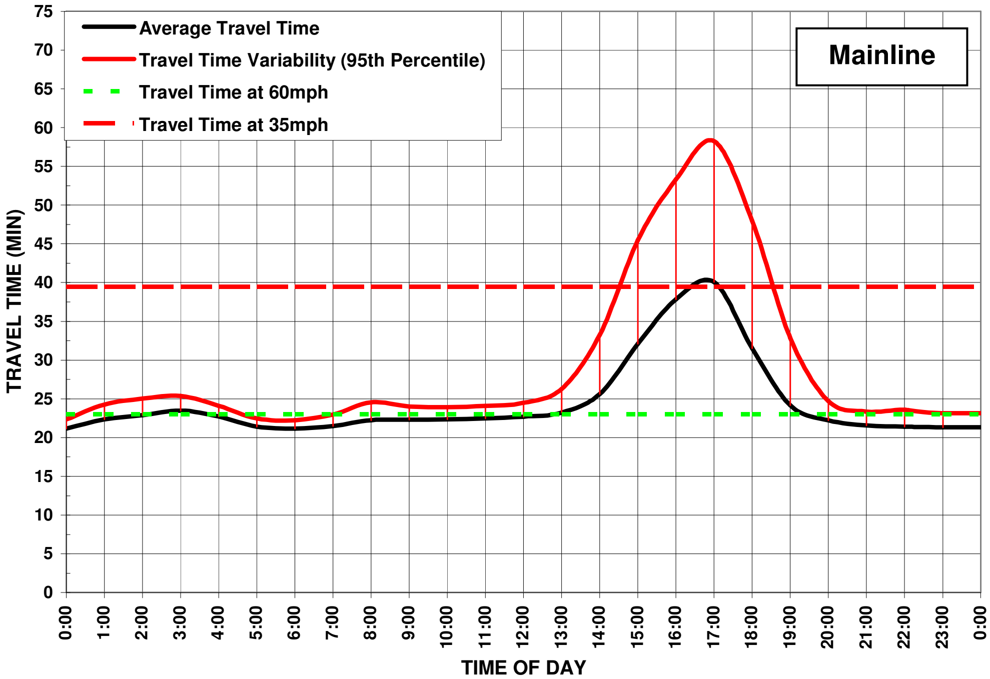
Source: Caltrans detector data

Exhibit 3B-26: Westbound Mainline Travel Time Variability (2007)



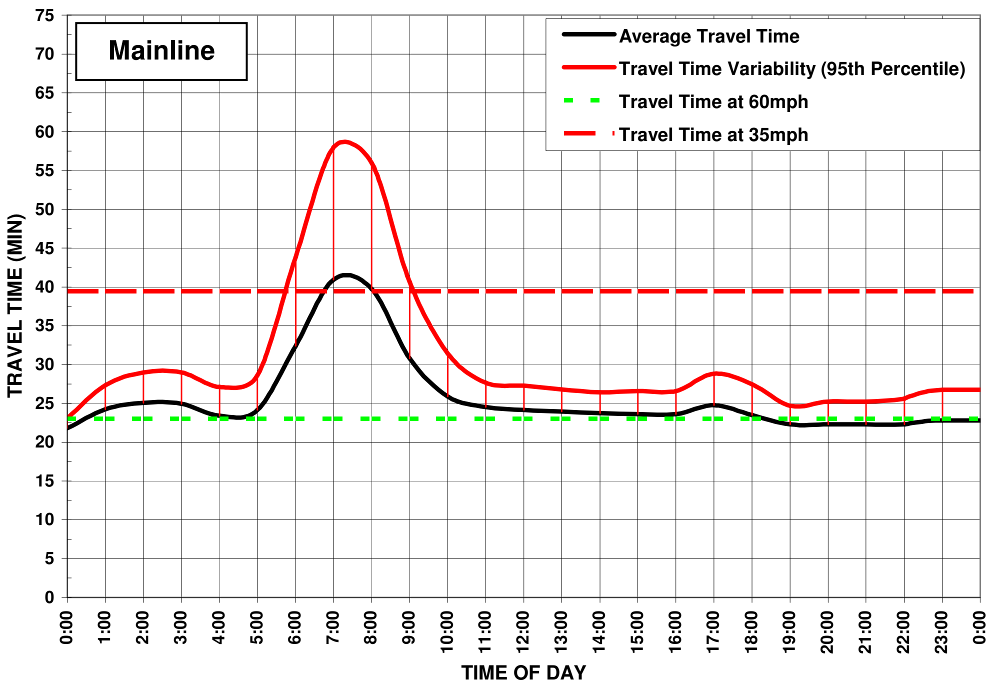
Source: Caltrans detector data

Exhibit 3B-27: Eastbound Mainline Travel Time Variability (2008)



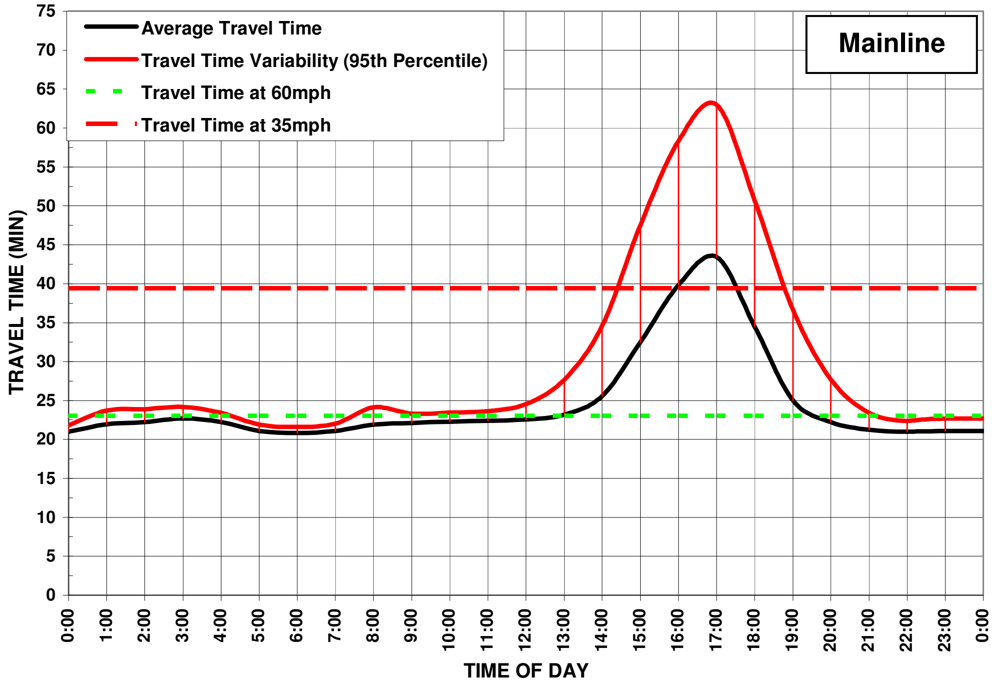
Source: Caltrans detector data

Exhibit 3B-28: Westbound Mainline Travel Time Variability (2008)



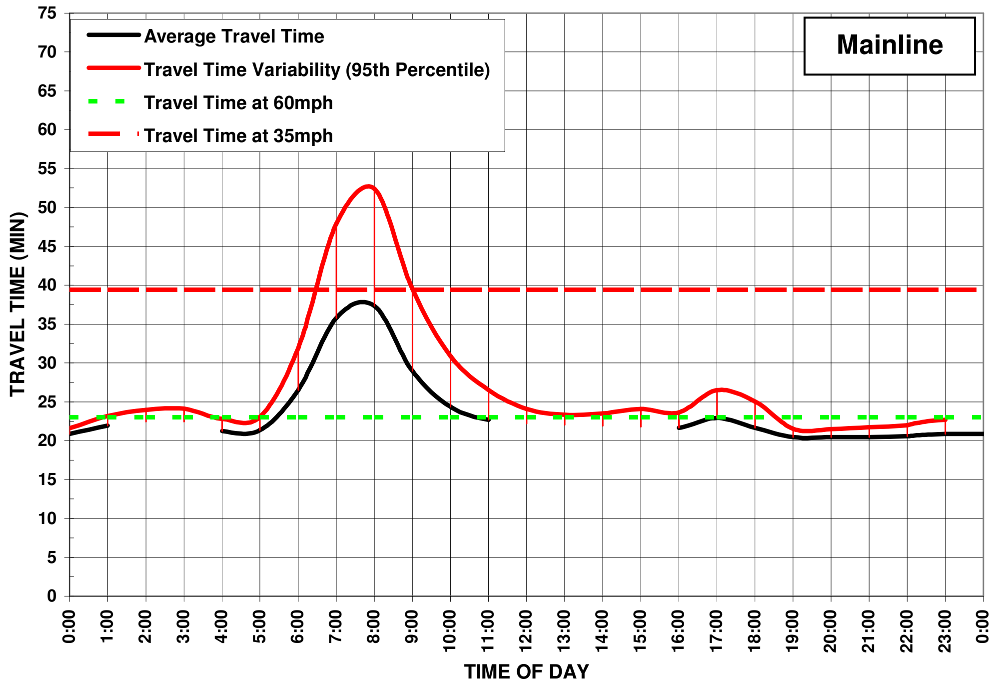
Source: Caltrans detector data

Exhibit 3B-29: Eastbound Mainline Travel Time Variability (2009)



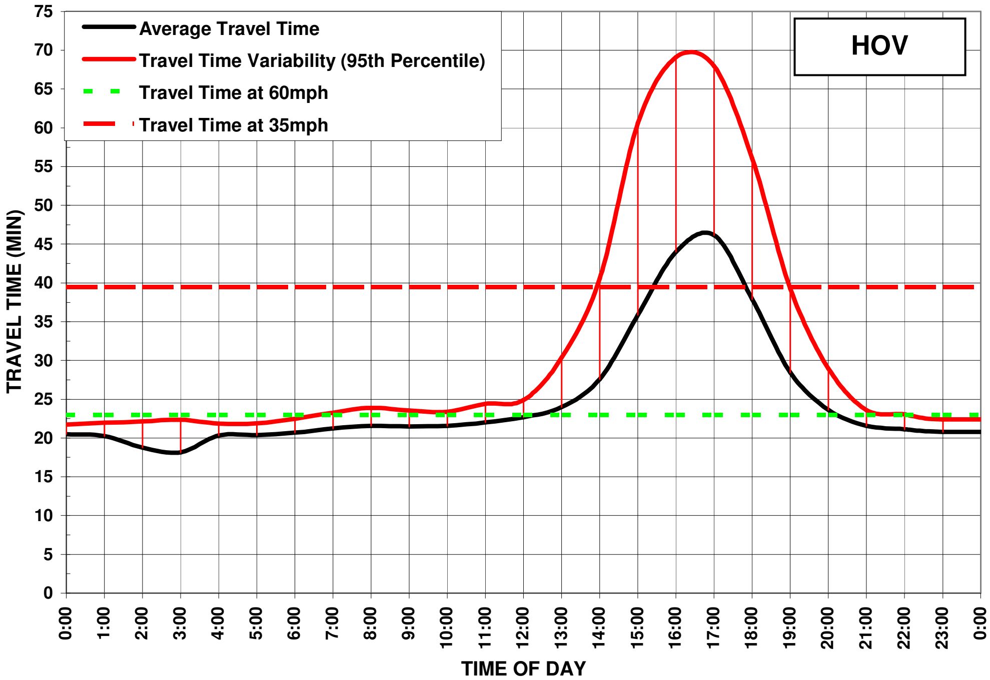
Source: Caltrans detector data

Exhibit 3B-30: Westbound Mainline Travel Time Variability (2009)



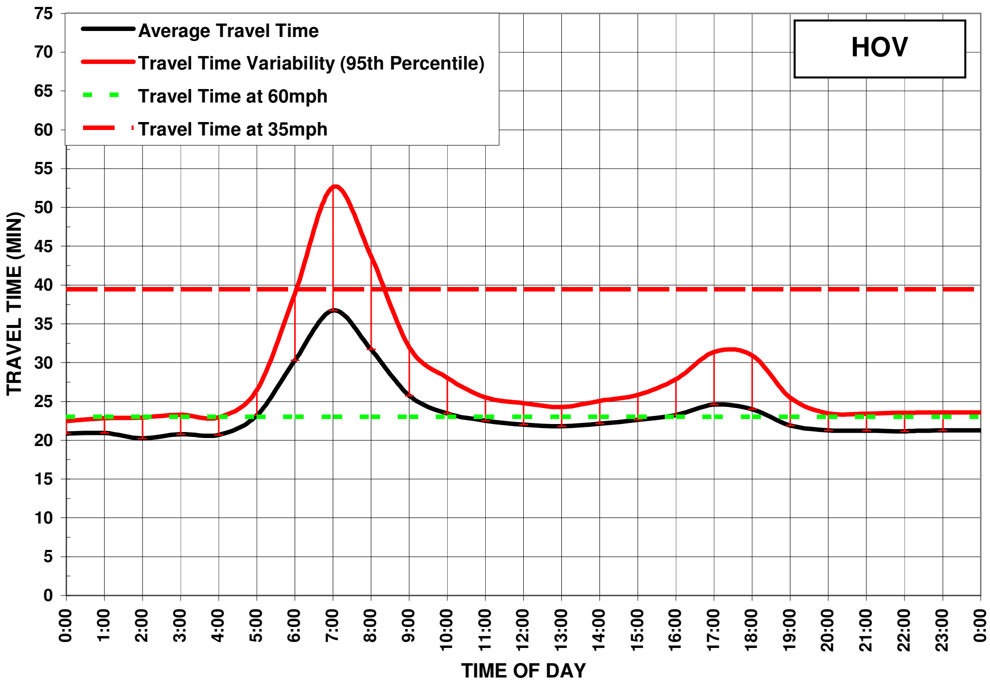
Source: Caltrans detector data

Exhibit 3B-31: Eastbound HOV Travel Time Variability (2005)



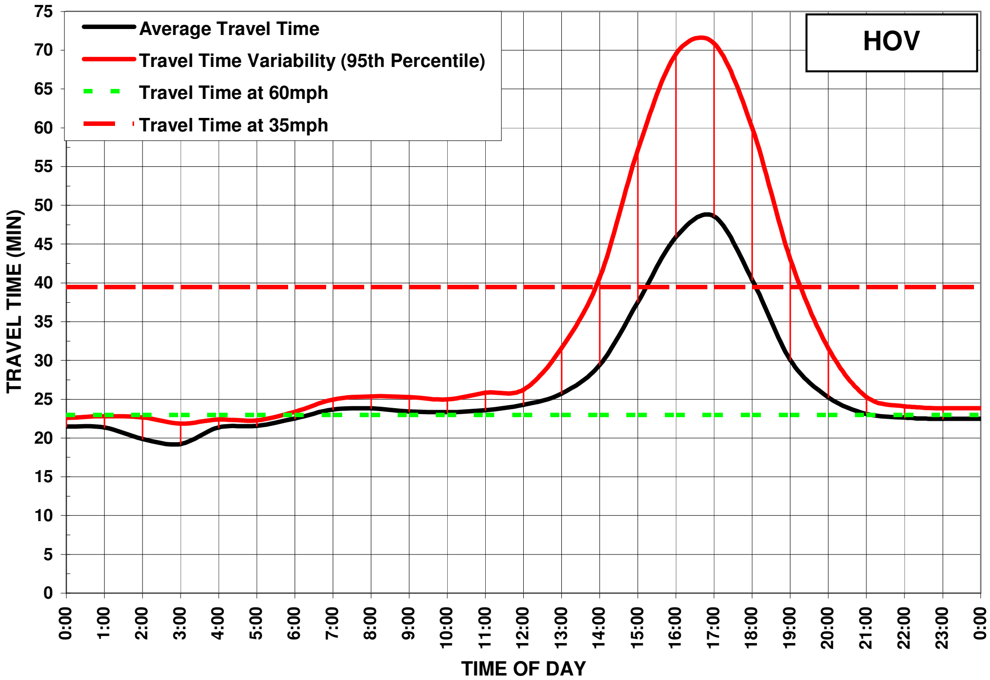
Source: Caltrans detector data

Exhibit 3B-32: Westbound HOV Travel Time Variability (2005)



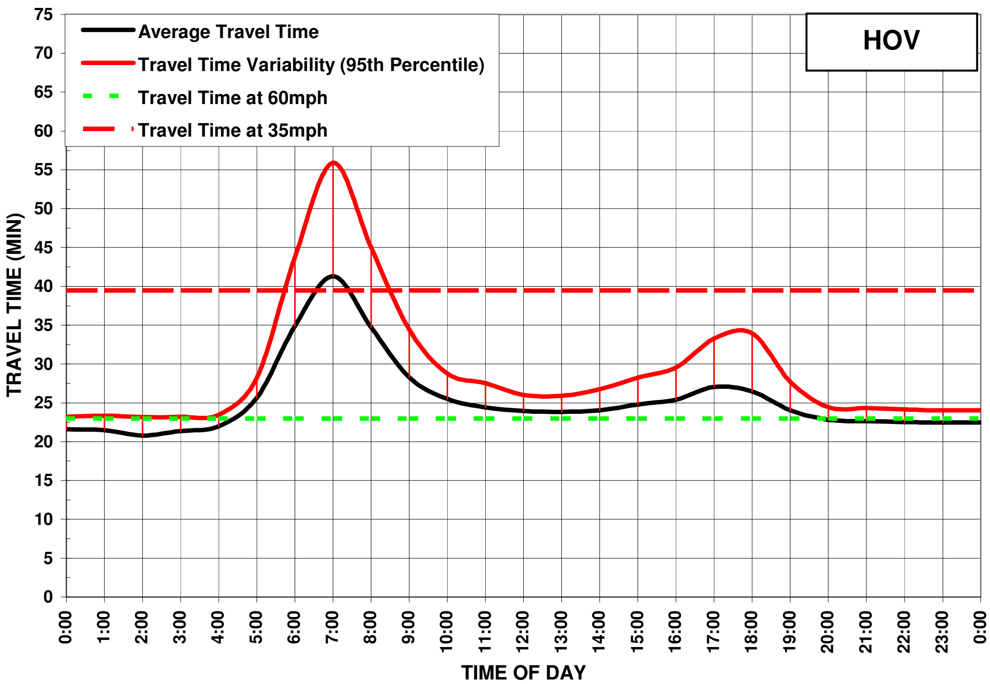
Source: Caltrans detector data

Exhibit 3B-33: Eastbound HOV Travel Time Variability (2006)



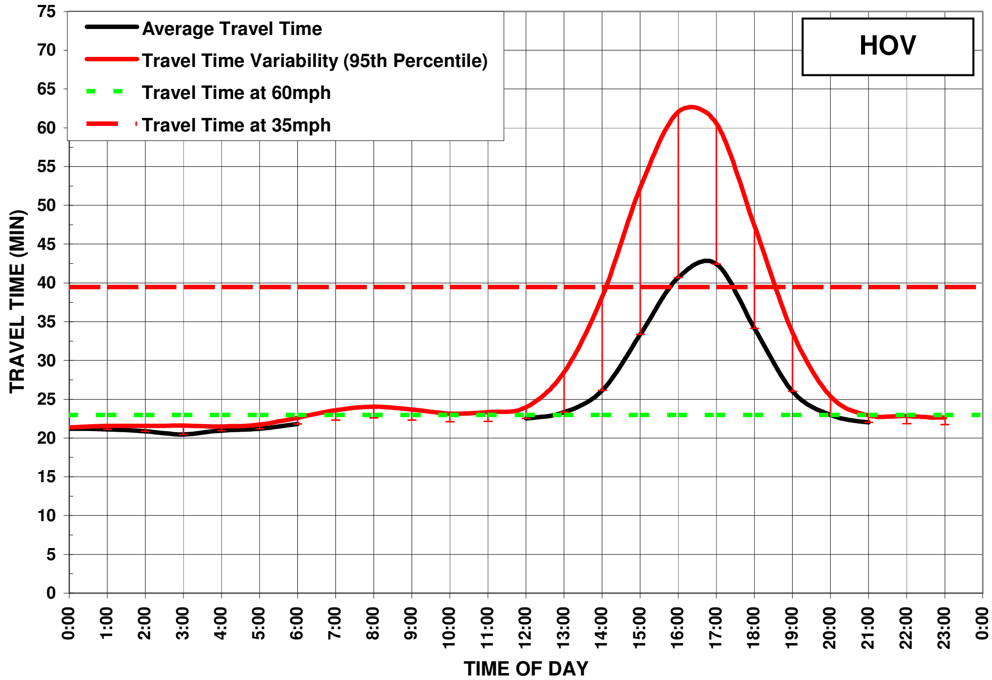
Source: Caltrans detector data

Exhibit 3B-34: Westbound HOV Travel Time Variability (2006)



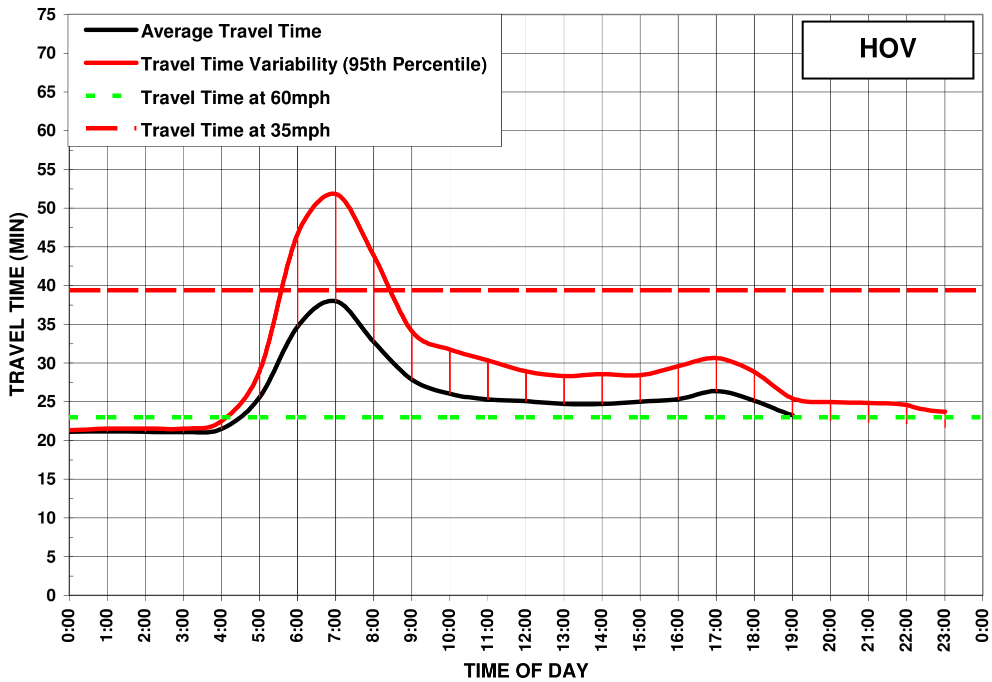
Source: Caltrans detector data

Exhibit 3B-35: Eastbound HOV Travel Time Variability (2007)



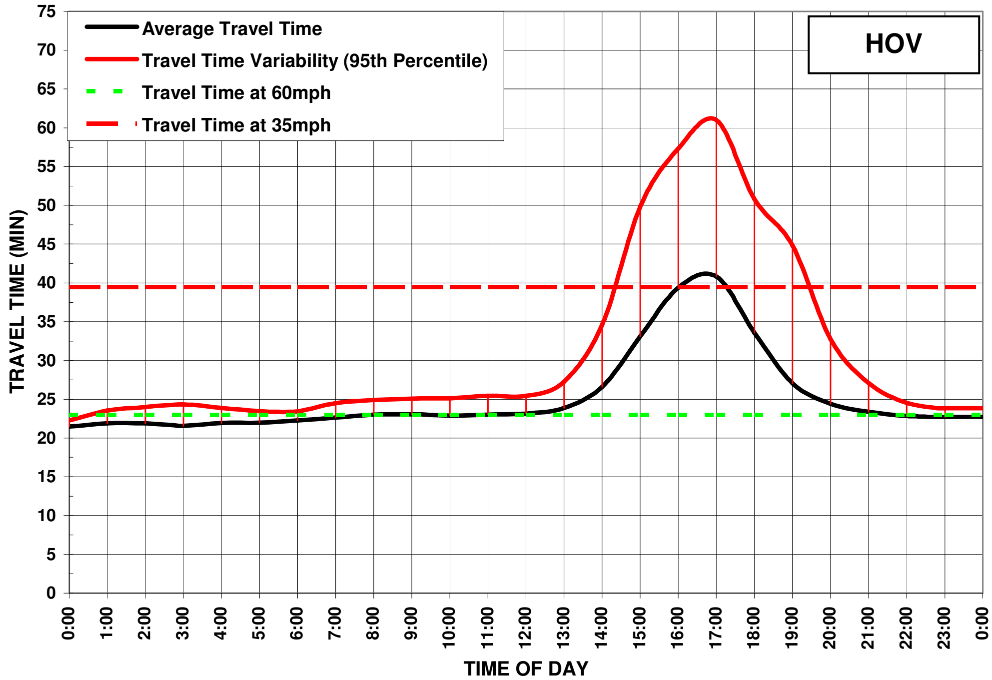
Source: Caltrans detector data

Exhibit 3B-36: Westbound HOV Travel Time Variability (2007)



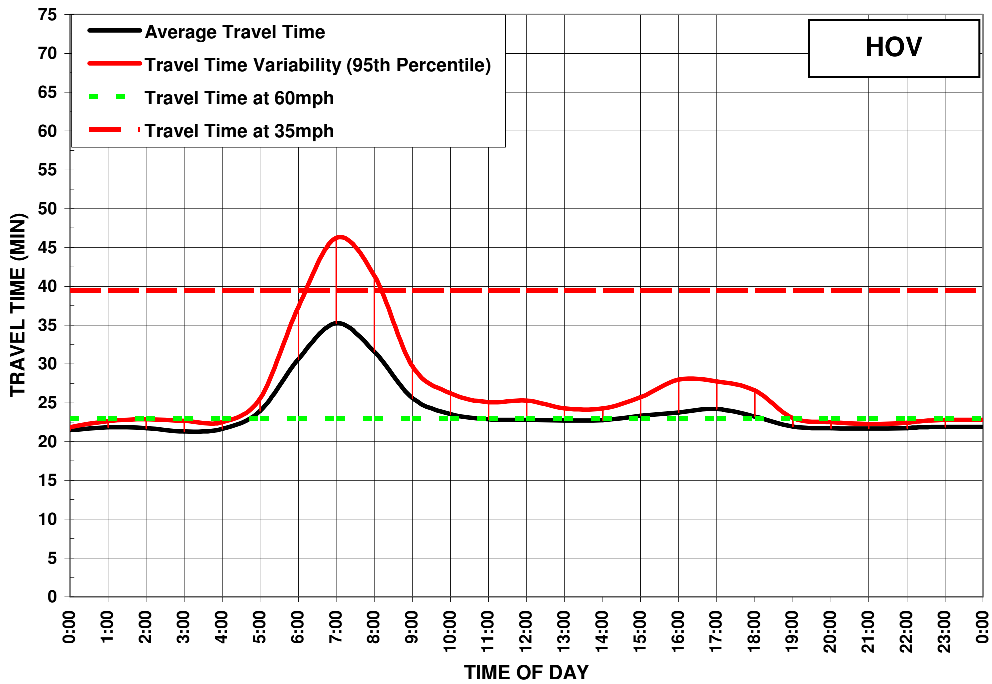
Source: Caltrans detector data

Exhibit 3B-37: Eastbound HOV Travel Time Variability (2008)



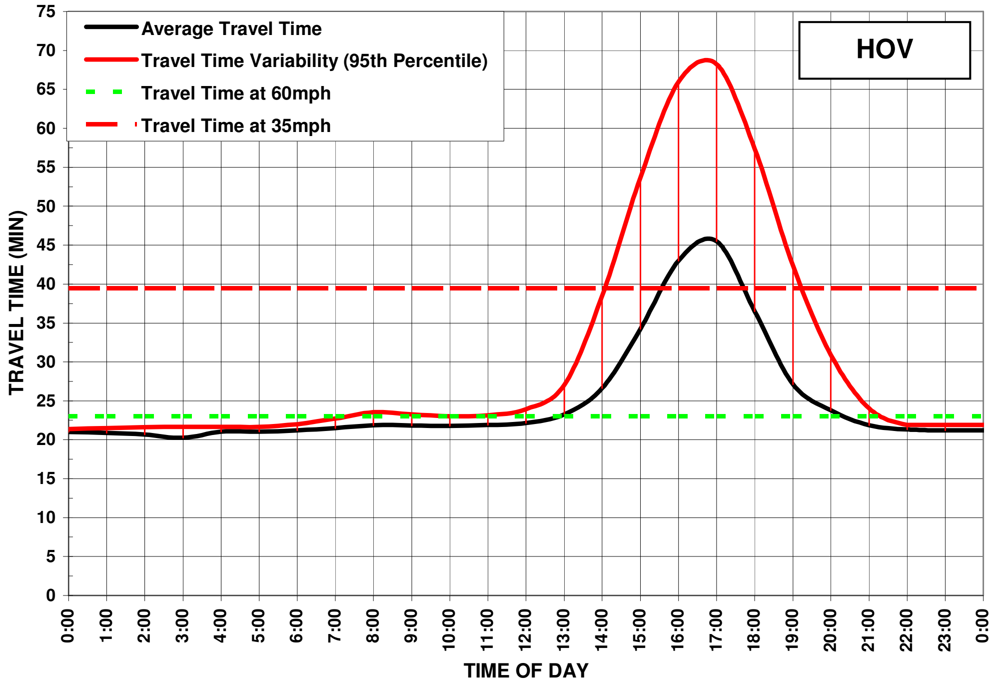
Source: Caltrans detector data

Exhibit 3B-38: Westbound HOV Travel Time Variability (2008)



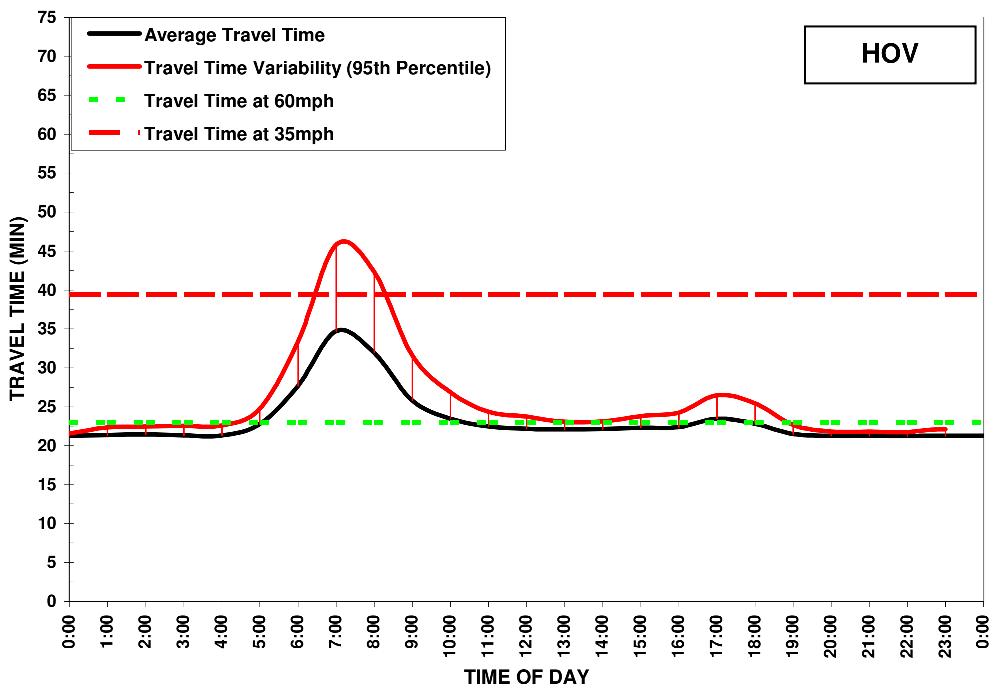
Source: Caltrans detector data

Exhibit 3B-39: Eastbound HOV Travel Time Variability (2009)



Source: Caltrans detector data

Exhibit 3B-40: Westbound HOV Travel Time Variability (2009)



Source: Caltrans detector data

Safety

The adopted performance measures to assess safety are the number of accidents and accident rates computed from the Caltrans Traffic Accident Surveillance and Analysis System (TASAS). This is a traffic records system containing an accident database linked to a highway database. The highway database contains description 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 excluded (e.g., local streets and roads).

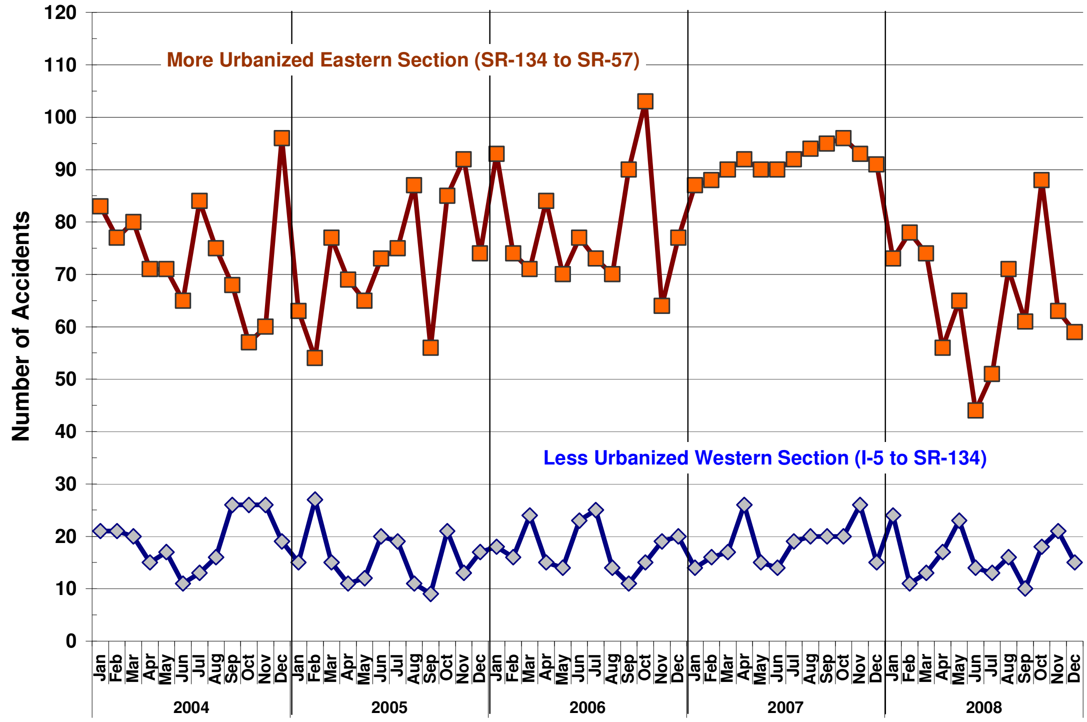
The safety assessment in this report is intended to characterize the overall accident history and trends in the corridor, and to highlight notable accident concentration locations or patterns that are readily apparent. This report is not intended to supplant more detailed safety investigations routinely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

Exhibits 3B-41 and 3B-42 show the I-210 total number of eastbound and westbound accidents by month, respectively. For the accident analysis, the corridor is split in half: the "less urban" western half of the corridor from I-5 (postmile 0) in Sylmar to SR-134 in Pasadena (postmile R22.00) and the "more urban" eastern half from SR-134 to SR-57 (postmile R45) in San Dimas. The latest available TASAS data from PeMS is to December 30, 2008. Accidents are reported for the study corridor and not separated by mainline and HOV facility. The exhibits summarize the latest available three-year data from January 1, 2006 through December 31, 2008.

Both the eastbound and westbound directions have similar accident profiles, with the more urbanized eastern half of the corridor (postmile R22 to R45) experiencing nearly 4.5 times as many accidents as the western half (PM 0 to R22). The eastbound (Exhibit 3B-41) direction has around 79 accidents on average per month in the more-urbanized section, and just fewer than 18 accidents in the less-urbanized section.

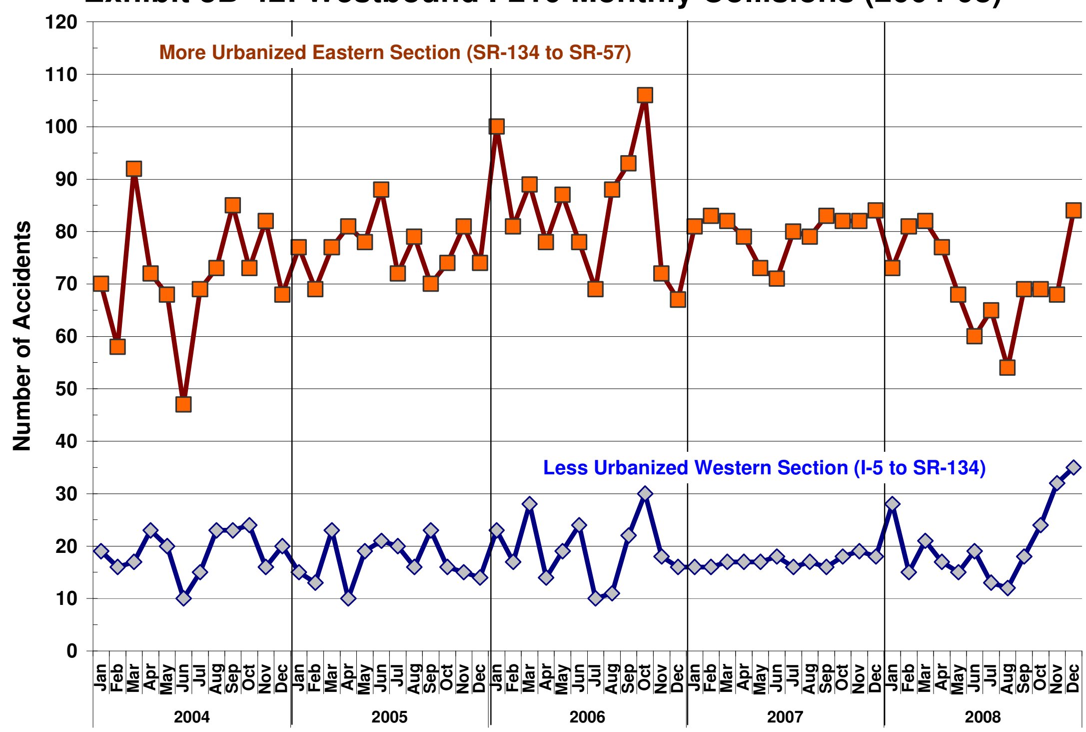
The westbound direction has just fewer than 78 accidents on average per month in the more-urbanized section, and just fewer than 18 in the less-urbanized section. This is very similar to the eastbound direction.

Exhibit 3B-41: Eastbound I-210 Monthly Collisions (2004-08)



Source: TASAS data

Exhibit 3B-42: Westbound I-210 Monthly Collisions (2004-08)



Source: TASAS data

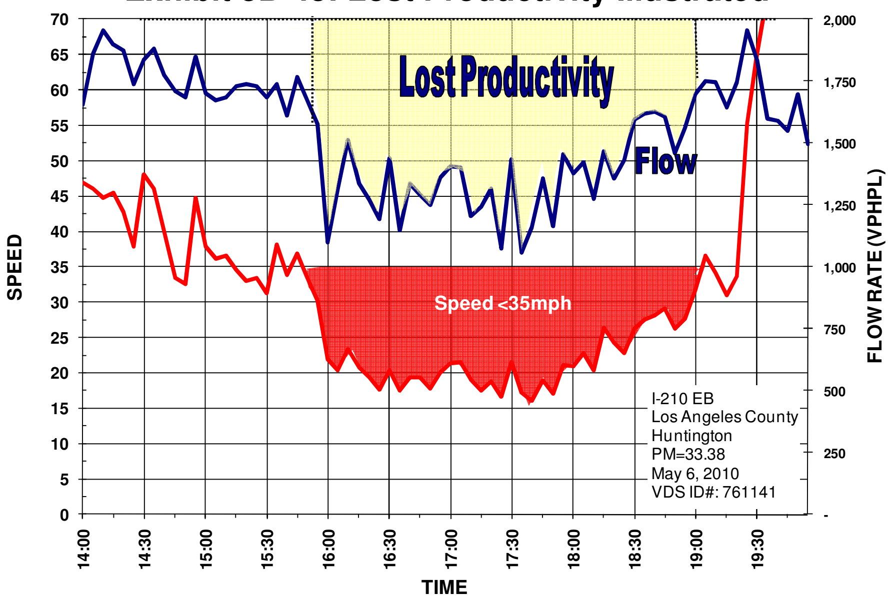
Productivity

Productivity is a system efficiency measure used to analyze the capacity of the corridor, and is defined as the ratio of output (or service) per unit of input. In the case of transportation, productivity is the number of people served divided by the level of service provided. For highways, it is the number of vehicles compared to the capacity of the roadways.

For the corridor analysis, productivity is defined as the percent utilization of a facility or mode under peak conditions. The highway productivity performance measure is calculated as actual volume divided by the capacity of the highway. Travel demand models generally do not estimate capacity loss for highways, but detailed micro-simulation tools can forecast productivity. For highways, productivity is particularly important because the lowest "production" from the transportation system occurs often when capacity is needed the most.

This loss in productivity example is illustrated in Exhibit 3B-43. As traffic flow increases to the capacity limits of a roadway, speeds decline rapidly and throughput drops dramatically. This loss in throughput is the lost productivity of the system. There are a few ways to estimate productivity losses. Regardless of the approach, productivity calculations require good detection or significant field data collection at congested locations. One approach is to convert this lost productivity into "equivalent lost lane-miles." These lost lane-miles represent a theoretical level of capacity that would need to be added in order to achieve maximum productivity. For example, losing six lane-miles implies that congestion has caused a loss in capacity roughly equivalent to one lane along a six-mile section of freeway.

Exhibit 3B-43: Lost Productivity Illustrated



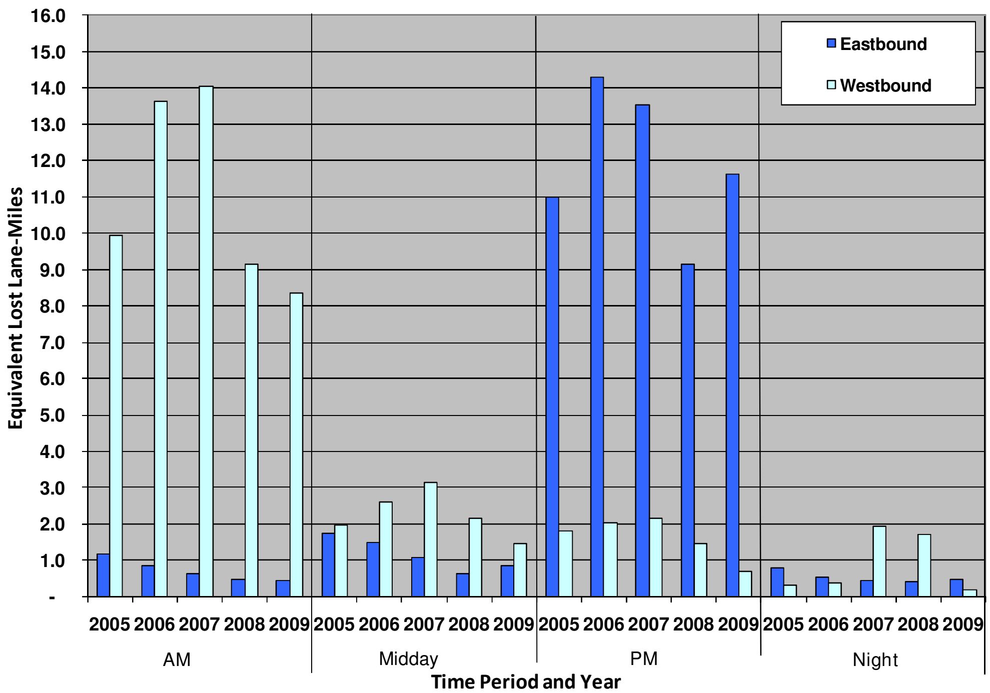
Equivalent lost lane-miles is computed as follows (for congested locations only):

$$LostLaneMiles = \left(1 - \frac{ObservedLaneThroughput}{2000vphpl}\right) \times Lanes \times CongestedDistance$$

Exhibits 3B-44 and 3B-45 summarize the productivity losses on the I-210 Corridor mainline and HOV facilities during the 2005-2009 period. The trends in the productivity losses are comparable to the delay trends. The largest productivity losses occurred in the eastbound direction during the PM peak hours, which is the direction and time period that experienced the most congestion. On the mainline facility, the westbound direction experienced nearly as high productivity loses during the AM peak period. On the HOV lanes, a greater productivity loss in the eastbound peak period is more evident.

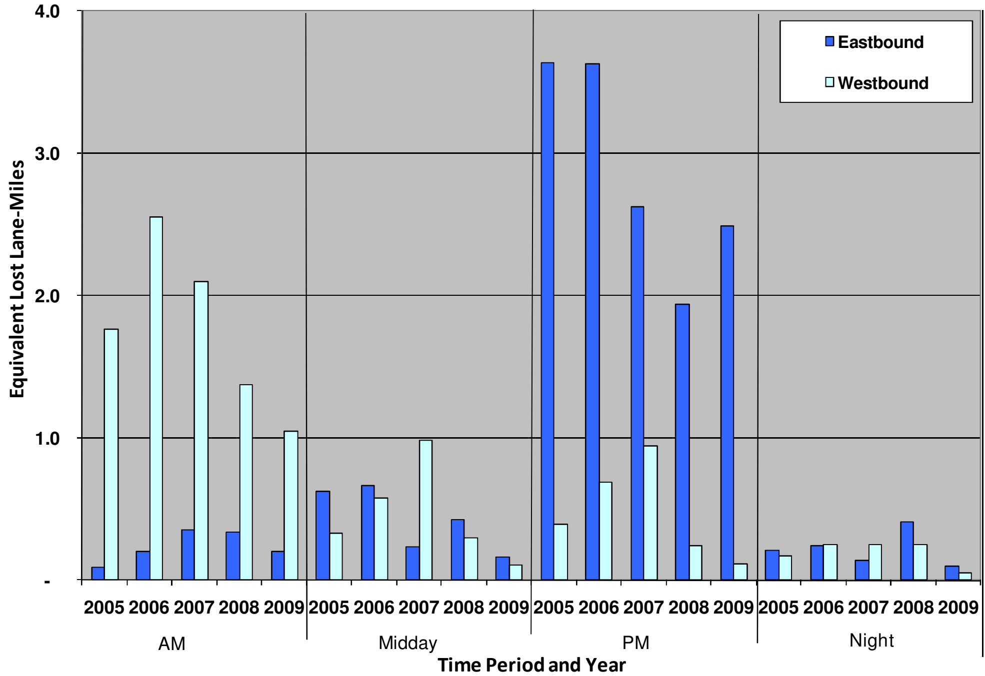
Strategies to combat such productivity losses are primarily related to operations. These strategies include building new or extending auxiliary lanes, developing more aggressive ramp metering strategies without negatively influencing the arterial network, and improving incident clearance times.

Exhibit 3B-44: Mainline Avg Daily Equivalent Lost Lane-Miles by Dir, Time Period, and Year



Source: Caltrans detector data

Exhibit 3B-45: HOV Avg Daily Equivalent Lost Lane-Miles by Dir, Time Period, and Year



Source: Caltrans detector data

C. Corridor-wide Pavement Condition

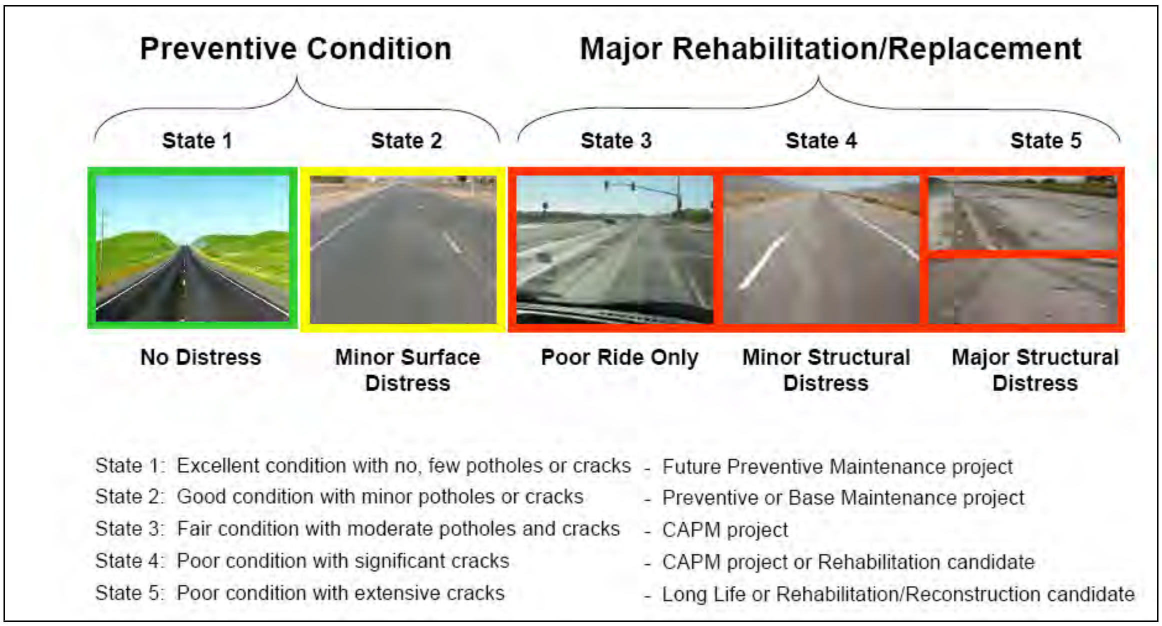
The condition of the roadway pavement (or ride quality) on the corridor can influence its traffic performance. Rough or poor pavement conditions can decrease the mobility, reliability, safety, and productivity of the corridor, whereas smooth pavement can have the opposite effect. Pavement preservation refers to maintaining the structural adequacy and ride quality of the pavement. It is possible for a roadway section to have structural distress without affecting ride quality. Likewise, a roadway section may exhibit poor ride quality, while the pavement remains structurally adequate.

Performance Measures

Caltrans conducts an annual Pavement Condition Survey (PCS) that can be used to compute two performance measures commonly estimated by Caltrans: distressed lane miles and International Roughness Index (IRI). Although Caltrans generally uses distressed lane miles for external reporting, this report uses the Caltrans data to present results for both measures.

Using distressed lane miles allows us to distinguish among pavement segments that require only preventive maintenance at relatively low costs and segments that require major rehabilitation or replacement at significantly higher costs. All segments that require major rehabilitation or replacement are considered to be distressed. Segments with poor ride quality are also considered to be distressed. Exhibit 3C-1 provides an illustration of this distinction. The first two pavement conditions include roadway that provides adequate ride quality and is structurally adequate. The remaining three conditions are included in the calculation of distressed lane-miles.

Exhibit 3C-1: Pavement Condition States Illustrated



Source: Caltrans Division of Maintenance, 2007 State of the Pavement Report

IRI distinguishes between smooth-riding and rough-riding pavement. The distinction is based on measuring the up and down movement of a vehicle over pavement. When such movement is measured at 95 inches per mile or less, the pavement is considered good or smooth-riding. When movements are between 95 and 170 inches per mile, the pavement is considered acceptable. Measurements above 170 inches per mile reflect unacceptable or rough-riding conditions.

Existing Pavement Condition

The most recent pavement condition survey, completed in November 2007, recorded 12,998 distressed lane-miles statewide. Unlike prior surveys, the 2007 PCS included pavement field studies for a period longer than a year, due to an update in the data collection methodology. The survey includes data for 23 months from January 2006 to November 2007.

The fieldwork consists of two parts. In the first part, pavement raters visually inspect the pavement surface to assess structural adequacy. In the second part, field staff uses vans with automated profilers to measure ride quality. The 2007 PCS revealed that the majority of distressed pavement was on freeways and expressways (Class 1 roads). This is the result of approximately 56 percent of the State Highway System falling into this road class. As a percentage of total lane miles for each class, collectors and local roads (Class 3 roads) had the highest amount of distress.

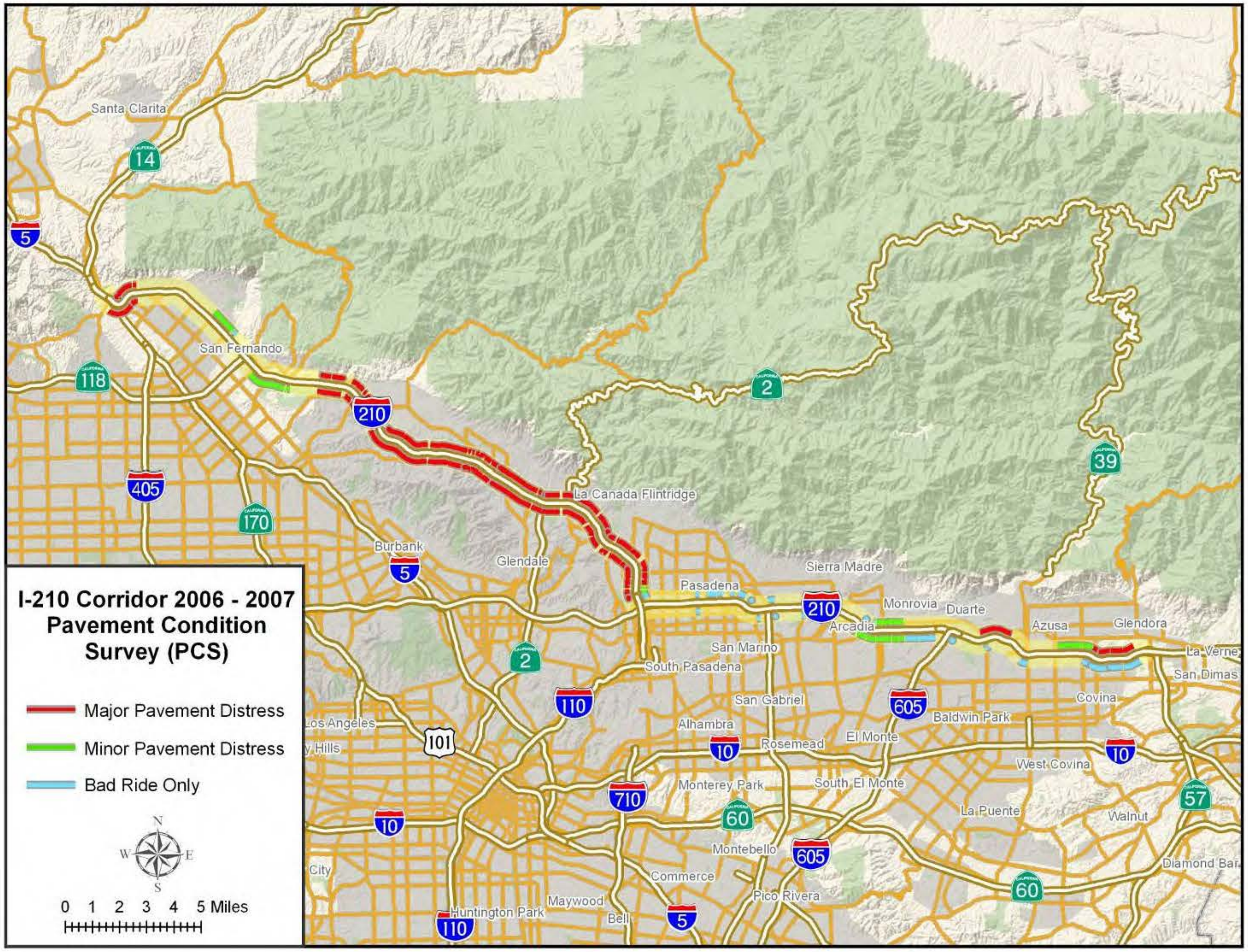
Exhibit 3C-2 shows the pavement distress recorded along the I-210 Corridor for the 2007 PCS data. The three categories shown in this exhibit represent the three distressed conditions that require major rehabilitation or replacement (See Exhibit 3C-1).

In general, pavement on the I-210 Corridor is in better condition than the pavement in District 7 as a whole. Most major pavement distress occurs along a 16-mile section between Wentworth Street in Sunland (just south of San Fernando) and SR-134. Other sections generally show no distress, minor pavement distress, or bad ride quality only.

Exhibit 3C-3 shows results from prior pavement condition surveys for the I-210 Corridor. After increasing by about 20 distressed lane-miles per year between 2003 and 2005, the total number of distressed lane-miles was cut in half from about 140 to about 70 lane-miles by the 2006-2007 period. Most of the improvement was due to the rehabilitation of minor pavement distress. Ride quality only issues have increased slightly, while the amount of major distress has declined slightly from about 70 to about 50 lane-miles.

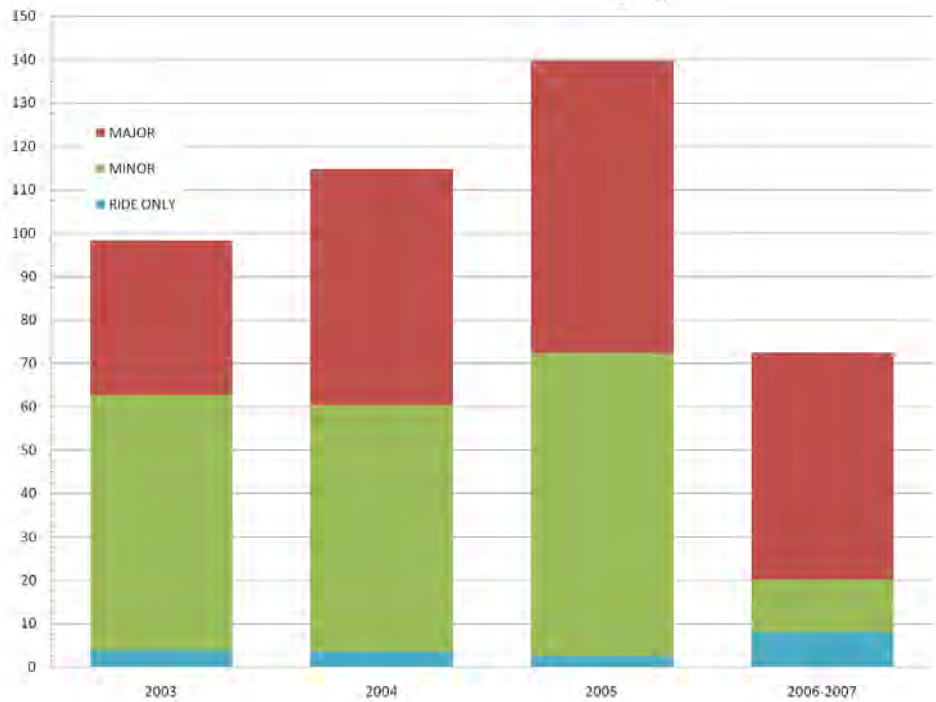
Exhibit 3C-4 shows how the mix in the types of distressed lane-miles has changed over the last few years. As the minor and ride quality issues have been addressed, major rehabilitation needs have increased as a share of total needs. However, as shown in Exhibit 3C-3, the total number of distressed lane-miles has decreased and most of the major distress is concentrated in one section.

Exhibit 3C-2: Distressed Lane-Miles on I-210 Corridor (2006-07)



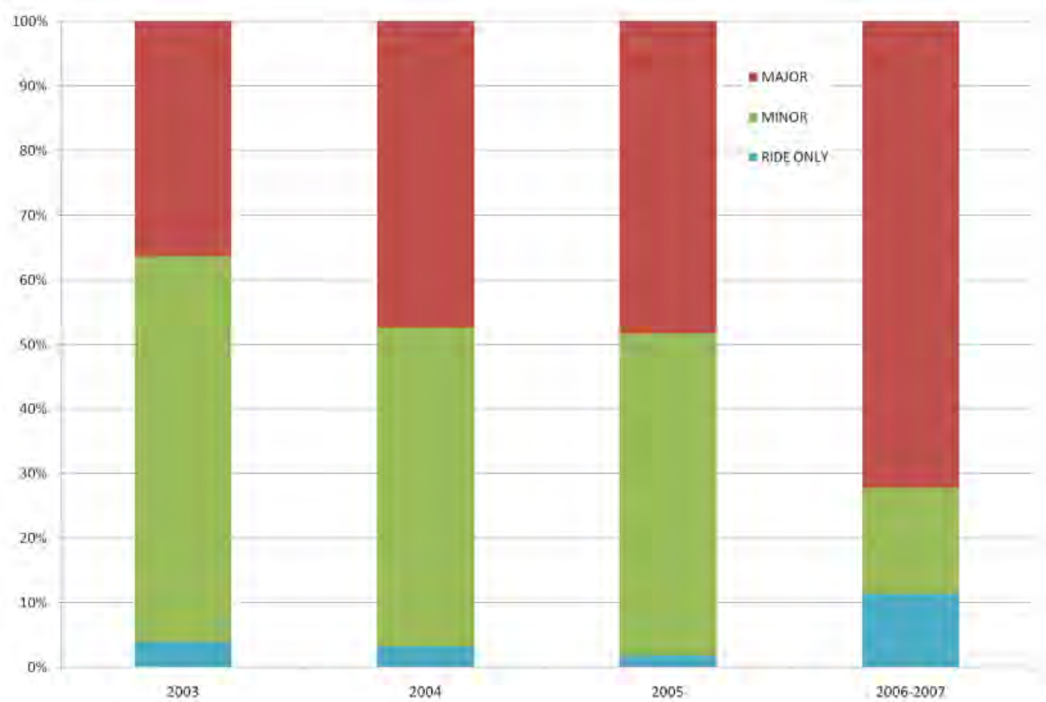
Source: Mapping of 2007 Pavement Condition Survey data

Exhibit 3C-3: I-210 Distressed Lane-Miles Trends



Source: 2003 to 2007 Pavement Condition Survey data

Exhibit 3C-4: I-210 Distressed Lane-Miles by Type



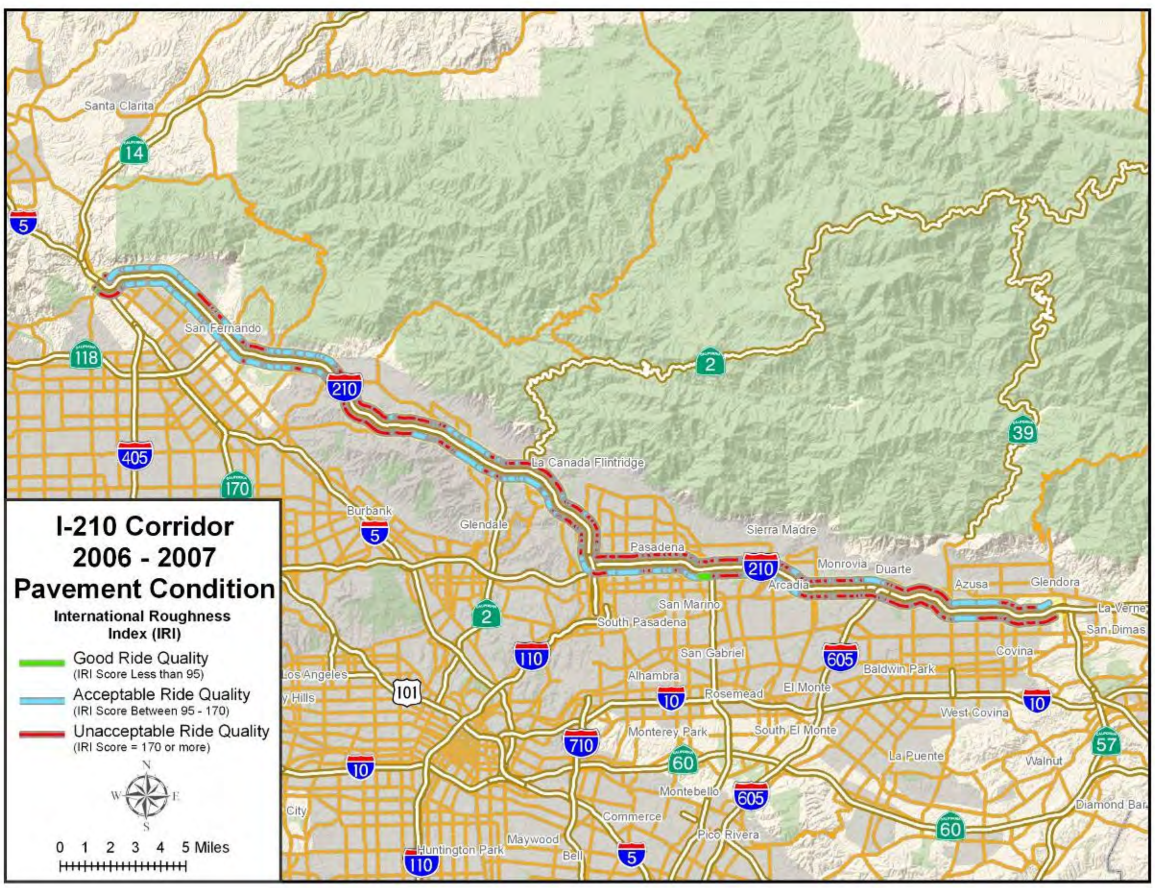
Source: 2003 to 2007 Pavement Condition Survey data

Exhibit 3C-5 shows IRI along the study corridor for the lane with the poorest pavement condition along each freeway segment. The worst pavement quality is shown since pavement investment decisions are made on this basis. Although the exhibit suggests there are many sections with unacceptable ride quality, there are many lanes with good ride quality within these sections. The study corridor comprises roughly 426 lane-miles, of which:

- 19 lane-miles, or 4 percent, are considered to have good ride quality (IRI ≤ 95)
- 303 lane-miles, or 71 percent, are considered to have acceptable ride quality (95 < IRI ≤ 170)
- 104 lane miles, or 24 percent, are considered to have unacceptable ride quality (IRI > 170)

Note that these percentages do not total to 100 percent due to rounding. The majority of the 104 lane-mile with unacceptable ride quality occur in sections with pavement distress, so few lane-miles exhibit only ride issues (as shown in Exhibits 3C-2 and 3C-3).

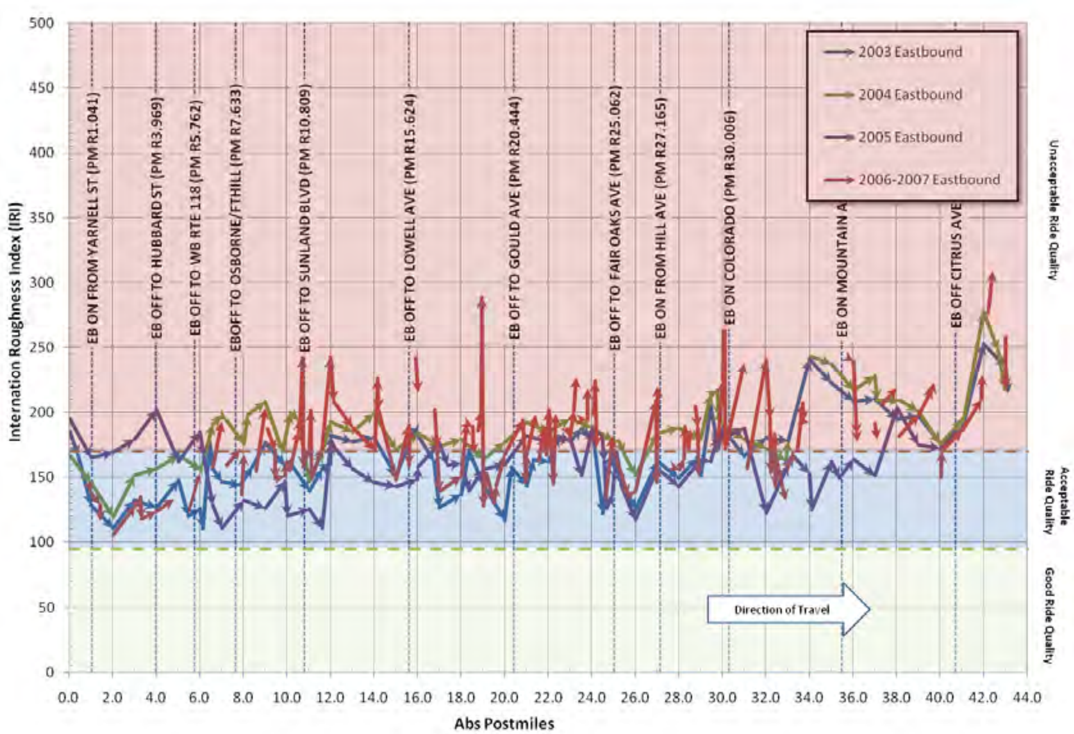
Exhibit 3C-5: I-210 Road Roughness (2006-07)



Source: Mapping of 2007 Pavement Condition Survey data

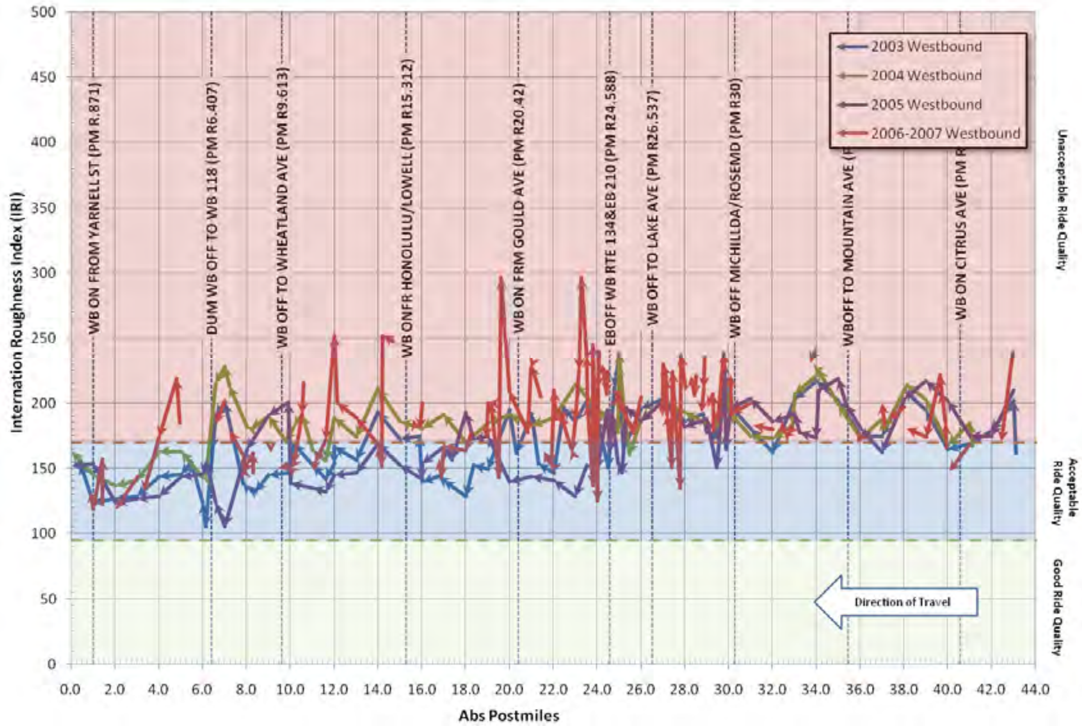
Exhibits 3C-6 and 3C-7 present ride conditions for the worst lane in each section on the I-210 Corridor using IRI from the last four pavement surveys. The information is presented by postmile and direction. The exhibits include color-coded bands to indicate the three ride quality categories defined by Caltrans: good ride quality (green), acceptable ride quality (blue), and unacceptable ride quality (red). Ride quality has worsened slightly over the last few surveys, but it has improved on some roadway sections, such as the portion in San Fernando between I-5 and Sunland Boulevard. The exhibits exclude sections that were not measured or had calibration problems (i.e., IRI = 0) in the 2006-07 period.

Exhibit 3C-6: Eastbound I-210 Road Roughness (2003-07)



Source: 2003 to 2007 Pavement Condition Survey data

Exhibit 3C-7: Westbound I-210 Road Roughness (2003-07)



Source: 2003 to 2007 Pavement Condition Survey data

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4. BOTTLENECK IDENTIFICATION & CAUSALITY ANALYSIS

A. Bottleneck Identification

Bottlenecks were identified and verified during the winter of 2007 and spring of 2008 based on a variety of data sources, including HICOMP, probe vehicle runs, automatic detector data, and field reviews. The team conducted numerous field observations and videotaped major bottlenecks to further document the bottleneck locations. These efforts resulted in confirming consistent sets of bottlenecks for both directions of the freeway. This section summarizes the findings of that analysis. Exhibits 4A-1 and 4A-2 summarize the bottleneck locations identified in this analysis by direction. Exhibits 4A-3 and 4A-4 are maps that identify the bottleneck locations by AM and PM peak period.

In this section of the report, the results of the bottleneck analysis are presented. The bottleneck analysis was conducted to identify potential bottleneck locations. Potential freeway bottleneck locations that create mobility constraints are identified and documented, and their relative contribution to corridor-wide congestion is reported.

Exhibit 4A-1: Eastbound I-210 Identified Bottleneck Locations

Abs	CA	Bottleneck Location	Active Period	
			AM	PM
25.0	R25.0	Fair Oaks	✓	✓
26.5	R26.5	Lake On-ramp		✓
28.6	R28.7	San Gabriel On-ramp		✓
29.4	R29.4	Rosemead On-ramp		✓
33.0	R32.7	Huntington Interchange	✓	✓
36.6	R36.3	I-605	✓	✓
40.0	R39.7	Azusa On-ramp	✓	✓
40.8	R40.6	Citrus On-ramp		✓
45.0	R45.0	SR-57 On-ramp	✓	✓

Exhibit 4A-2: Westbound I-210 Identified Bottleneck Locations

Abs	CA	Bottleneck Location	Active Period	
			AM	PM
40.1	R39.8	Azusa On-ramp	✓	✓
36.8	R36.5	I-605 Off-ramp	✓	✓
32.2	R31.9	Santa Anita On-ramp	✓	✓
30.7	R30.4	Baldwin On-ramp	✓	✓
29.7	L29.7	Rosemead On-ramp	✓	✓
28.0	R28.1	Altadena On-ramp	✓	✓
26.1	R26.1	Lake On-ramp	✓	✓

Exhibit 4A-3: I-210 AM Bottleneck Locations

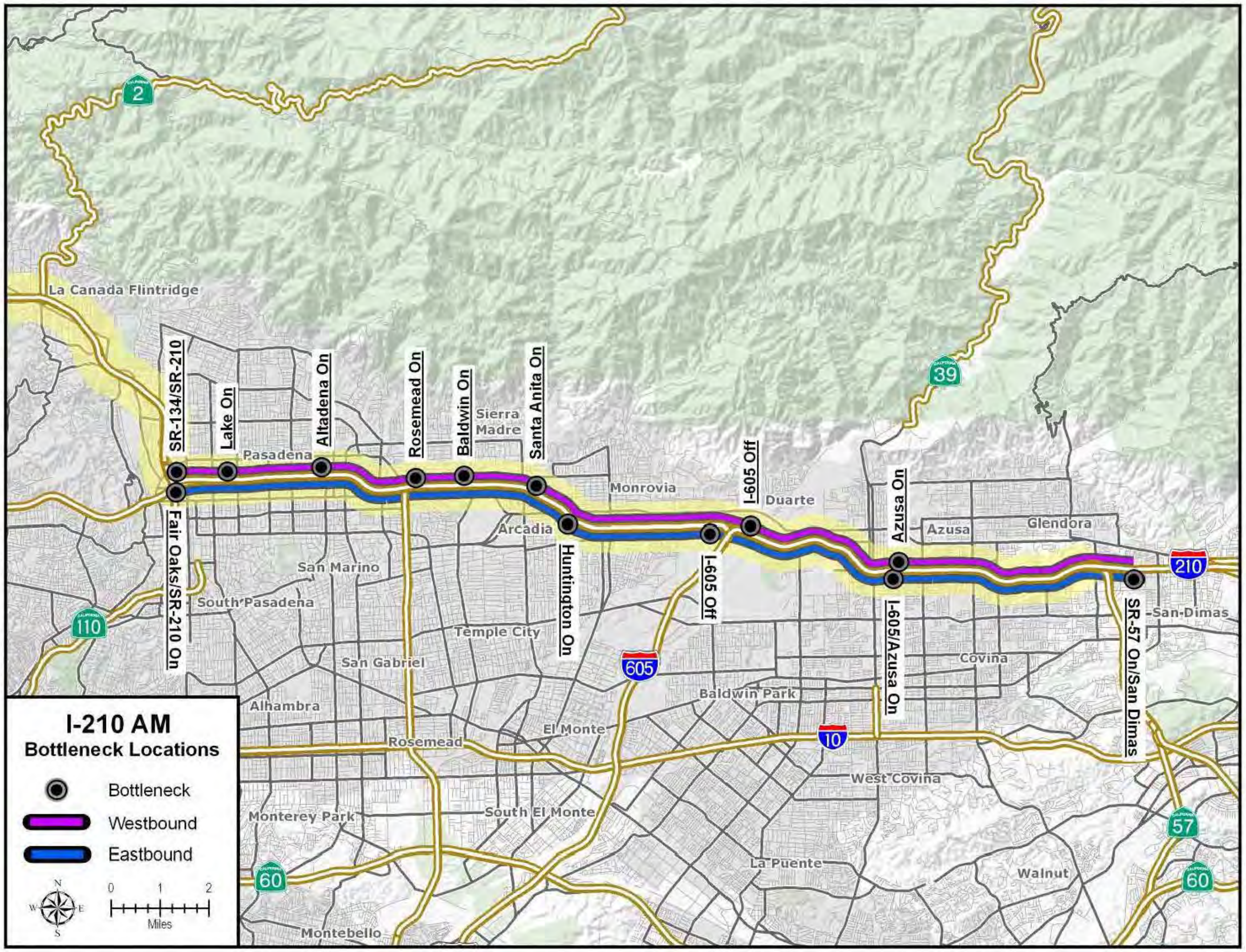
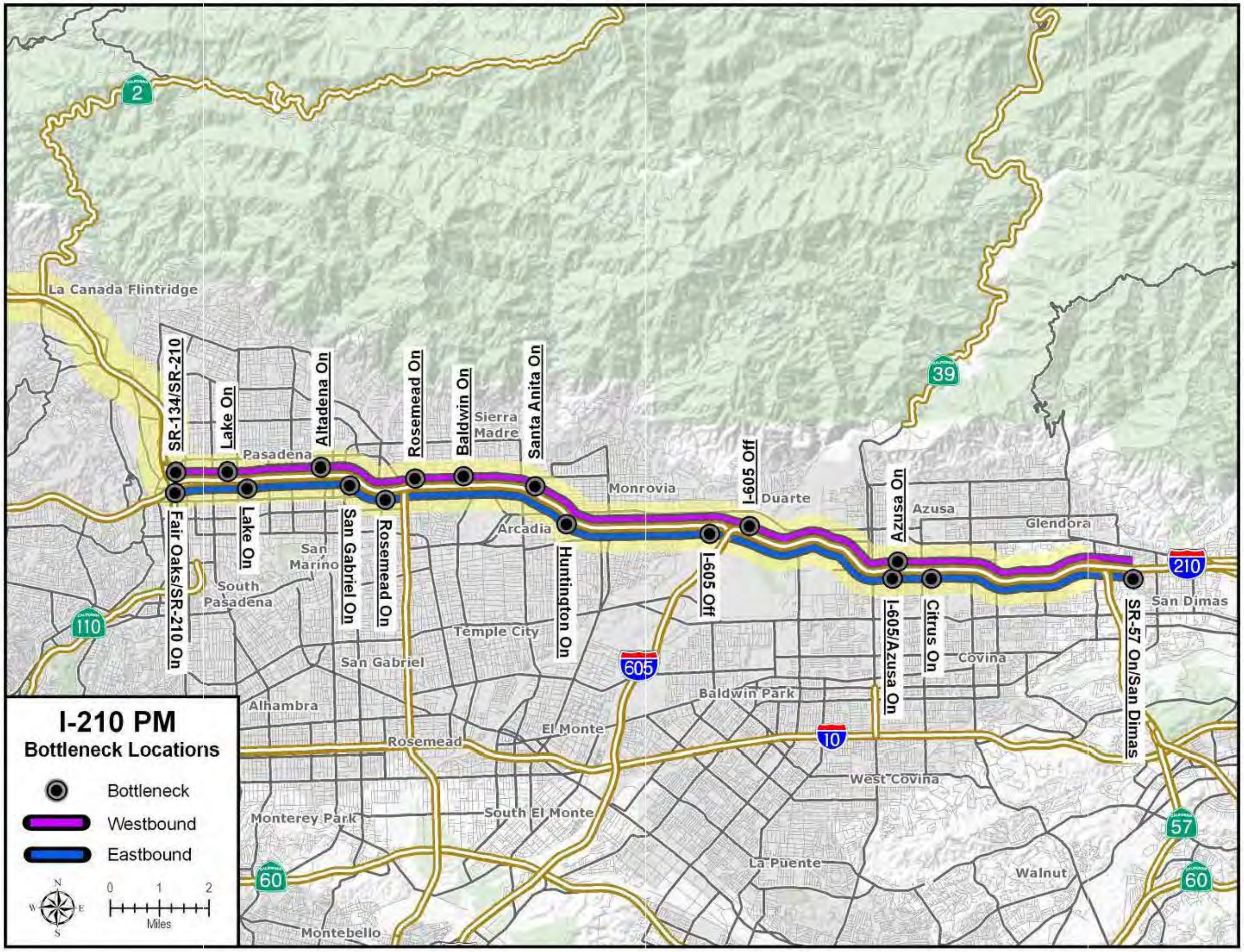


Exhibit 4A-4: I-210 PM Bottleneck Locations



Data Sources

The study team used data analysis and extensive field verification to identify potential bottleneck locations (i.e., places with mobility constraints). All bottleneck locations were photographed to both document the field visits as well as to assist the modeling team in calibrating the micro-simulation model used in the study. The field visits were carried out during the winter of 2007 and spring of 2008.

The study team consulted a variety of data sources to identify bottlenecks:

- 2006 Highway Congestion Monitoring Program (HICOMP) report
- Probe vehicle data (electronic tachometer or GPS runs)
- Caltrans Freeway detector data
- Aerial photos
- Field observations.

HICOMP

The study team began the problem area identification by reviewing the 2006 Caltrans HICOMP report. Congested queues form upstream from bottlenecks, which are located "at the front" of the congested segment. Exhibits 4A-5 and 4A-6 show the HICOMP congestion maps with circles overlaid to indicate potential bottleneck locations. Bottleneck areas are identified with blue circles in the eastbound direction and red circles in the westbound direction.

Exhibit 4A-6 shows PM peak period bottlenecks using data from the 2006 HICOMP Report. The PM peak period tends to be more congested than the AM peak period, which is shown in both HICOMP and sensor data.

Exhibit 4A-5: 2006 HICOMP AM Congestion Map with Potential Bottlenecks

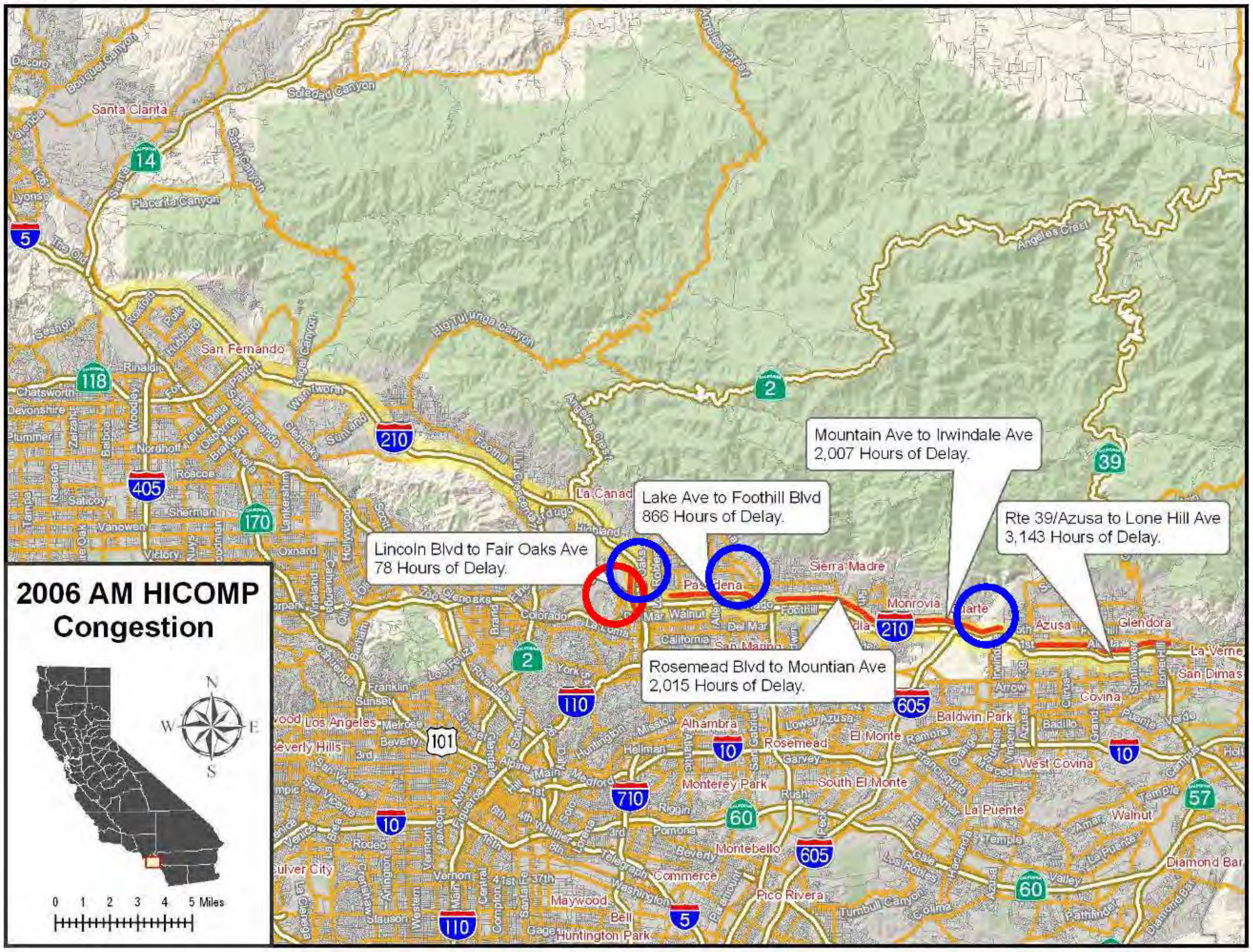
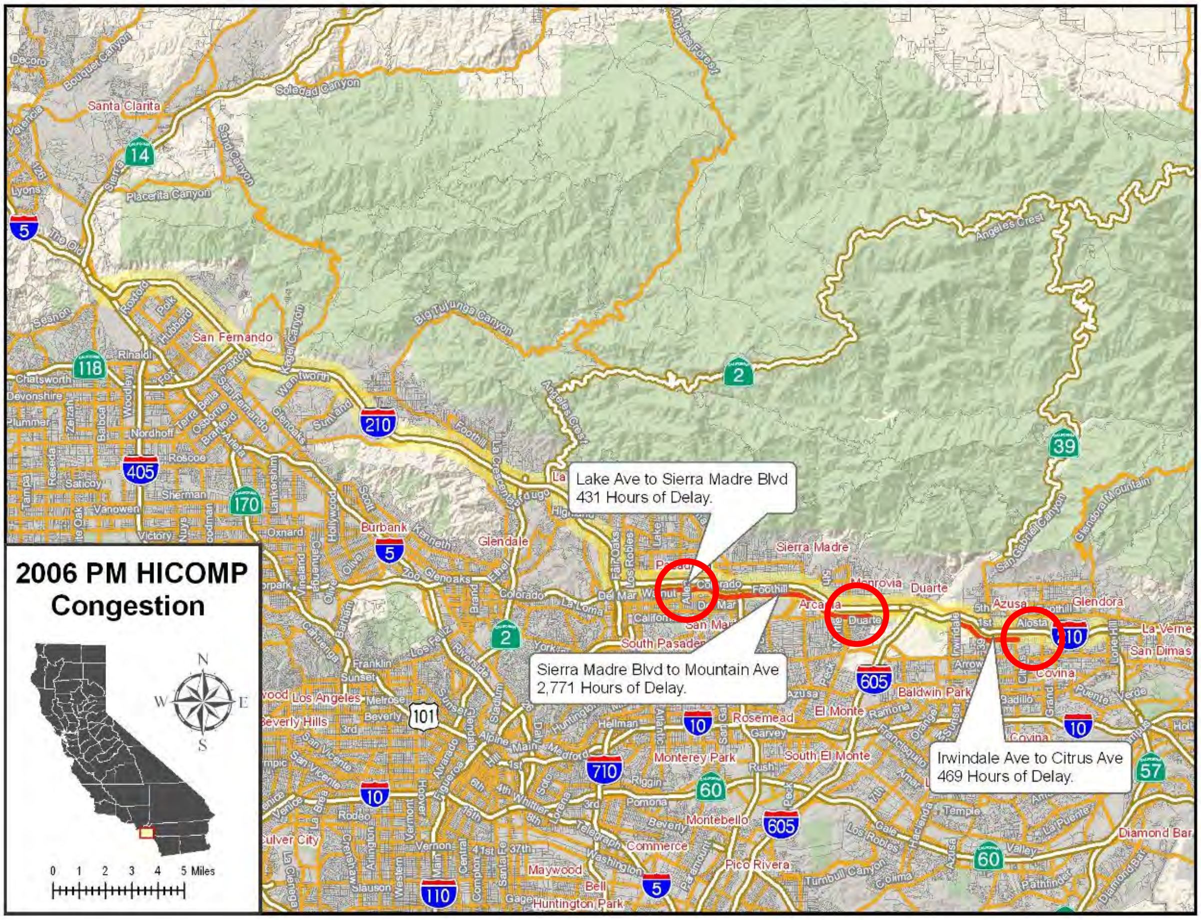


Exhibit 4A-6: 2006 HICOMP PM Congestion Map with Potential Bottlenecks



Probe Vehicle Runs

The study team used probe vehicle data collected by Caltrans District 7 and conducted additional analyses to verify the bottlenecks identified in the HICOMP data. Probe vehicle runs provide speed plots across the corridor for various departure times. Caltrans collects the data by driving a vehicle equipped with various electronic devices (e.g., tachograph and global positioning system) along the corridor at various departure times (usually at 10 to 20 minute intervals). The vehicles are driven in a middle lane to capture “typical” conditions during the peak periods. Actual speeds are recorded as the vehicle traverses the corridor. Bottlenecks can be found at the downstream end of a congested location where vehicles accelerate from congested speeds (e.g., below 35 mph) to a higher speed within a very short distance.

Caltrans District 7 collected probe vehicle run data in March and May of 2002, their most recent data available, for the I-210 from Calgrove Boulevard (north of I-5) to

Foothill Boulevard (east of SR-57). Exhibit 4A-7 illustrates the I-210 eastbound probe vehicle runs, from Foothill to I-5, at 4PM, 5PM, and 6PM conducted on March and May 2006. Exhibit 4A-8 illustrates the westbound probe vehicle runs at 7AM, 7:30AM, and 8AM. No speeds below 35 miles per hour were reported in the westbound direction during the PM peak hours or in the eastbound direction during the AM peak hours.

Exhibit 4A-7: Eastbound I-210 Sample Probe Vehicle Runs

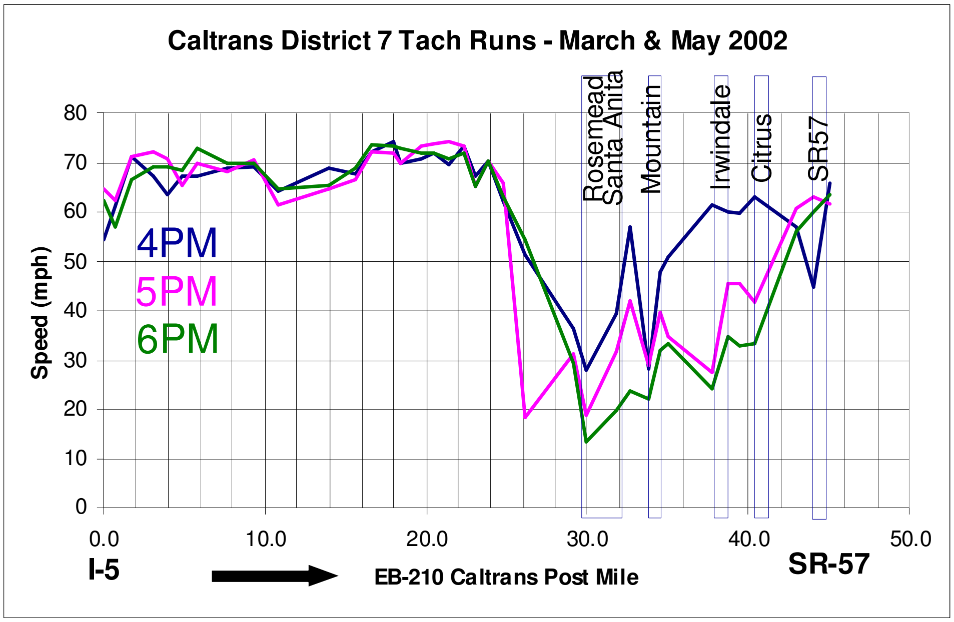
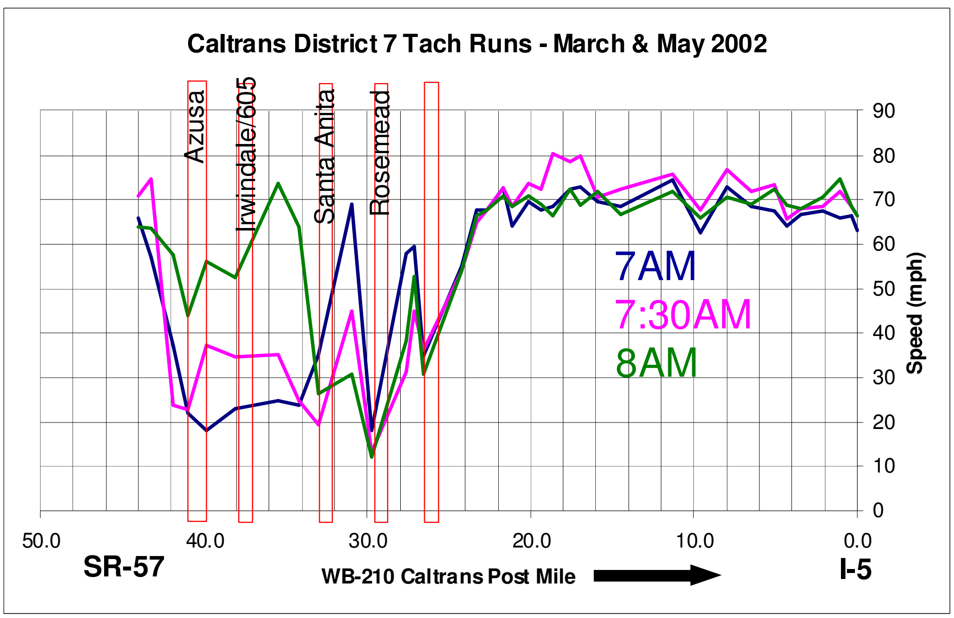


Exhibit 4A-8: Westbound I-210 Sample Probe Vehicle Runs



Automatic Detector Data

Using automatic detector data, speed plots are also used to identify potential bottleneck locations. Speed plots are very similar to probe vehicle run graphs. Unlike the probe vehicle runs, however, each speed plot has universally the same time across the corridor. For example, an 8AM plot includes the speed at one end of the corridor at 8AM and the speed at the other end of the corridor also at 8AM. With probe vehicle runs, the end time, or time at the end of the corridor is the departure time plus the actual travel time. Despite this difference, they both identify the same problem areas. These speed plots are then compiled at every five minutes and presented in speed contour plots.

Eastbound I-210 Detector Analysis

Speed contour and profile plots for sample days in April and November 2006 and 2006 quarterly weekday average long contours were analyzed. These speed contour plots represent typical weekday samples to illustrate the repetitive pattern of bottleneck locations and the ensuing congestion. Exhibits 4A-9 and 4A-10 illustrate the speed contour plots in the eastbound direction (traffic moving left to right on the plot) on four typical weekdays in April and November 2006 and 2006 quarterly weekday average long contours. Along the vertical axis is the time period from 4AM to 8PM. Along the horizontal axis is the corridor segment from west of SR-134 to east of SR-57. The four sample days had observed or “good” detection data that ranged from 65 percent (November 16, 2006) to 86 percent (April 13, 2006), providing reasonably accurate results.

The various colors represent the average speeds corresponding to the color speed chart shown below the diagram. As shown, the dark blue blotches represent congested areas where speeds are reduced. The ends of each dark blotches represent bottleneck areas, where speeds pickup after congestion, typically to 30 to 50 miles per hour in a relatively short distance. The horizontal length of each plot is the congested segment, queue lengths. The vertical length is the congested time period.

- Based on these contour plots of typical weekday samples in April and November 2006, the following bottlenecks were identified in the eastbound direction:
    - Lake On
    - Huntington Off
    - I-605 Off
    - Azusa On
    - SR-57 On

Exhibit 4A-9: Eastbound I-210 Speed Contour Plots (April/November 2006)

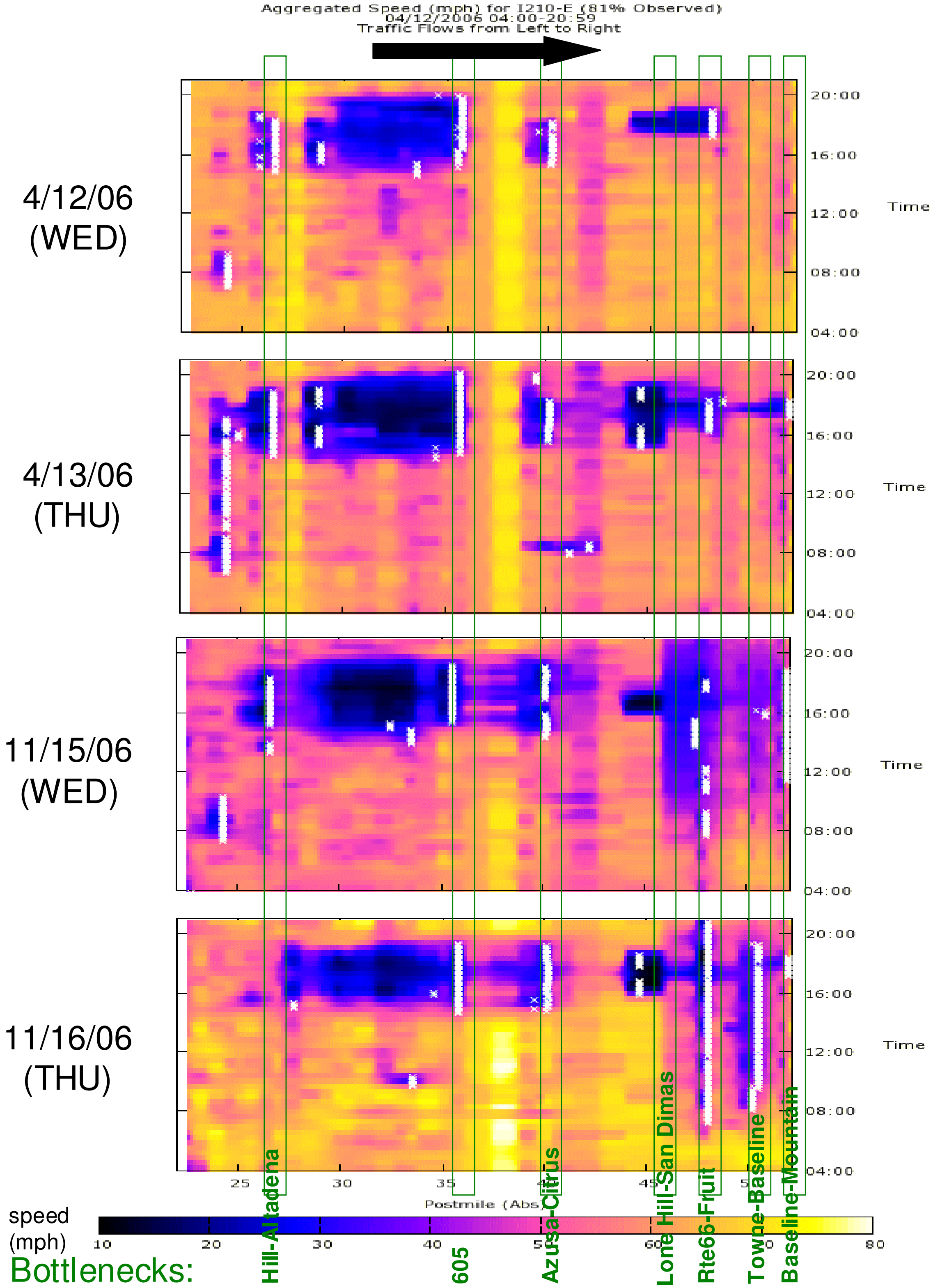
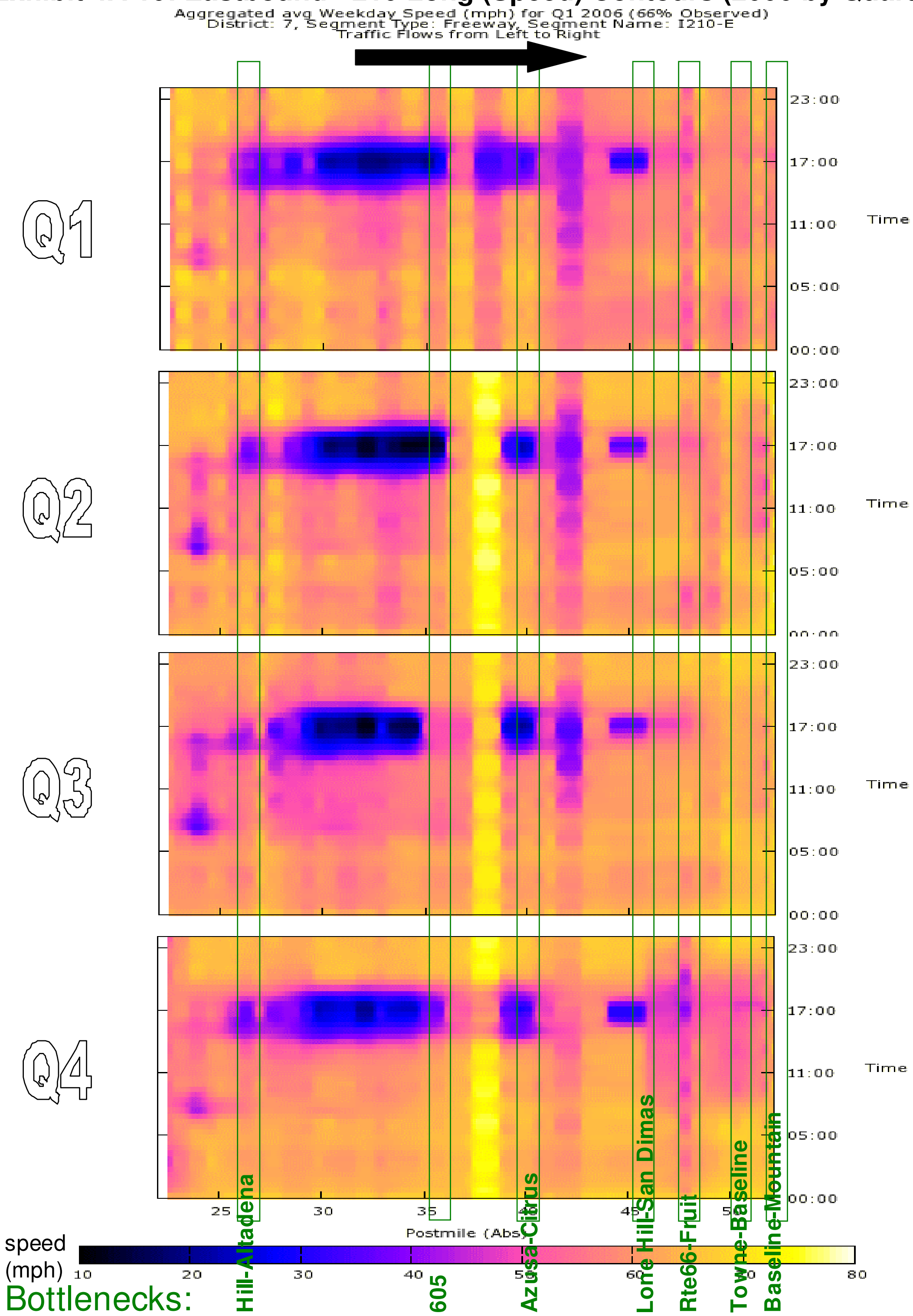


Exhibit 4A-10: Eastbound I-210 Long (Speed) Contours (2006 by Quarter)



Westbound I-210 Detector Analysis

Exhibit 4A-11 illustrates the speed contour plots on Wednesday, April 12, 2006 and November 15, 2006, and Thursday, April 13, 2006 and November 16, 2006. The four sample days had observed or "good" detection data that ranged from 73 percent (November 16, 2006) to 87 percent (April 13, 2006), providing reasonably accurate results.

These speed contour plots illustrate the typical speed contour diagram for the I-210 freeway in the westbound direction (traffic moving left to right on the plot). Along the vertical axis is the time period from 4AM to 8PM. Along the horizontal axis is the corridor segment from east of SR-57 to west of SR-134.

In addition to multiple days, larger averages were also analyzed. Exhibit 4A-12 illustrates weekday averages by each quarter of 2006. The same bottleneck locations are identified. From the long contours, the same bottlenecks are evident.

- Based on these contour plots of typical weekday samples in April and November 2006, the following bottlenecks were identified in the westbound direction:
    - Azusa On
    - Irwindale/I-605
    - Santa Anita on
    - Baldwin On
    - Rosemead On
    - Altadena On
    - Lake On

Exhibit 4A-11: Westbound I-210 Speed Contour Plots (April/November 2006)

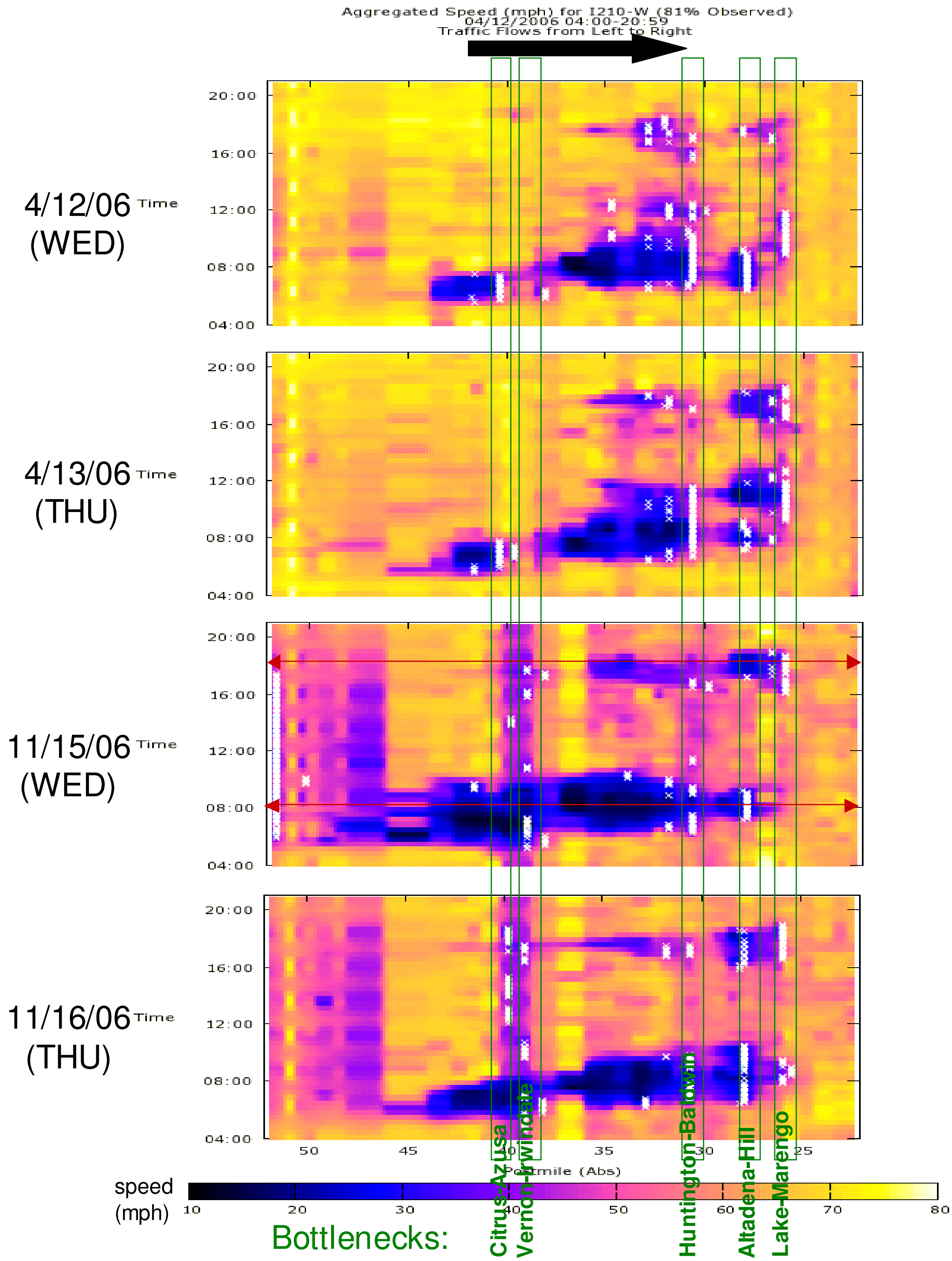
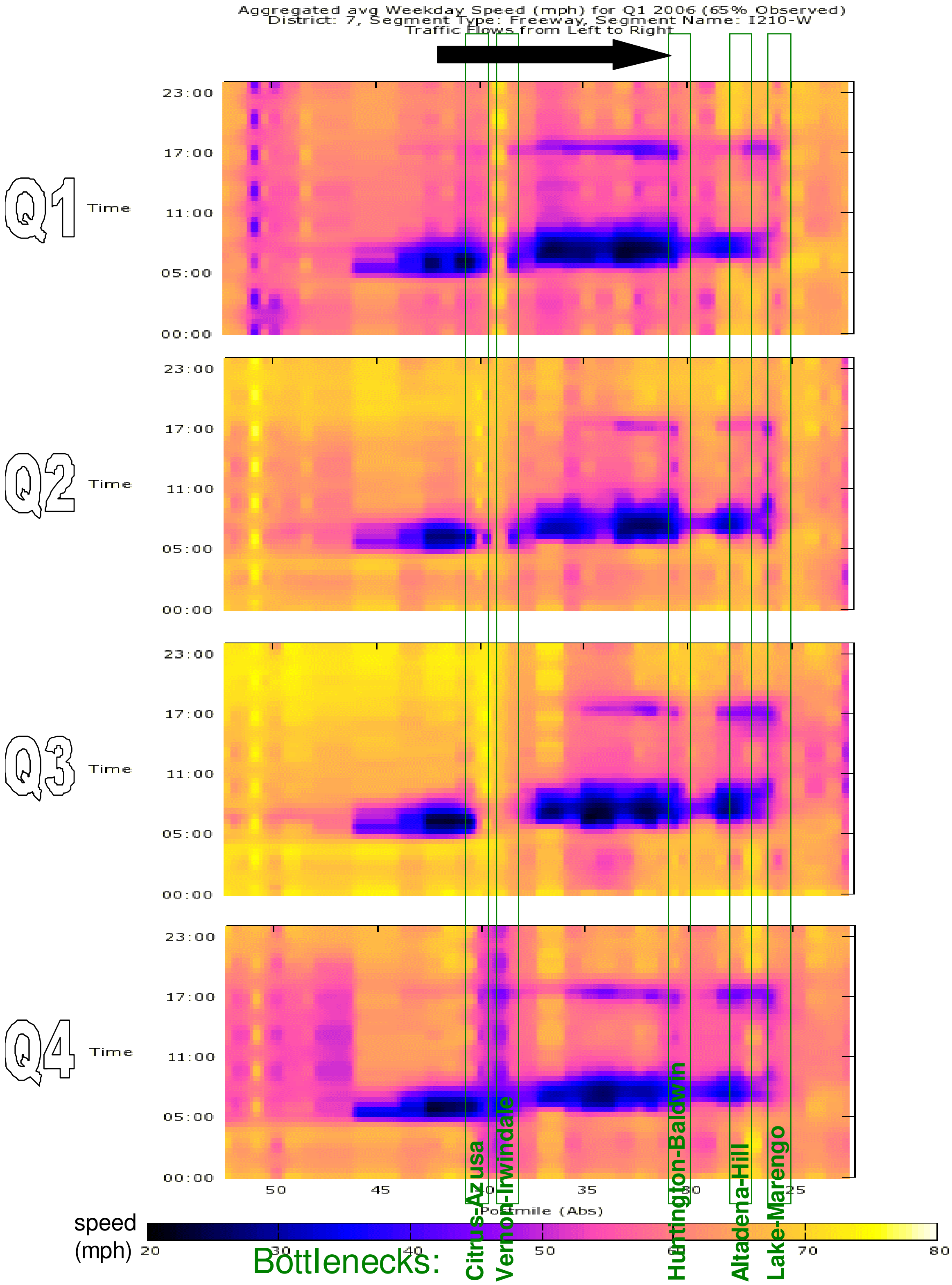


Exhibit 4A-12: Westbound I-210 Long (Speed) Contours (2006 by Quarter)



B. Bottleneck Causality Analysis

Major bottlenecks are the primary cause of corridor performance degradation and resulting congestion and lost productivity. It is important to verify the specific location and cause of each major bottleneck to determine appropriate solutions to traffic operational problems.

The location of each major bottleneck should be verified by multiple field observations on separate days. The cause of each major bottleneck can also be identified with field observations and additional traffic data analysis. For the I-210 Corridor, field observations were conducted by the project team on multiple days (midweek) in November and December 2007 as well as February and May 2008 during the AM and PM peak hours.

By definition, a bottleneck is a condition where traffic demand exceeds the capacity of the roadway facility. In most cases, the cause of bottlenecks is related to a sudden reduction in capacity, such as roadway geometry, heavy merging and weaving, and driver distractions; or a surge in demand that the facility cannot accommodate. Due to the limited vehicle detector stations along this corridor, traffic volume data was not readily available for consideration. Nevertheless, major bottleneck conditions were verified and their causes identified. Below is a summary of the causes of the bottleneck locations.

Mainline Facility

Eastbound Bottlenecks and Causes

The eastbound bottlenecks and congestion were mostly in the PM peak hours, although evidence of some of the same bottlenecks to a lesser degree was found in the AM peak hours. The causes of these bottleneck locations are summarized below.

<u>Mountain On-Ramp to Fair Oaks</u>

Exhibit 4B-1 is an aerial photograph of the eastbound I-210 mainline approaching the SR-134 interchange and the Lincoln tunnel. Most of the traffic is headed either to the eastbound I-210 freeway or to the westbound SR-134. The two-lane connector capacity is often inadequate to accommodate the demand. As a result, significant congestion and queuing occurs from this location, mostly in the AM peak hours but sometimes even in the PM peak hours. Congestion and queuing is accentuated on days preceding major holiday weekends.

Exhibit 4B-1: Eastbound I-210 at SR-134/Lincoln Tunnel

Lake On-Ramp to Hill Off-Ramp

The primary cause of this bottleneck is that the mainline facility cannot accommodate the surge in demand from the heavy traffic from Lake on-ramp. The Lake on-ramp often exceeds 900 vehicles per hour during PM peak hours, even with ramp metering.

San Gabriel On-Ramp to Madre Off-Ramp

The primary cause of this bottleneck is that the mainline capacity at this location cannot accommodate the increase in demand from the San Gabriel on-ramp, although the demand is modest at less than 600 vehicles per hour with ramp metering. There is a large reversing horizontal curve to the right at San Gabriel and then left at Madre. However, an auxiliary lane is provided between the two interchanges with sufficient distance to allow for easier merging and weaving.

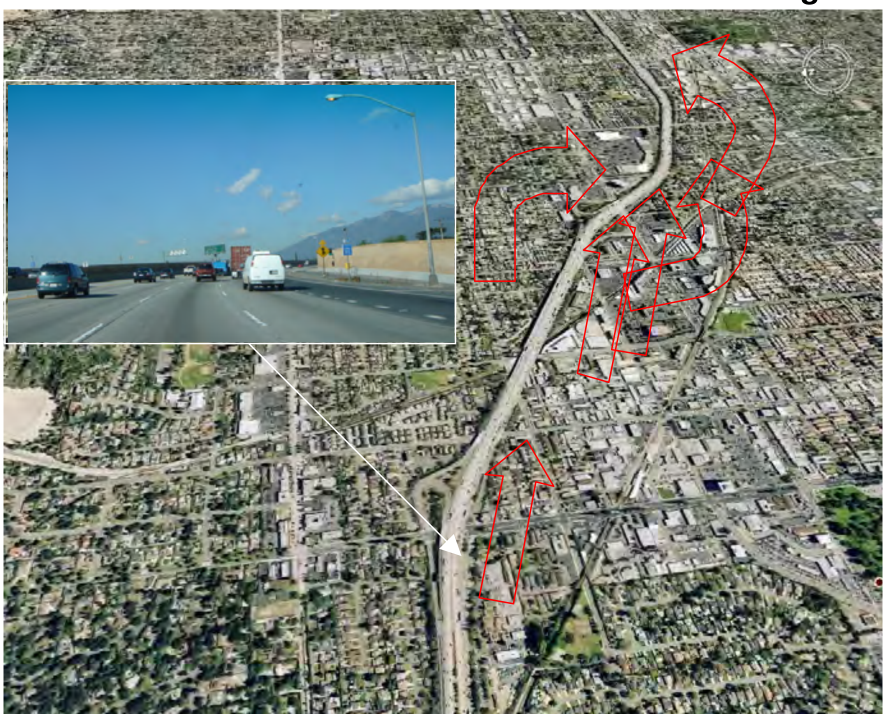
Rosemead On-Ramp to Baldwin Off-Ramp

The primary cause of this bottleneck is the heavy traffic from two consecutive on-ramps from Rosemead and Michillinda merging into the freeway traffic. Although the ramp volumes are very modest at less than 400 vehicles per hour combined, the mainline facility cannot accommodate the additional demand since the mainline traffic is near or at the threshold levels

Santa Anita On-Ramp to Huntington Off-Ramp

Exhibit 4B-2 is an aerial photograph of the eastbound I-210 mainline between Santa Anita and Huntington. As shown, the roadway here has multiple large horizontal curves with narrowing effect through this segment. Given the geometric conditions, the mainline cannot accommodate the additional demand from the Santa Anita and Huntington ramps.

Exhibit 4B-2: Eastbound I-210 at Santa Anita/Huntington



Mountain On-Ramp to I-605 Off-Ramp

Exhibit 4B-3 is an aerial photograph of the eastbound I-210 mainline approaching the I-605 interchange. The primary cause of this bottleneck is the heavy traffic from two consecutive on-ramps from Mountain and Buena Vista merging into the freeway traffic, compounded by mainline traffic weaving to get into the outside lanes in order to exit at I-605 connector. Combined, the two ramps exceed 1,200 vehicles per hour during PM peak hours, even with ramp metering. The photo illustrates the heavy traffic and difficulty in weaving.

Exhibit 4B-3: Eastbound I-210 at I-605 Off

<u>Irwindale On-Ramp to Vernon Off-Ramp</u>

Exhibit 4B-4 is an aerial photograph of the eastbound I-210 mainline between Irwindale and Azusa. As shown, the roadway here has multiple large horizontal curves. The primary cause of this bottleneck is the heavy traffic from the Irwindale on-ramp combined with the curvature of the roadway. Irwindale on-ramp exceeds 700 vehicles per hour during AM peak hours, even with ramp metering. The mainline traffic must negotiate the long turn and accommodate the merging traffic from the ramps.

Exhibit 4B-4: Eastbound I-210 at Irwindale

Azusa On-Ramp to Citrus Off-Ramp, Citrus On-Ramp to Grand Off-Ramp, and SR-57 On-Ramp to San Dimas Off-Ramp

The primary cause of these bottlenecks is the added demand from the ramps exceeding the available capacity of the mainline facility. The mainline traffic is at or near the threshold levels during the PM peak hours and cannot accommodate the additional demand.

Westbound Bottlenecks and Causes

Westbound bottlenecks and congestion were mostly in the AM peak hours, although evidence of the same bottlenecks to a lesser degree was found in the PM peak hours. The following is a summary of the eastbound bottlenecks and the identified causes.

Azusa On-Ramp to Vernon Off-Ramp

Exhibit 4B-5 is an aerial photograph of the westbound I-210 mainline approaching Azusa on-ramp. As shown, the roadway has a large horizontal curve to the right. The primary cause of this bottleneck is the heavy traffic from two consecutive on-ramps from

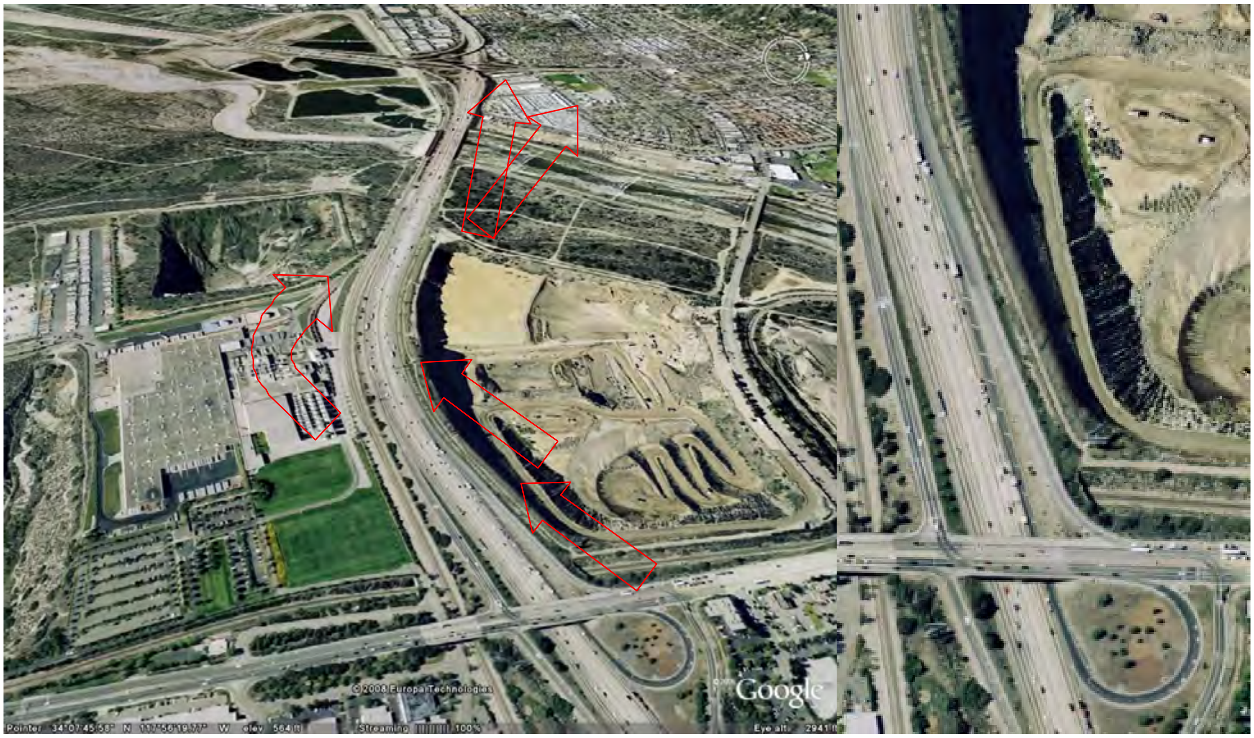
Azusa merging into the freeway traffic at the crest of the curve. Combined, the two ramps exceed 1,000 vehicles per hour during AM peak hours, even with ramp metering. The mainline traffic must negotiate the long turn and accommodate the merging traffic from consecutive ramps.

Exhibit 4B-5: Westbound I-210 at Azusa

Irwindale On-Ramp to I-605 Off-Ramp

Exhibit 4B-6 is an aerial photograph of the westbound I-210 mainline between Irwindale and I-605. As shown, the roadway here also has a large horizontal curve to the right. The primary cause of this bottleneck is the heavy traffic from two consecutive on-ramps from Irwindale merging into the freeway traffic, compounded by mainline traffic weaving to get into the outside lanes in order to exit at I-605 connector. Combined, the two ramps exceed 800 vehicles per hour during AM peak hours, even with ramp metering.

Exhibit 4B-6: Westbound I-210 at Irwindale and I-605



Santa Anita On-Ramp to Baldwin Off-Ramp

Exhibit 4B-7 is an aerial photograph of the westbound I-210 mainline between Huntington and Santa Anita. As shown, the roadway here has multiple large horizontal curves. The primary cause of this bottleneck is the heavy traffic from two consecutive on-ramps from Santa Anita merging into the freeway traffic at the crest of the curve. Combined, the two ramps exceed 900 vehicles per hour during AM peak hours, even with ramp metering. The mainline traffic must negotiate the long turn and accommodate the merging traffic from consecutive ramps. The lower photo shows the backup traffic in all lanes at Huntington. The upper photo shows the right two lanes congested while the inner lanes begin to move faster and separate. This indicates that the ramp traffic merging is affecting the mainline traffic flow.

Exhibit 4B-7: Westbound I-210 at Santa Anita

Baldwin On-Ramp to Michillinda Off-Ramp

Like most of the other locations, the primary cause of this bottleneck is the heavy traffic from two consecutive on-ramps from Baldwin (North and South Baldwin) merging into the freeway traffic. Combined, the two ramps exceed 900 vehicles per hour during AM peak hours, even with ramp metering.

Rosemead On-Ramp to Sierra Madre Villa Off-Ramp

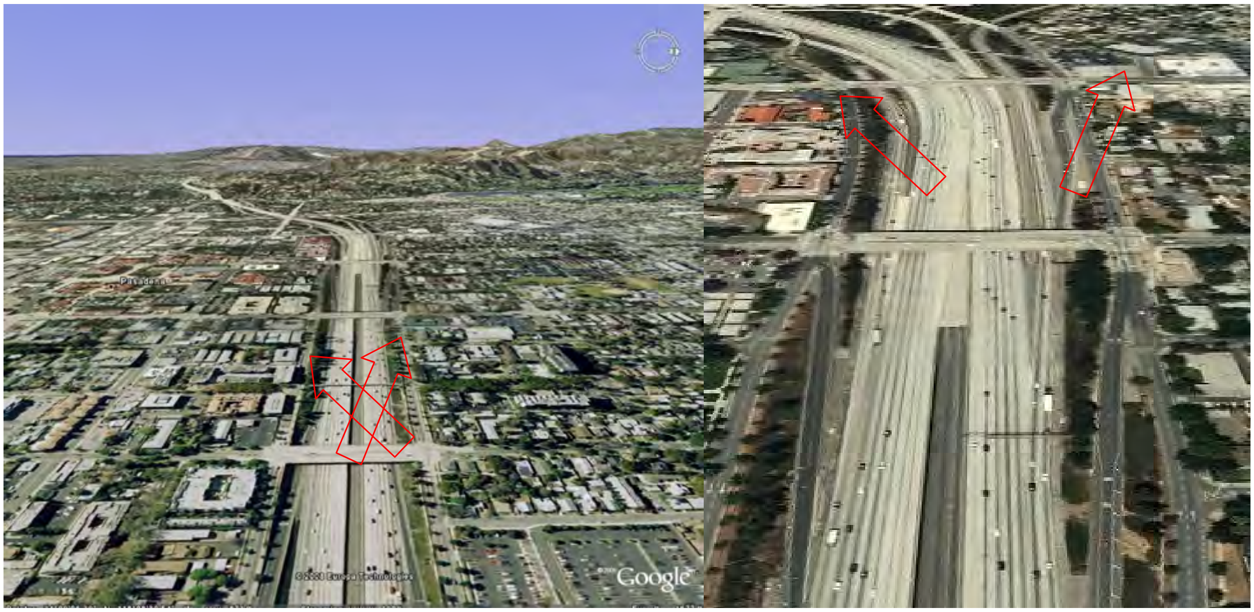
The primary cause of this bottleneck is the heavy traffic from three consecutive on-ramps from Michillinda, Foothill, and Rosemead merging into the freeway traffic, compounded by the weaving from traffic exiting at Sierra Madre Villa. Combined, the three ramps exceed 1,700 vehicles per hour during AM peak hours, even with ramp metering. Exhibit 4B-8 illustrates this location.

Exhibit 4B-8: Westbound I-210 at Rosemead

Lake On-Ramp to SR-134 Off-Ramp

The primary cause of this bottleneck is the weaving between the heavy traffic from the Lake on-ramp and exiting traffic to I-210 west. Lake on-ramp exceeds 700 vehicles per hour during AM peak hours, even with ramp metering. Exhibit 4B-9 illustrates this location.

Exhibit 4B-9: Westbound I-210 at Lake and SR-134



SR-118 On-Ramp to Maclay Street Off-Ramp

The primary cause of this bottleneck is the heavy SR-118 freeway on-ramp traffic merging with the I-210 mainline traffic during the PM peak hours. The eastbound SR-118 freeway terminates at this I-210 junction. Two connector lanes to westbound I-210 merge into one and enter the freeway. The I-210 mainline facility cannot handle the heavy demand and platoon of vehicles from this connector. Exhibit 4B-10 illustrates this location. The bottom photograph illustrates the light volume on the westbound I-210 mainline approaching the SR-118 interchange. The middle photograph illustrates the congestion and queuing resulting from the SR-118 connector on-ramp merging. To make matters worse, the fourth lane (provided from the connector on) is dropped after the Maclay Street off-ramp, as shown on the top photograph. It also shows the clearing of the congestion past the Maclay Street interchange.

Exhibit 4B-10: Westbound I-210 at SR-118

High Occupancy Vehicle Facility

A bottleneck and causality analyses was also conducted for the HOV facility of the SR-210 Corridor. The HOV-lane stretches about 20-miles in each direction between SR-134 and SR-57. They operate on a full-time basis separated by a buffer with varying widths. It has a vehicle occupancy requirement of two plus (2+) in both directions. Automatic detector data was primarily used to conduct the HOV analysis.

Eastbound HOV Bottlenecks and Causes

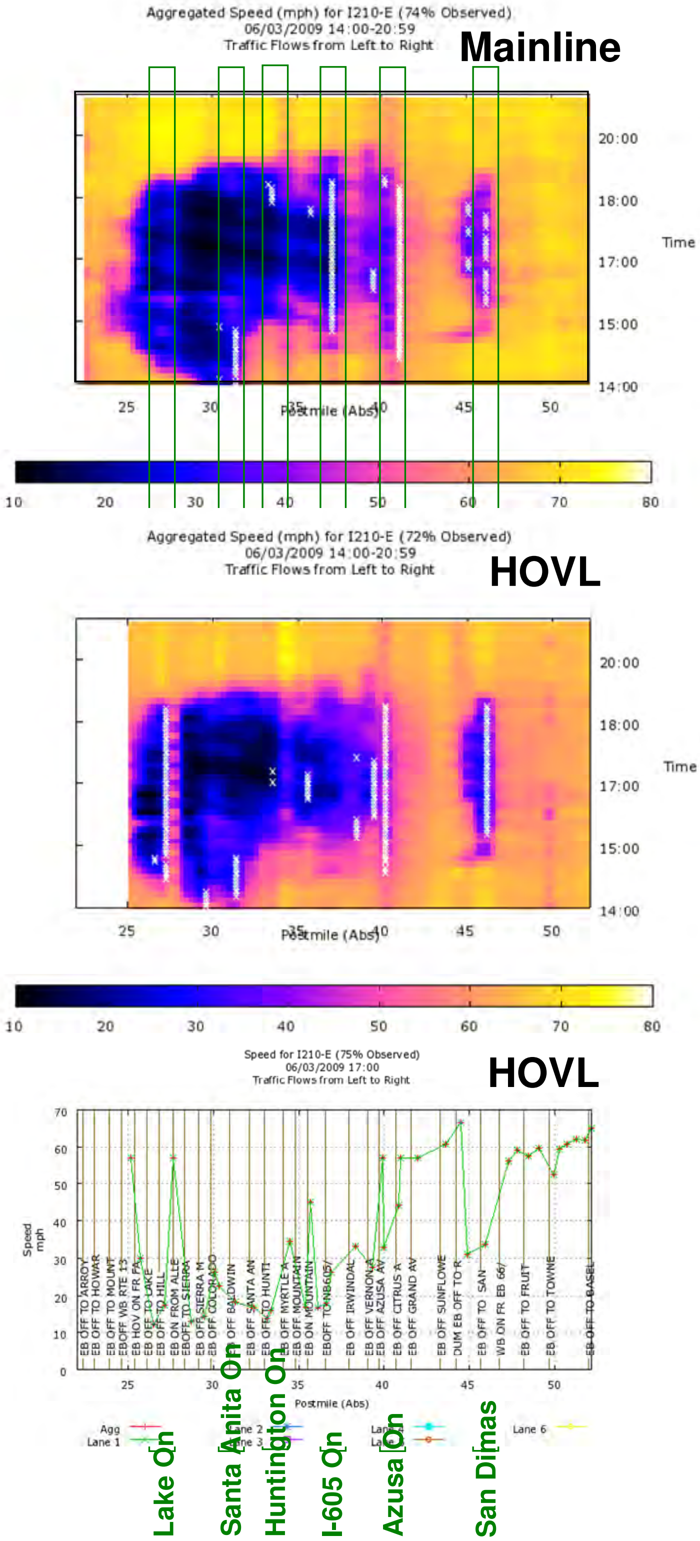
In the eastbound direction, six major bottlenecks were identified based on data analysis, at the following locations:

- Lake Avenue On
- Santa Anita Avenue On
- Huntington Drive On
- I-605 On
- Azusa Avenue On
- San Dimas

Exhibit 4B-11 presents the speed contour diagram of the eastbound I-210 mainline and HOV lanes for a recent weekday in June 2009. These diagrams indicate locations of congestion and bottlenecks. A review of multiple sample days and monthly averages throughout 2007 and 2008 revealed the appearance of the same bottleneck locations.

As indicated in Exhibit 4B-11, the HOV-lane bottleneck locations coincide exactly with the mainline bottleneck locations. This is primarily due to the close proximity of the HOV-lane to the mainline lane. For most of the facility, the existing HOV-lane is separated from the mainline by a double yellow and white stripe separation (about 2-feet in width). The HOV-lane has little to no inside shoulder. When the mainline is congested and speeds are at stop and go, the HOV traffic will also slow down (out of caution), breaking down the flow particularly near the HOV-lane ingress/egress locations and at roadway curves.

Exhibit 4B-11: Eastbound I-210 ML & HOVL Speed Contour (June 2009)



Westbound HOV Bottlenecks and Causes

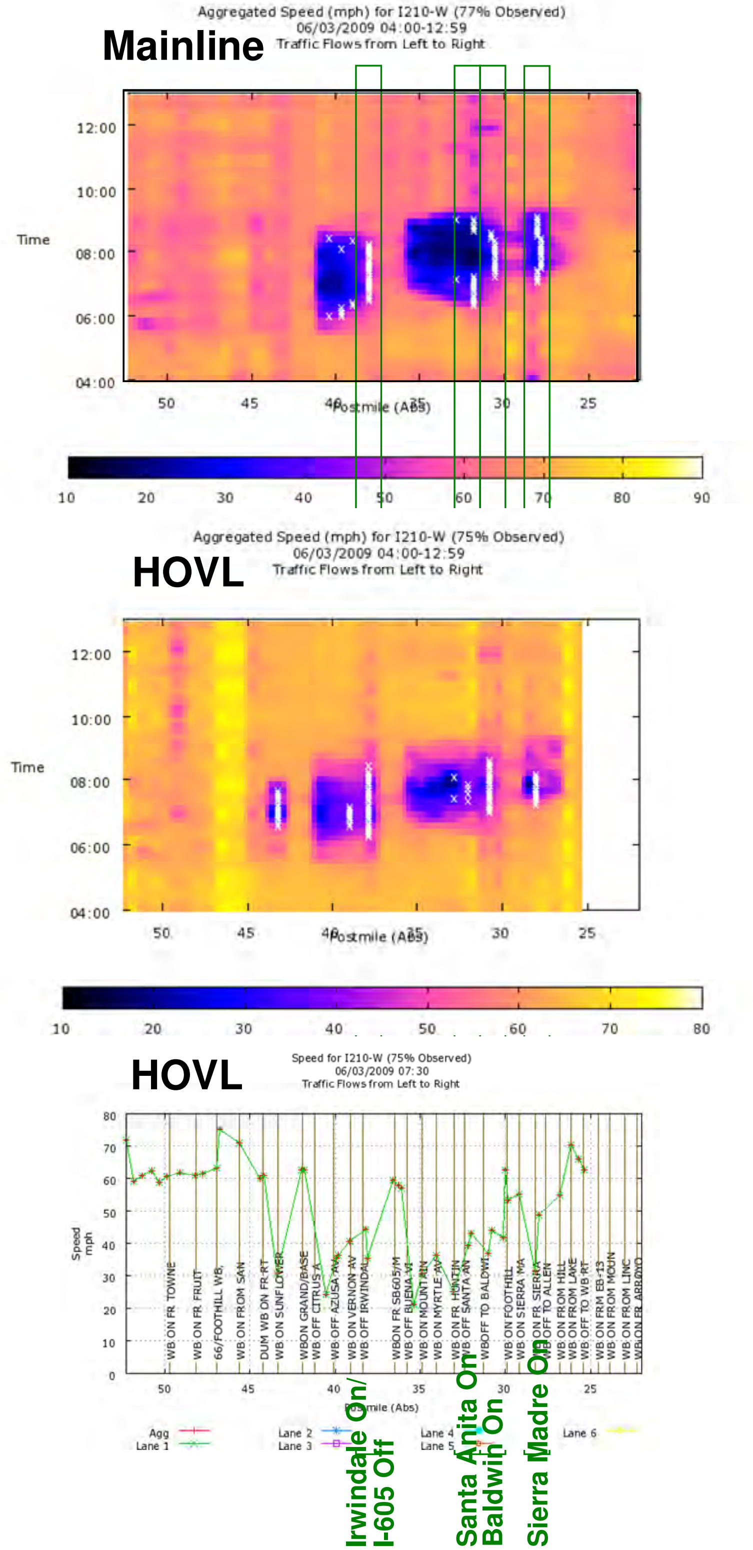
In the westbound direction, four major bottlenecks were identified based on data analysis, at the following locations:

- Irwindale Avenue On/I-605 Off
- Santa Anita Avenue On
- Baldwin Avenue On
- Sierra Madre On

Exhibit 4B-12 presents the speed contour diagram of the westbound I-210 mainline and HOV lanes for a recent weekday in June 2009. These diagrams indicate locations of congestion and bottlenecks. A review of multiple sample days and monthly averages throughout 2007 and 2008 revealed the appearance of the same bottleneck locations.

Like the eastbound direction, the westbound HOV-lane bottleneck locations also coincide with the mainline bottleneck locations, as indicated in Exhibit 4B-12. Again, this is primarily due to the close proximity of the HOV-lane to the mainline lane. For most of the facility, the westbound HOV-lane is separated from the mainline by a double yellow and white stripe separation (about 2-feet in width). The HOV-lane has little to no inside shoulder. When the mainline is congested and speeds are at stop and go, the HOV traffic will also slow down (out of caution), breaking down the flow particularly near the HOV-lane ingress/egress locations and at roadway curves.

Exhibit 4B-12: Westbound I-210 ML & HOVL Speed Contour (June 2009)



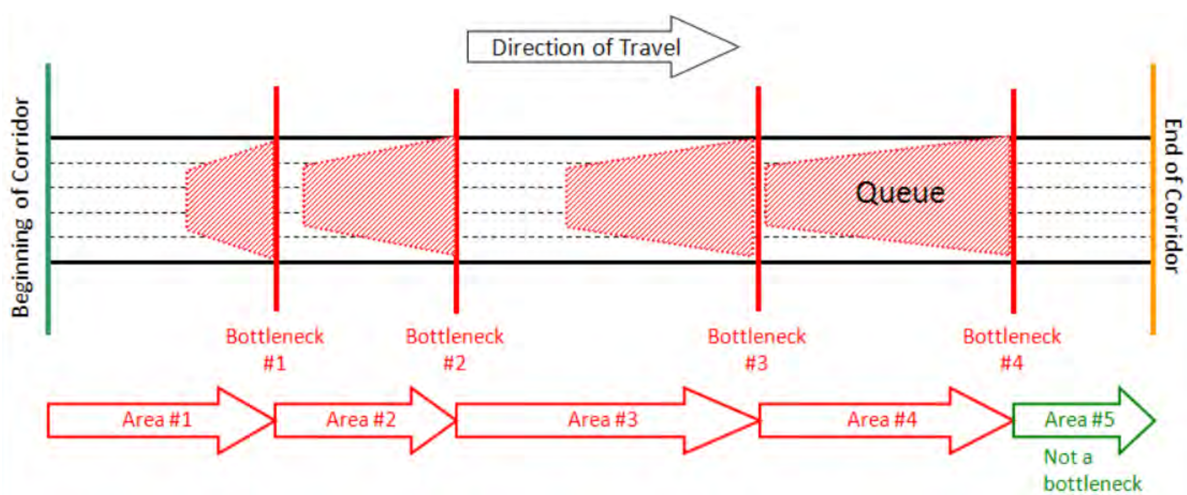
C. Bottleneck Area Performance

Once the bottlenecks were identified, the corridor is divided into "bottleneck areas." Bottleneck areas represent segments that are defined by one major bottleneck (or a number of smaller ones). By segmenting the corridors into these bottleneck areas, the performance statistics that were presented earlier for the entire corridor can be segmented by bottleneck area. This way, the relative contribution of each bottleneck area to the degradation of the corridor performance can be gauged. The performance statistics that lend themselves to such segmentation include:

- Delay
- Productivity
- Safety

The analysis of bottleneck areas is based on 2006 data to assist the modelers in calibrating the baseline year. It is also limited to the mainline facility due to the limited detection available on the HOV facility. Based on this approach, the study corridor comprises several bottleneck areas, which differ by direction. Exhibit 4C-1 illustrates the concept of bottleneck areas in one direction. The red lines in the exhibit represent the bottleneck locations and the arrows represent the bottleneck areas.

Exhibit 4C-1: Dividing a Corridor into Bottleneck Areas



Dividing the corridor into bottleneck areas makes it easier to compare the various segments of the freeway with each other. Dividing the corridor into bottleneck areas makes it easier to compare the various segments of the freeway with each other. Based on the above, the bottlenecks previously identified in Exhibit 4A-1 and 4A-2 are shown again in Exhibit 4C-2 and 4C-3 with the associated bottleneck areas.

Exhibit 4C-2: Eastbound I-210 Identified Bottleneck Areas

Bottleneck Location	Bottleneck Area	Active Period		From		To		Distance (miles)
		AM	PM	Abs	CA	Abs	CA	
Fair Oaks	SR-134 to Fair Oaks	✓	✓	22.0	R22.0	25.0	R25.0	3.0
Lake On	Fair Oaks to Lake On		✓	25.0	R25.0	26.5	R26.5	1.5
San Gabriel On	Lake On to San Gabriel On		✓	26.5	R26.5	28.6	R28.7	2.1
Rosemead On	San Gabriel On to Rosemead On		✓	28.6	R28.7	29.4	R29.4	0.8
Huntington I/C	Rosemead On to Huntington I/C	✓	✓	29.4	R29.4	33.0	R32.7	3.6
I-605	Huntington I/C to I-605	✓	✓	33.0	R32.7	36.6	R36.3	3.6
Azusa On	I-605 to Azusa On	✓	✓	36.6	R36.3	40.0	R39.7	3.4
Citrus On	Azusa On to Citrus On		✓	40.0	R39.7	40.8	R40.6	0.8
SR-57 On	Citrus On to SR-57 On	✓	✓	40.8	R40.6	45.0	R45.0	4.2

Exhibit 4C-3: Westbound I-210 Identified Bottleneck Areas

Bottleneck Location	Bottleneck Area	Active Period		From		To		Distance (miles)
		AM	PM	Abs	CA	Abs	CA	
Azusa On	SR-57 to Azusa On	✓	✓	45.0	R45.0	40.1	R39.8	4.9
I-605 Off	Azusa On to I-605 Off	✓	✓	40.1	R39.8	36.8	R36.5	3.3
Santa Anita On	I-605 Off to Santa Anita On	✓	✓	36.8	R36.5	32.2	R31.9	4.6
Baldwin On	Santa Anita On to Baldwin On	✓	✓	32.2	R31.9	30.7	R30.4	1.5
Rosemead On	Baldwin On to Rosemead On	✓	✓	30.7	R30.4	29.7	L29.7	1.0
Altadena On	Rosemead On to Altadena On	✓	✓	29.7	L29.7	28.0	R28.1	1.7
Lake On	Altadena On to Lake On	✓	✓	28.0	R28.1	26.1	R26.1	1.9
None	Lake On to SR-134	N/A		26.1	R26.1	22.0	R22.0	4.1

Mobility by Bottleneck Area

Mobility describes how quickly the vehicles move along the corridor. To evaluate how well (or poorly) vehicles move through each bottleneck area, vehicle-hours of delay were calculated for each segment. The results reveal the areas of the corridor that experience the worst mobility.

Exhibits 4C-4 and 4C-5 show the vehicle-hours of delay experienced by bottleneck area and reflect the directional pattern of travel on I-210. As depicted in Exhibit 4C-4, delay in the eastbound direction is concentrated in the PM peak. The bottleneck area between Rosemead and the Huntington Interchange, which is the location of the bottleneck, experienced the greatest delay in the eastbound direction. This bottleneck accounted for roughly 408,000 annual vehicle-hours of delay or 30 percent of the corridor delay during the PM peak.

Exhibit 4C-5 shows that delay in the westbound direction exhibits the reverse pattern. The delays in the AM peak period are much larger than those in the PM peak. During the AM peak period, the largest delays occur between SR-57 and Azusa On-Ramp with 321,000 vehicle-hours of delay (33 percent) followed by the bottleneck area at I-605 to Santa Anita with nearly 300,000 vehicle-hours of delay (30 percent).

Exhibit 4C-4: Eastbound I-210 Annual Vehicle-Hours of Delay (2006)

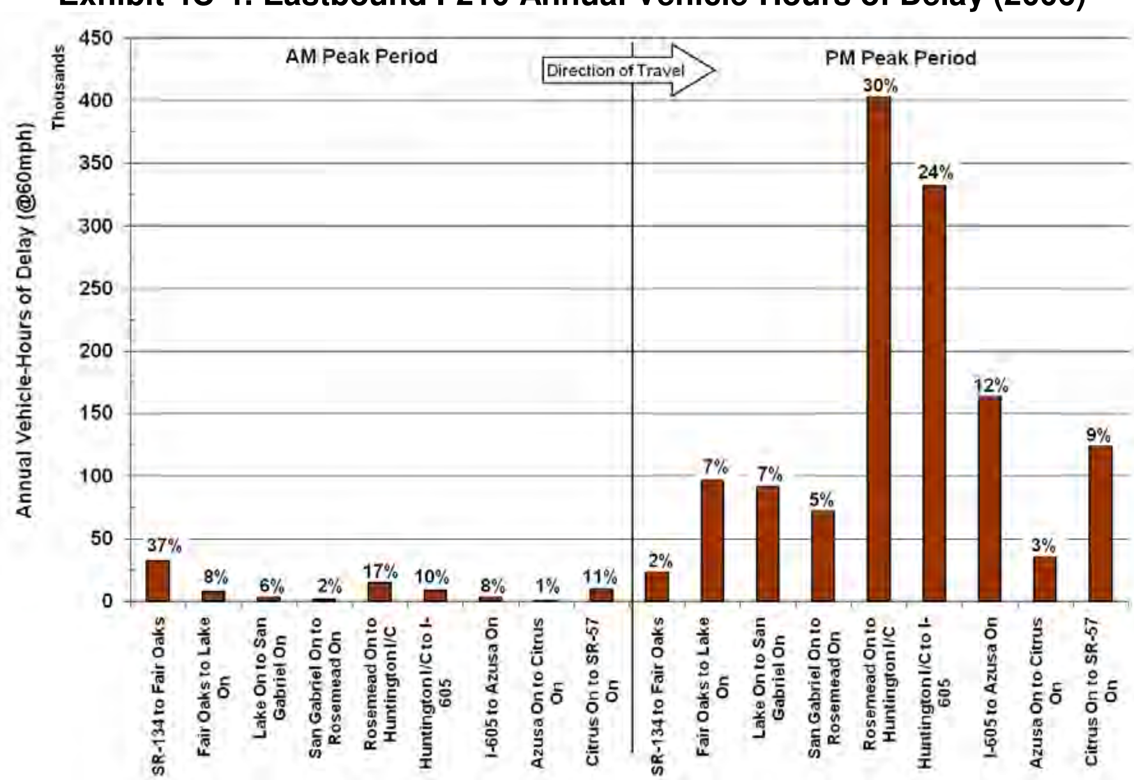
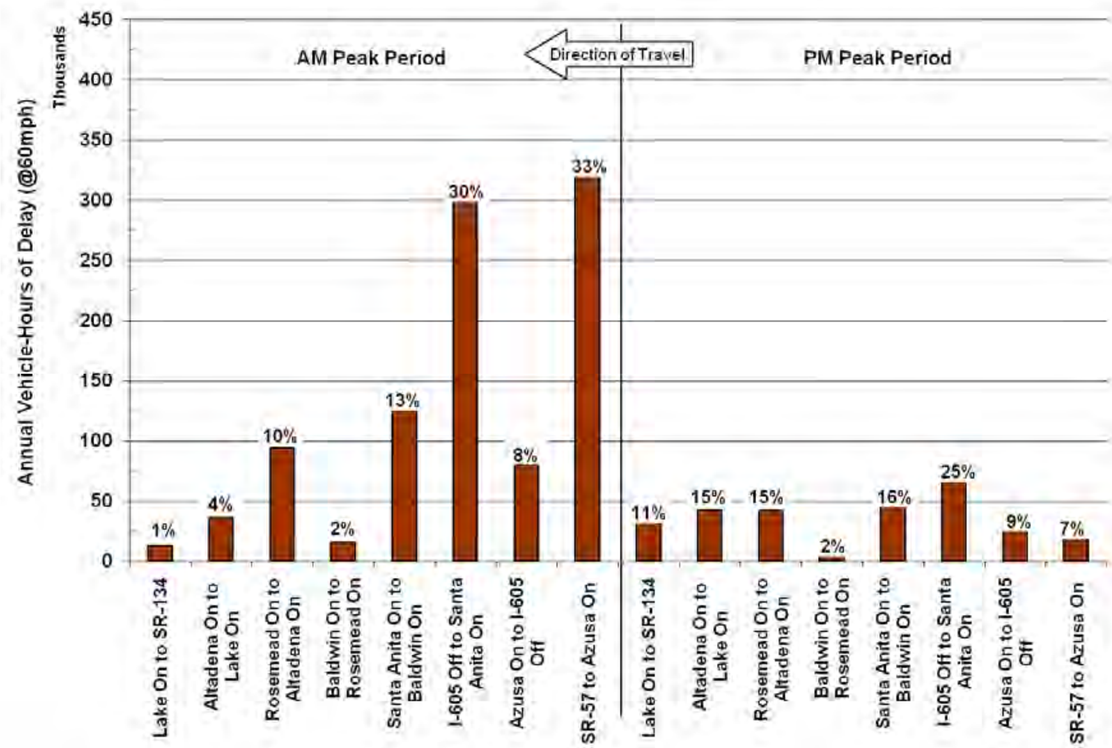


Exhibit 4C-5: Westbound I-210 Annual Vehicle-Hours of Delay (2006)



Exhibits 4C-6 and 4C-7 are normalized to reflect the concentration of delays in the physical area of the corridor. The delay calculated for each bottleneck area was divided by the total lane-miles for each bottleneck area to obtain delay per lane-mile. The results of these exhibits reveal slightly different delay patterns than those shown in Exhibits 4C-4 and 4C-5. In the eastbound direction, the areas with the largest delay in the PM peak period are similar to those shown in the non-normalized graph (compare Exhibit 4C-6 with Exhibit 4C-4). The area between Rosemead and the Huntington Interchange remains the location with the largest delays. However, the patterns in the westbound direction are different. The section between Santa Anita and Baldwin has the largest concentration of delay. This bottleneck area is followed by the two areas previously identified in Exhibit 4C-5.

Exhibit 4C-6: Eastbound I-210 Delay per Lane-Mile (2006)

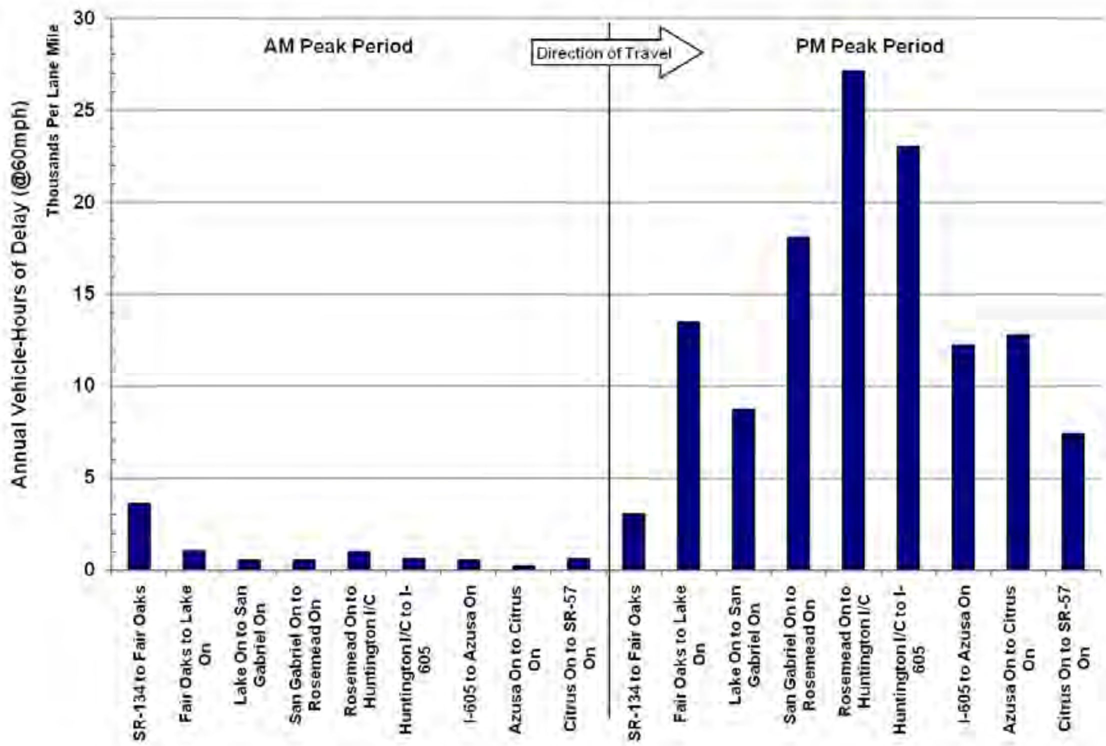
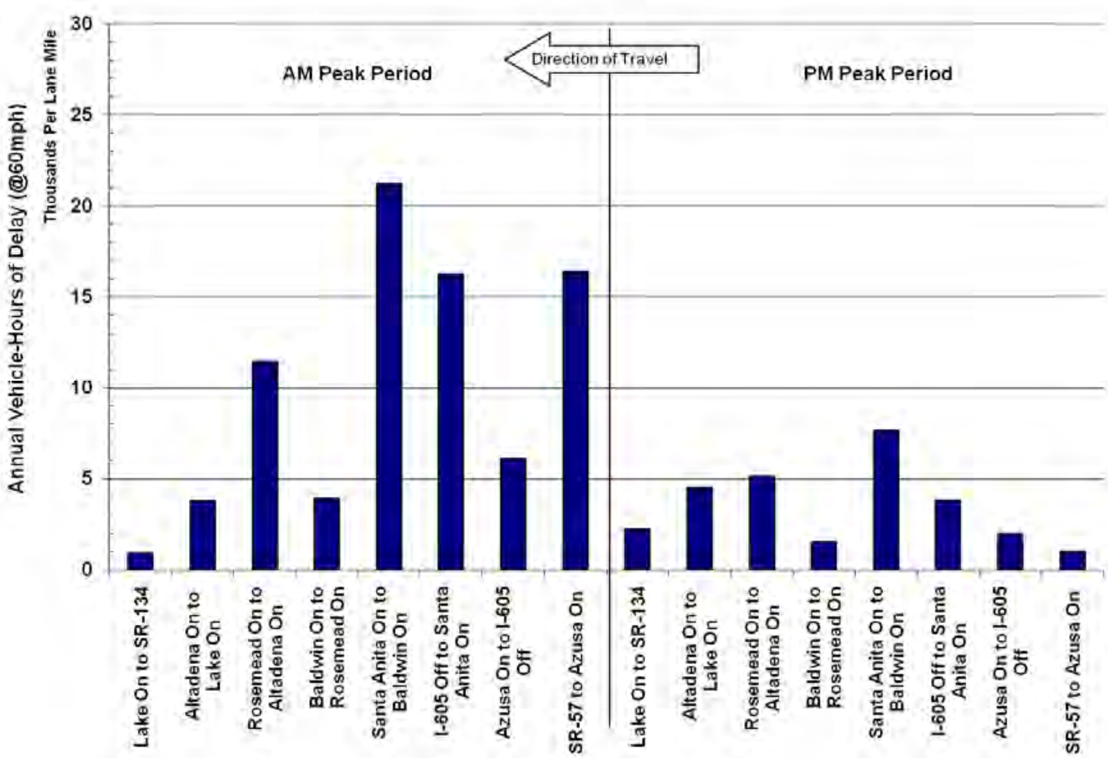


Exhibit 4C-7: Westbound I-210 Delay per Lane-Mile (2006)



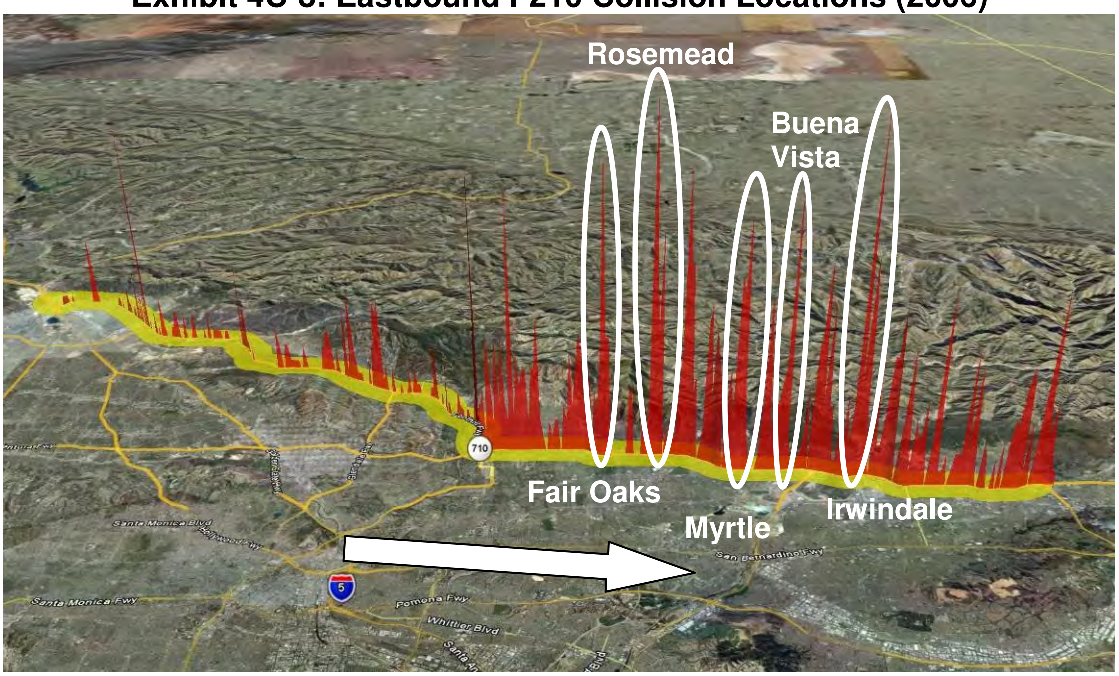
Safety by Bottleneck Area

As indicated previously in Section 3, the safety assessment in this report characterizes the overall accident history and trends along the corridor. It also highlights notable accident concentration locations or readily apparent patterns. The following discussion examines the patterns by bottleneck area.

Exhibit 4C-8 shows the location of all collisions plotted along the I-210 Corridor in the eastbound direction. The spikes show the total number of collisions (fatality, injury, and property damage only) that occurred within 0.1 mile segments in 2006. The highest spike corresponds to roughly 20 collisions in a single 0.1 mile location. The size of the spikes is a function of how collisions are grouped. If the data were grouped in 0.2 mile segments, the spikes would be higher.

The magnitude of these spikes is less interesting than the concentration. Previous sections reported performance results for the congested urban area between the SR-134 and the SR-57. This is due mostly to the lack of detection in the western section. However, as Exhibit 4C-8 shows, this focus also makes sense from a performance standpoint. The number of collisions is much greater in the congested urban area. As explained earlier, this is probably due to higher traffic volumes.

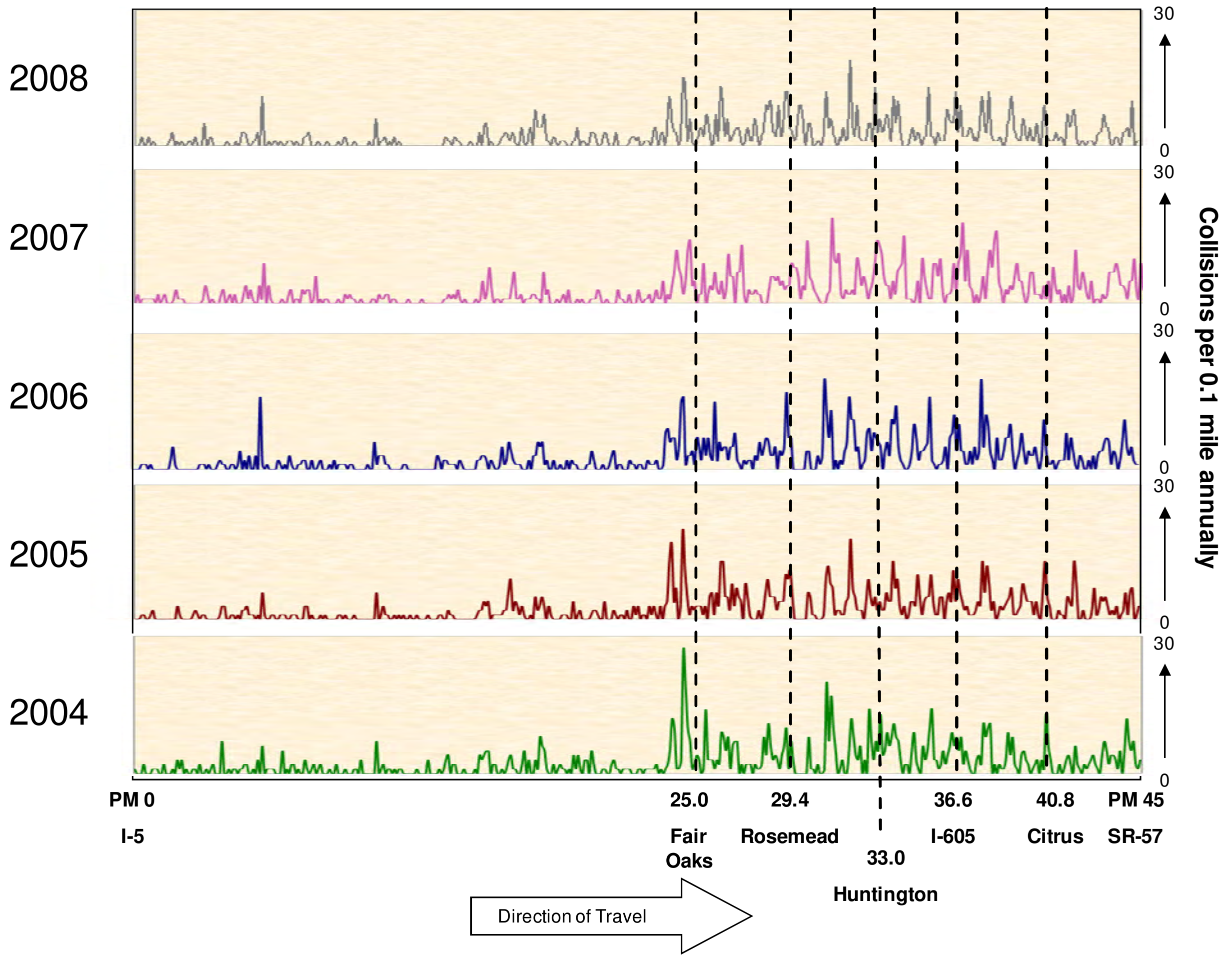
Exhibit 4C-8: Eastbound I-210 Collision Locations (2006)



Source: TASAS data

Exhibit 4C-9 illustrates the same data for the five-year period between 2004 and 2008. Each graph within the exhibit represents one year, with the spikes indicating the number of collisions, which occurred at a specific post mile location. The collisions range anywhere between zero (the minimum) and 30 (the maximum) as reflected on the y-axis. The vertical lines in the exhibit separate the corridor by bottleneck area. Exhibit 4C-9 suggests that the high accident locations identified in 2006 (Exhibit 4C-8) were similar in the preceding years. Moving eastbound, spikes indicating high accident locations were most notable near Fair Oaks at (PM 25.0), followed by Rosemead (PM 29.4), Myrtle Avenue (PM 34.1), Buena Vista (PM 35.6), and Irwindale Avenue (37.9). Between 2004 and 2008, there is a tall spike near Fair Oaks (PM 25.0), which is also a bottleneck location. The exhibit shows that the pattern of collisions has remained fairly consistent over the years.

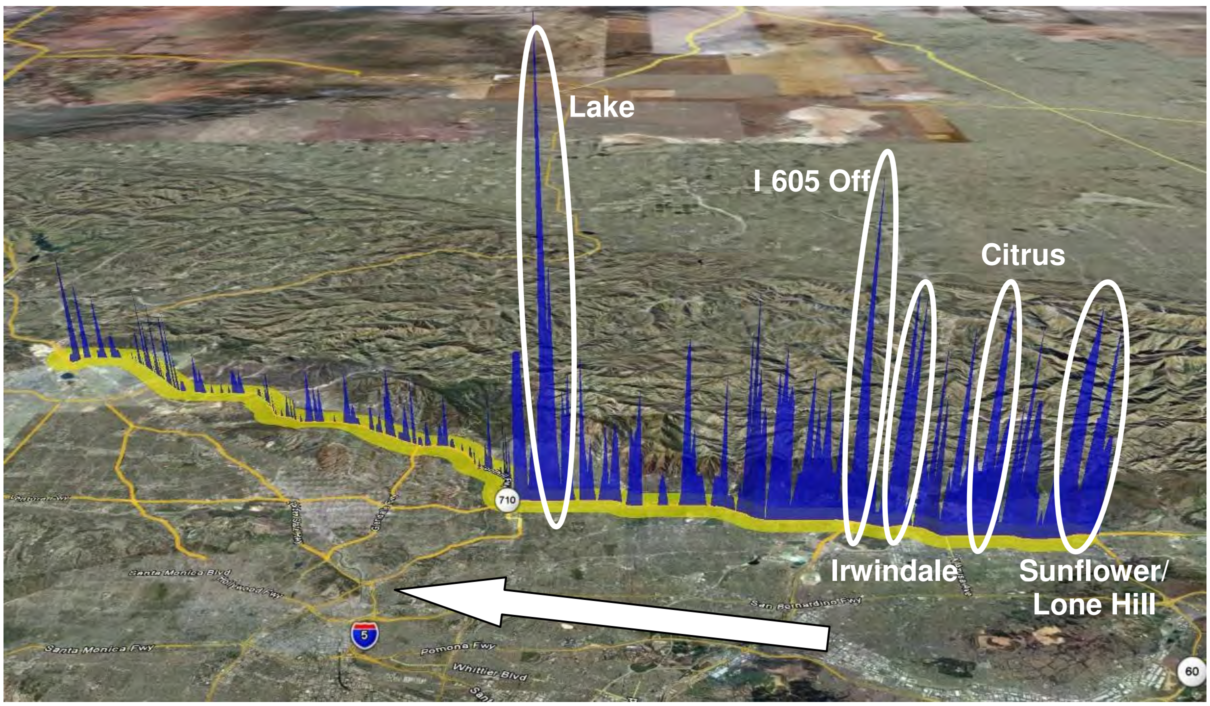
Exhibit 4C-9: Eastbound I-210 Collision Location by Bottleneck (2004-08)



Source: TASAS data

Exhibit 4C-10 shows the same 2006 collision data for I-210 in the westbound direction. The largest spike in this exhibit corresponds roughly to 26 collisions per 0.1 miles. The westbound direction experienced slightly more accidents than the eastbound direction did in 2006. Like the eastbound direction, there are noticeably higher numbers of collisions in the eastern urban section of the corridor (east of SR-134). As shown in Exhibit 4C-10, the highest spike (of 26 collisions per 0.1 miles) occurs near SR-134 at the Lake interchange.

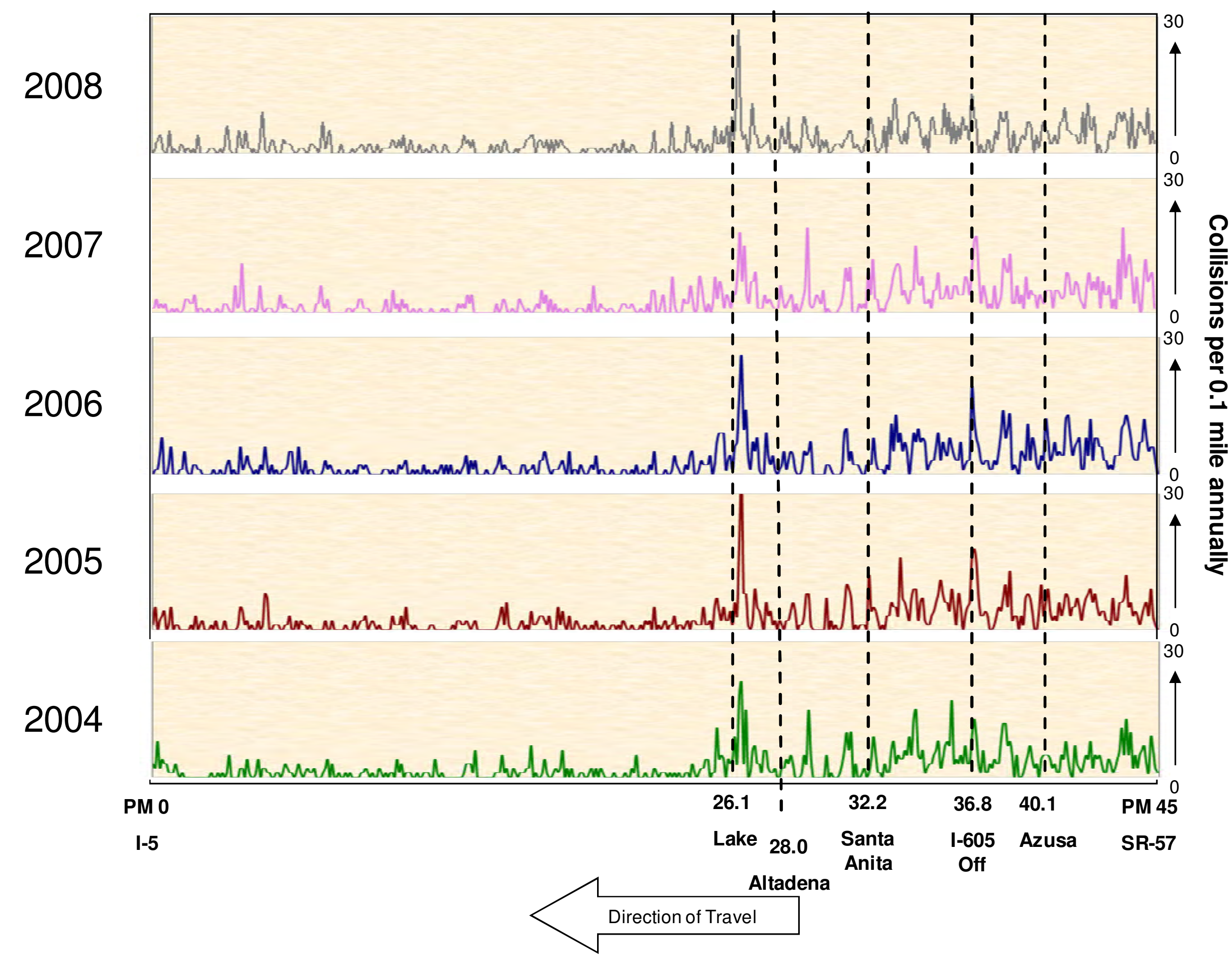
Exhibit 4C-10: Westbound I-210 Collision Locations (2006)



Source: TASAS data

Exhibit 4C-11 shows the trend of collisions for the westbound direction from 2004 to 2008 period. The pattern of collisions has been fairly steady from one year to the next. The highest number of accidents has occurred consistently at Lake Avenue (PM 26.1). Other high accidents locations are depicted in Exhibit 4C-10. Moving westbound, these are near Lone Hill and Sunflower (PM 43.5), Citrus Avenue (PM 40.9), Irwindale Avenue (PM 38.0), and the I-605 Off Ramp (PM 36.8). The high-collision location at the I-605 Off-ramp and Lake Avenue are also bottleneck locations, as identified in Exhibit 4C-11.

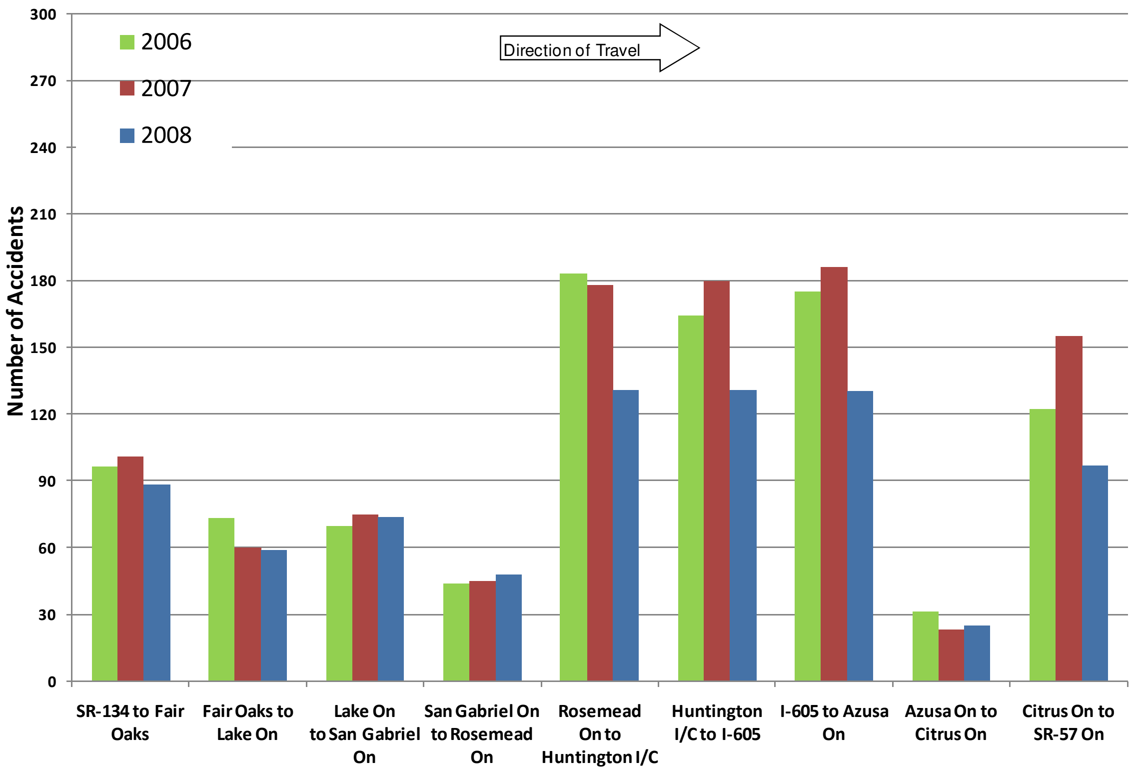
Exhibit 4C-11: Westbound I-210 Collision Location by Bottleneck (2004-08)



Source: TASAS data

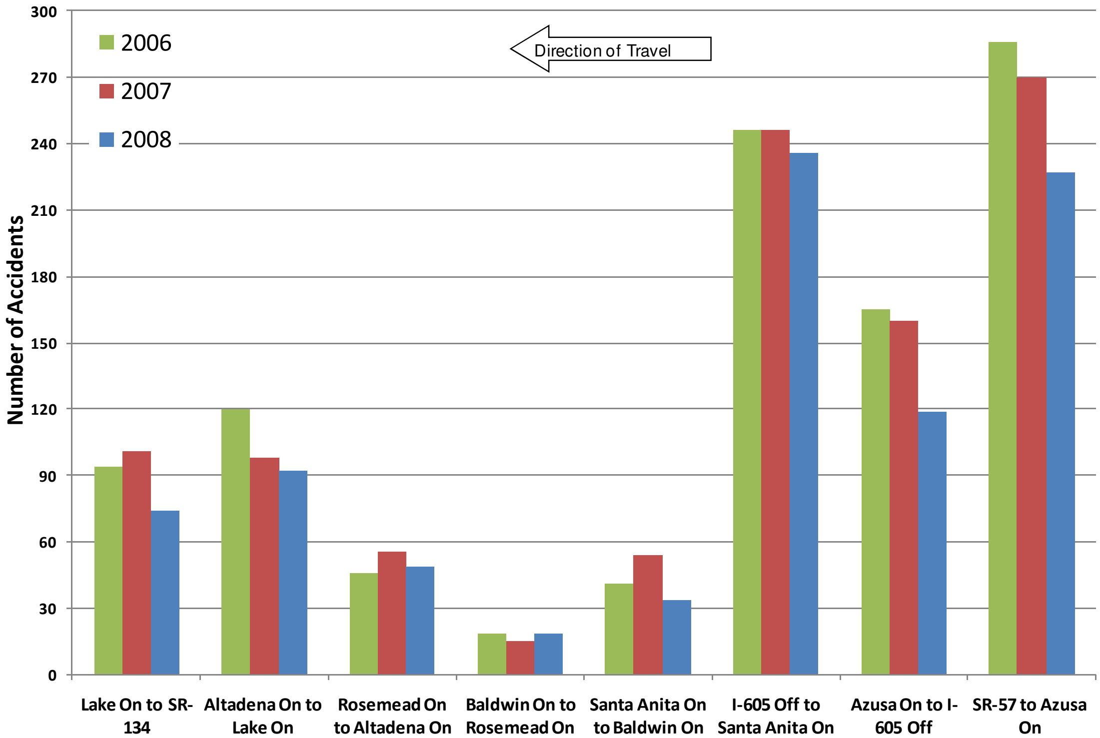
Exhibits 4C-12 and 4C-13 summarize the total number of accidents reported in TASAS by bottleneck area. The bars show the annual number of accidents that occurred in 2006, 2007, and 2008. From 2007 to 2008, the number of accidents in each direction decreased by over 15 percent. Almost each segment of the corridor experienced a decline in the number of accidents. In the eastbound direction, the greatest number of accidents occurred in the three bottleneck areas in the central part of the corridor between Rosemead and Azusa. In the westbound direction, most accidents are somewhat further east and cluster in the three bottleneck areas from SR-57 to Santa Anita.

Exhibit 4C-12: Eastbound I-210 Total Accidents (2006-08)



Source: TASAS data

Exhibit 4C-13: Westbound I-210 Total Accidents (2006-08)



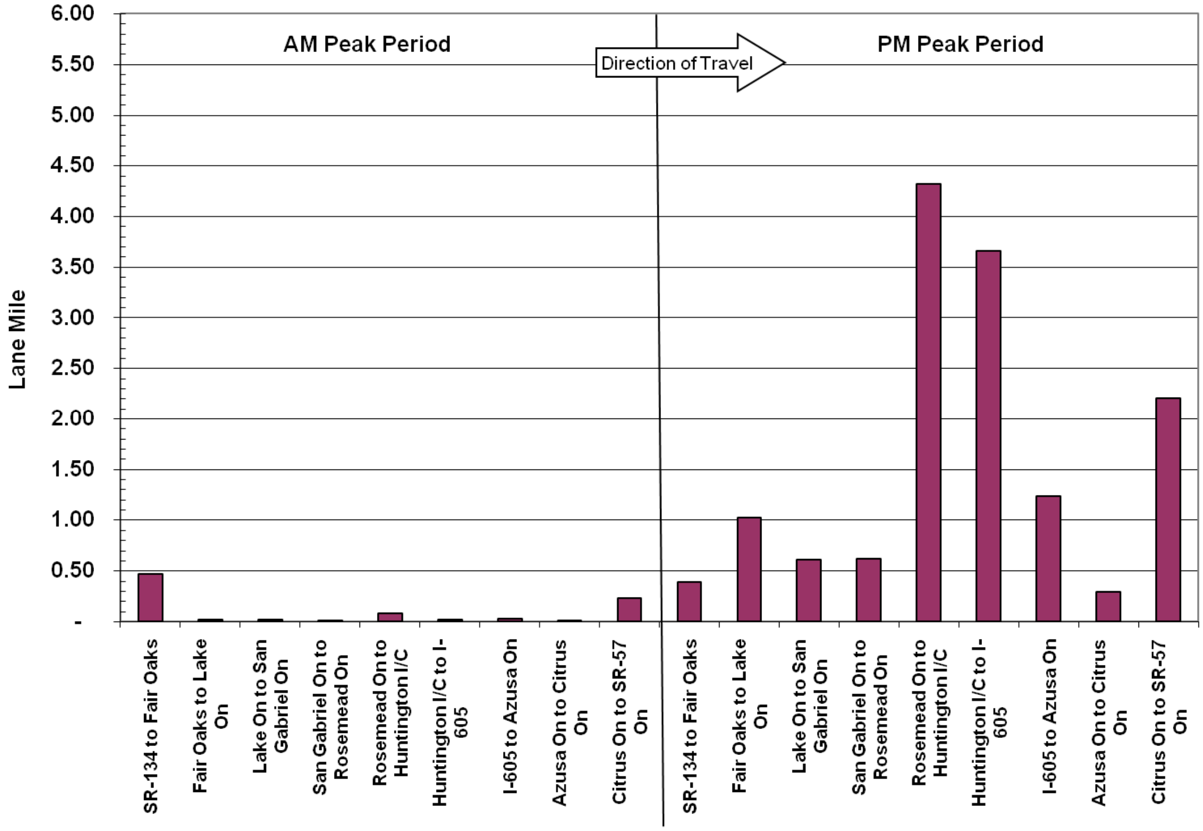
Source: TASAS data

Productivity by Bottleneck Area

As discussed in Section 3, the productivity of a corridor is defined as the degree of utilization under peak conditions. Productivity is measured by calculating the lost productivity of the corridor and converting it into “lost lane-miles.” These lost lane-miles represent a theoretical capacity that would need to be added to achieve maximum productivity. Actually adding this number of lane-miles would not necessarily achieve the desired throughput due to operational issues.

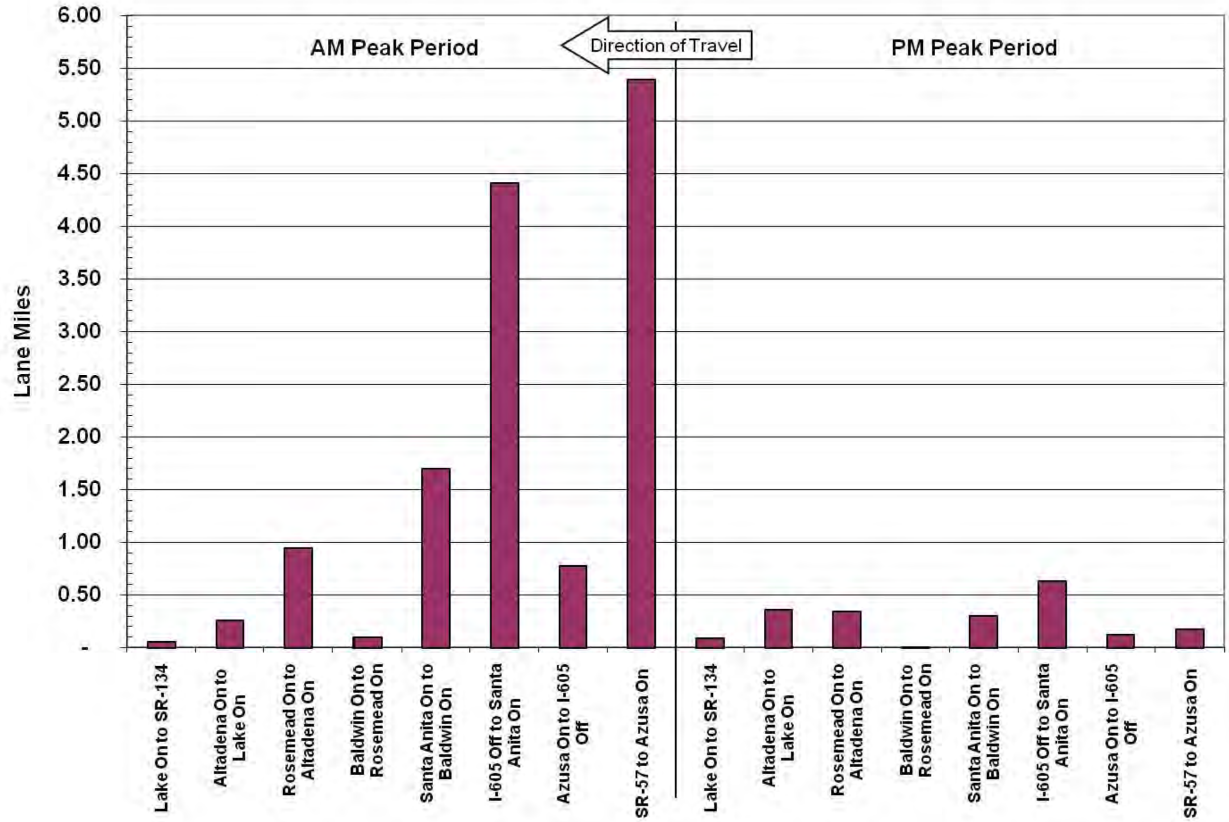
Exhibits 4C-14 and 4C-15 show the productivity losses for the corridor. In the eastbound direction (Exhibit 4C-14), the two bottleneck areas between the Rosemead On-Ramp and the I-605 experienced the worst productivity losses in the PM peak. Together, these two bottleneck areas lose an equivalent eight (8) lane-miles. Since this section is just over 7 miles long, the productivity loss is the equivalent of losing more than a lane of I-210. This section of lost productivity is in a similar area (although a bit smaller) to the section with high accidents. It is also very consistent with the location of the highest delays along the corridor.

Exhibit 4C-14: Eastbound I-210 Equivalent Lost Lane-Miles (2006)



In the westbound direction (Exhibit 4C-15), the largest productivity loss occurs in the bottleneck area between SR-57 and Azusa On-Ramp (nearly 5.50 lost lane-miles). The next largest productivity loss occurs in the bottleneck area from I-605 Off-Ramp to Santa Anita On-Ramp (almost 4.5 lost lane-miles). As in the eastbound direction, these locations are consistent with the highest number of accidents and the largest delays.

Exhibit 4C-15: Westbound I-210 Equivalent Lost Lane-Miles (2006)



Page Intentionally Left Blank for Future Updates on Bottleneck Identification, Bottleneck Area Definition, and Performance Measures by Bottleneck Area

5. SCENARIO DEVELOPMENT AND EVALUATION

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 evaluate improvements, including:

- Developing traffic models for the 2006 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

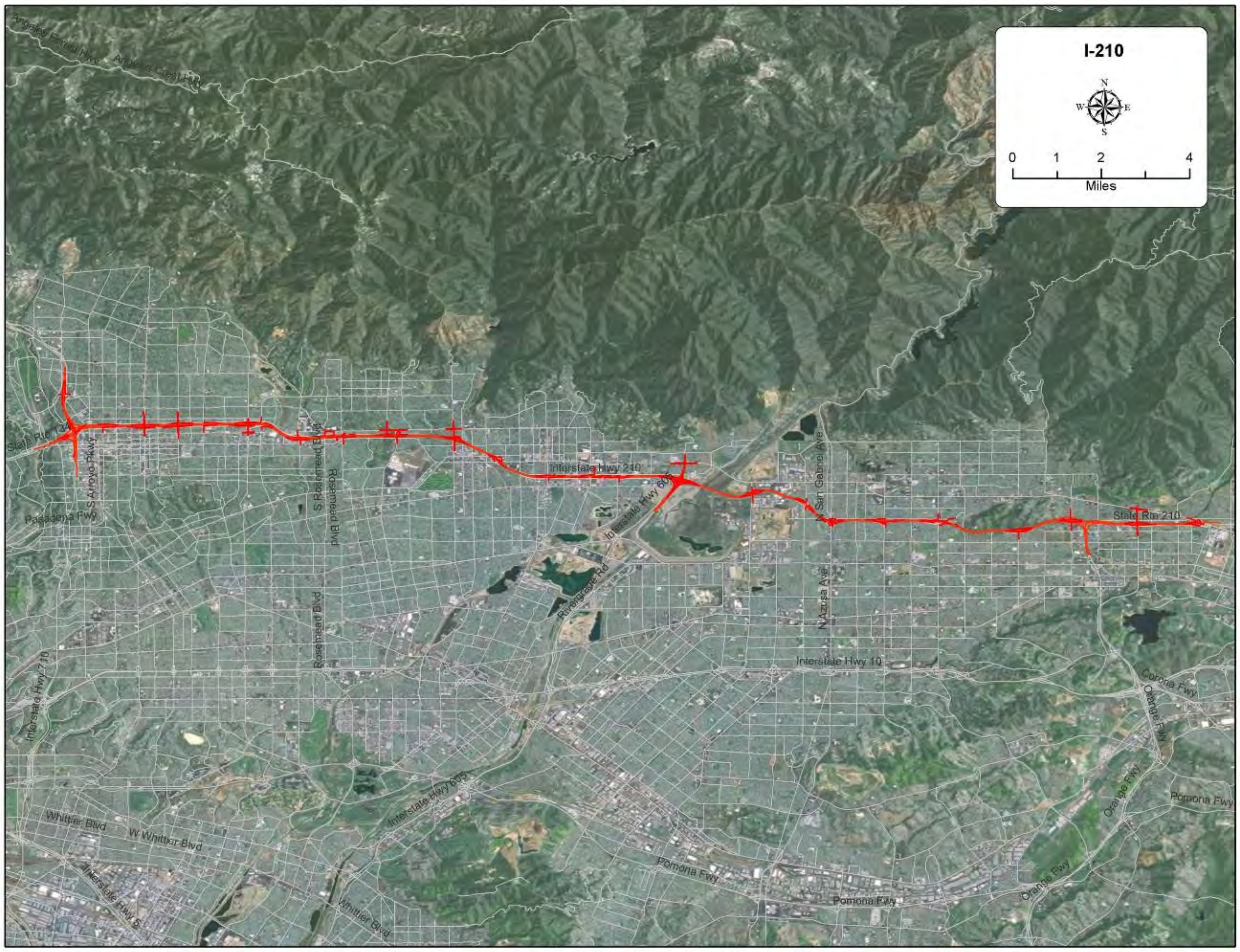
The study team developed a traffic model using the VISSIM micro-simulation software. It is important to note that micro-simulation models are complex to develop and calibrate for a large urban corridor. However, they are one of the only tools capable of providing a reasonable approximation of bottleneck 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 2006 conditions. This was a resource intensive effort, requiring several iterations of submittals and review cycles until the model reasonably matched bottleneck locations and relative severity. Once Caltrans approved the calibrated base year model, a 2020 model was developed based on SCAG's travel demand model demand 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 5-1 shows the model network. There were no parallel arterials modeled with the exception of arterials at interchanges. All freeway interchanges were included as well as on-ramps and off-ramps.

Exhibit 5-1: Micro-Simulation Model Network



Scenario Development Framework

The study team developed a framework to combine projects into scenarios. Ideally, it is desirable to evaluate every possible combination of projects, but this would require thousands of model runs. Instead, the team combined projects based on a number of factors, including:

- Projects that were fully constructed and completed from 2006 to 2010 were tested with both the 2006 and 2020 models
- Short- and mid- term operational projects were grouped into scenarios and tested with the both the 2006 and 2020 models
- Longer-range projects to be delivered by 2020 and beyond were used to develop scenarios to be tested with the 2020 model only
- Alternative ramp closures were grouped into isolated scenarios (future scenarios did not build on top of these) and tested with both the 2006 and 2020 models.

The study assumes that projects delivered before 2015 could reasonably be evaluated using the 2006 base year model. The 2020 forecast year for the I-210 study was consistent with the 2020 SCAG regional travel demand model origin-destination matrices used to develop the 2008 Regional Transportation Plan (RTP). When SCAG updates its travel demand model and RTP, it 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 RTP, and other sources such as special studies. Projects that do not directly affect mobility were eliminated. For instance, sound wall, landscaping, or minor arterial improvement projects were not evaluated since micro-simulation models cannot evaluate them.

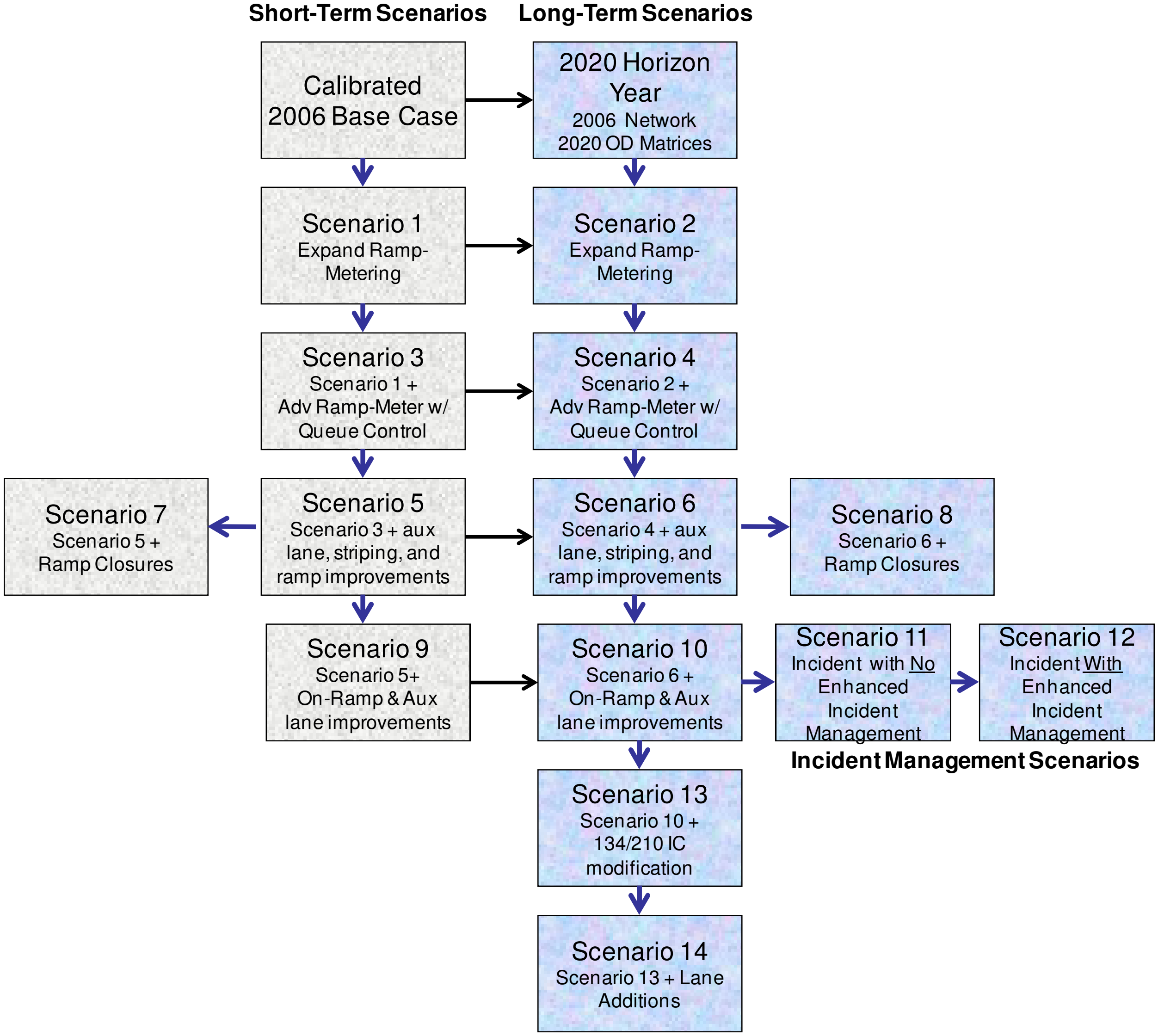
Scenario testing performed for the I-210 CSMP differed from traditional "alternatives evaluations" done for Major Investment Studies (MIS) or Environmental Impact Reports (EIRs). An MIS or EIR focuses on identifying alternative solutions to address current or projected corridor problems, so each alternative is evaluated separately and results among competing alternatives are compared resulting in a locally preferred alternative.

In contrast, for the I-210 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 5-2 summarizes the approach, the scenarios tested, and provides a general description of the projects included in the 2006 and 2020 micro-simulation runs. Most projects were tested for both the short- and long-term timeframes. Each scenario tested was built upon prior scenarios except for Scenarios 7 and 8, which were "stand alone" scenarios used to test alternative ramp closures.

Later scenarios build on Scenarios 5 and 6 and do not include the improvements tested in Scenarios 7 and 8. Enhanced incident management was tested in Scenarios 11 and 12 by comparing a simulated incident without and with enhanced incident management system. Scenarios 13 and 14 are expected for the longer term and were tested only with the 2020 model.

Exhibit 5-2: Micro-Simulation Modeling Approach



Scenario Evaluation Results

Exhibits 5-3 and 5-4 show the delay results for all the 2006 scenarios evaluated for the AM and PM peak periods, respectively. Exhibits 5-5 and 5-6 show similar results for scenarios evaluated using the 2020 horizon year model. The percentages shown in the exhibits indicate the difference in delay between the current scenario and the previous scenario (e.g., Percent Change = (Current Scenario-Previous Scenario)/Previous Scenario). Impacts of strategies differ based on a number of factors such as traffic flow conditions, ramp storage, bottleneck locations, and levels of congestion.

Exhibits 5-7 through 5-10 summarize the delay results of the 2006 base year model by bottleneck area for the eastbound and westbound directions and for each peak period. The delay results of the 2020 horizon year model are summarized in Exhibits 5-11 through 5-14.

For each scenario, the modeling team produced results by facility type (i.e., mainline, HOV, arterials, and ramps) and vehicle type (SOV, HOV, trucks) as well as speed contour diagrams. The study team scrutinized the results to ensure that they were consistent with general traffic engineering principles.

A traffic report with all the model output details is available under separate cover.

Exhibit 5-3: 2006 AM Peak Micro-Simulation Delay Results by Scenario

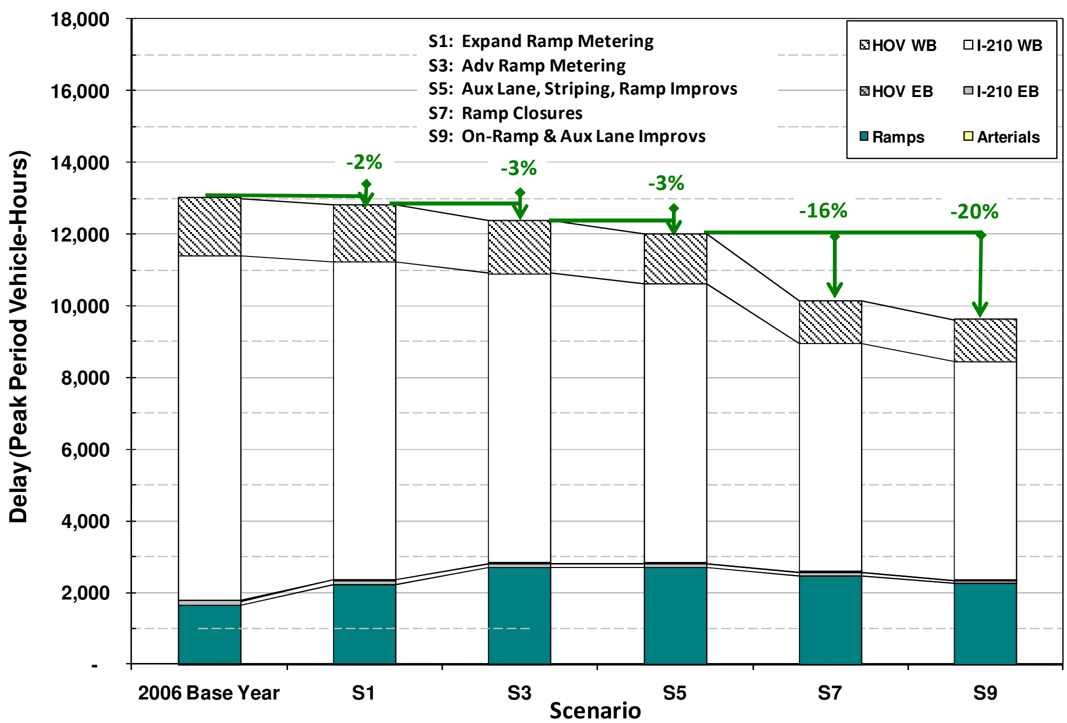


Exhibit 5-4: 2006 PM Peak Micro-Simulation Delay Results by Scenario

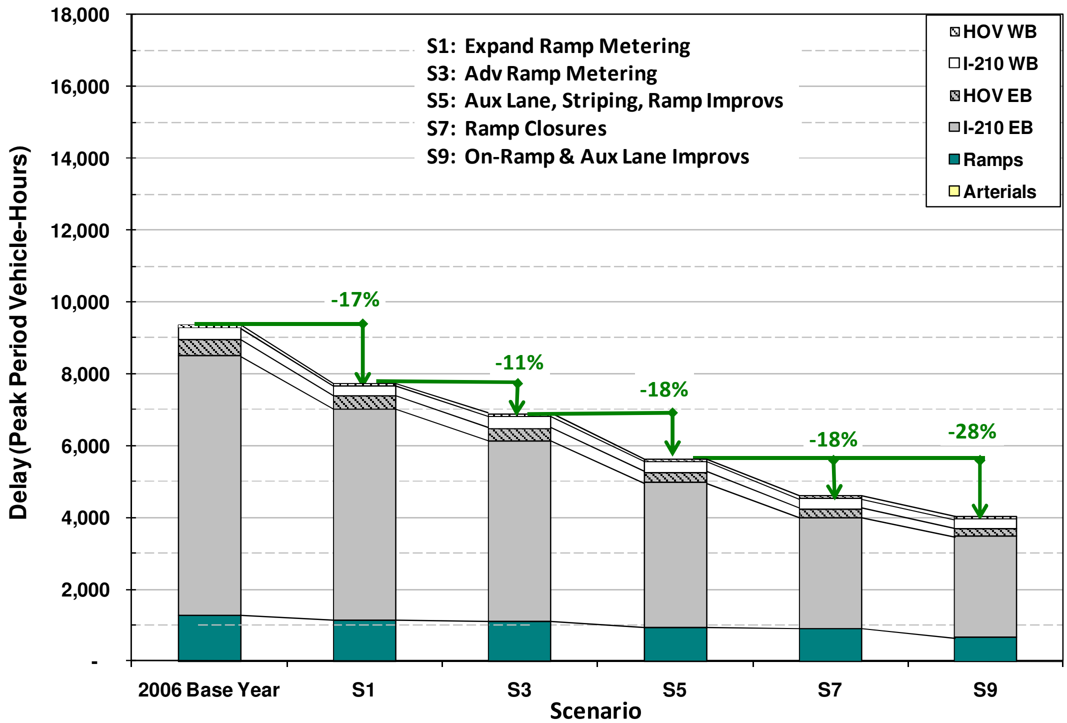


Exhibit 5-5: 2020 AM Peak Micro-Simulation Delay Results by Scenario

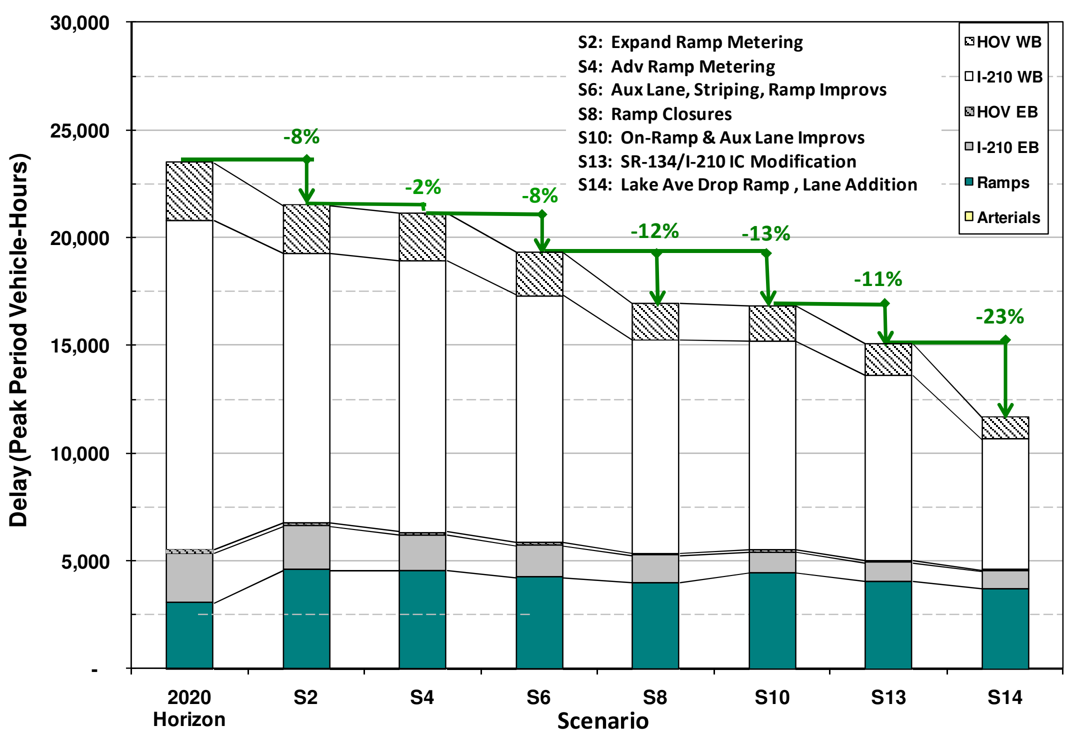


Exhibit 5-6: 2020 PM Peak Micro-Simulation Delay Results by Scenario

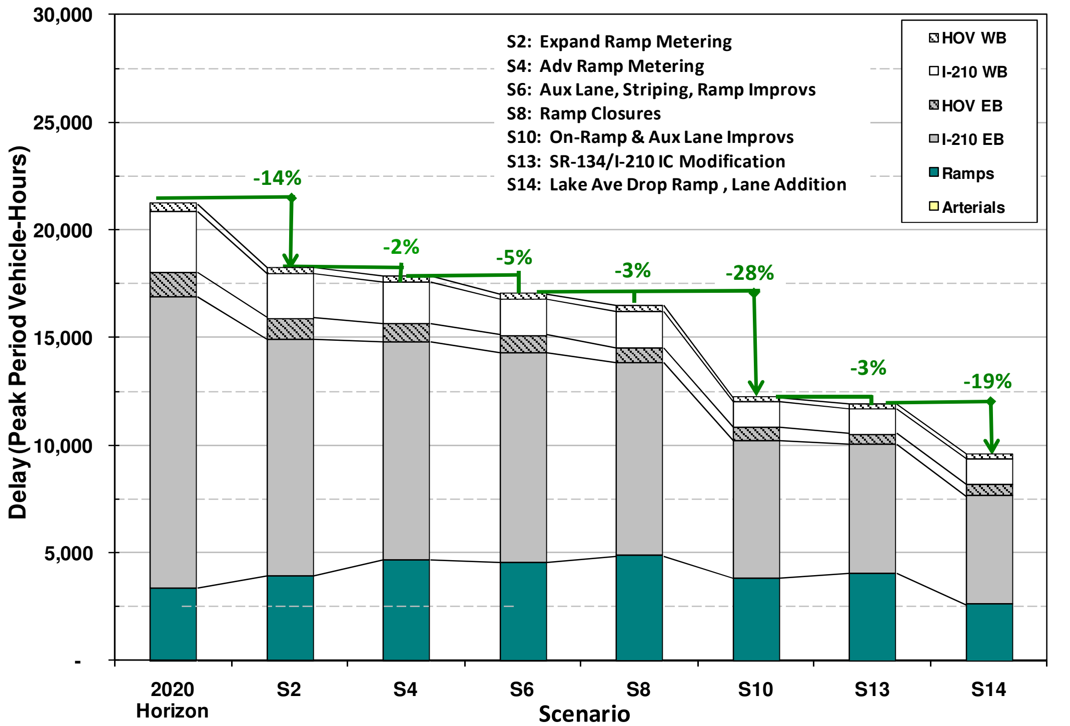


Exhibit 5-7: 2006 Eastbound AM Delay Results by Scenario and Bottleneck Area

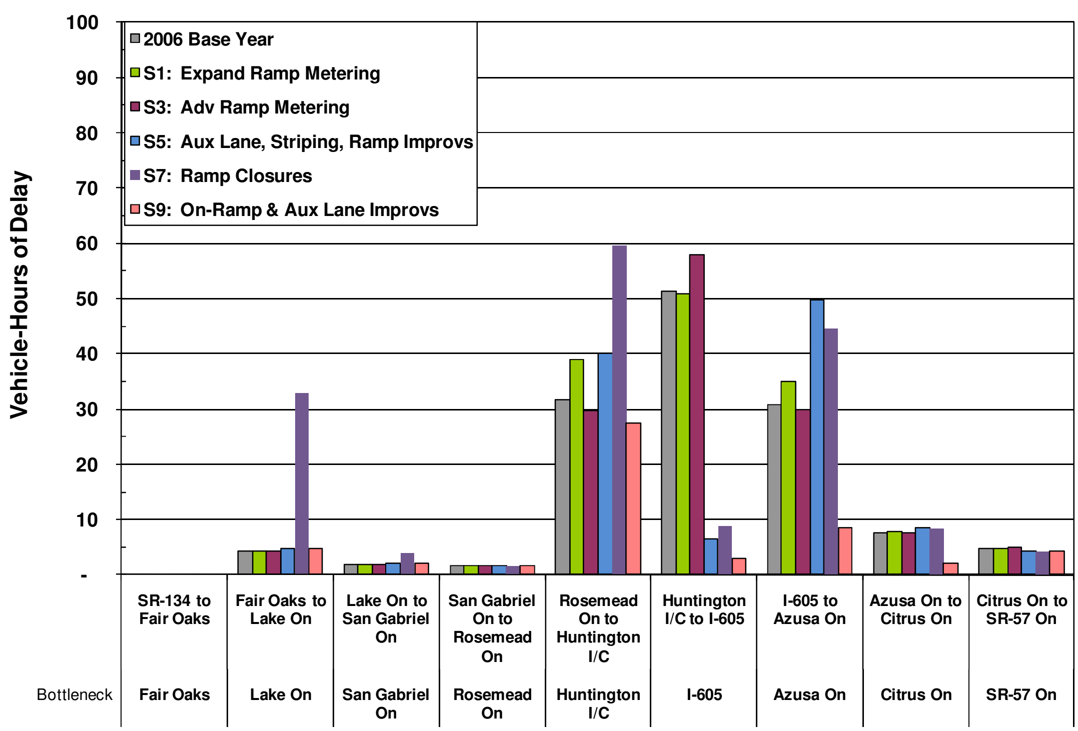


Exhibit 5-8: 2006 Eastbound PM Delay Results by Scenario and Bottleneck Area

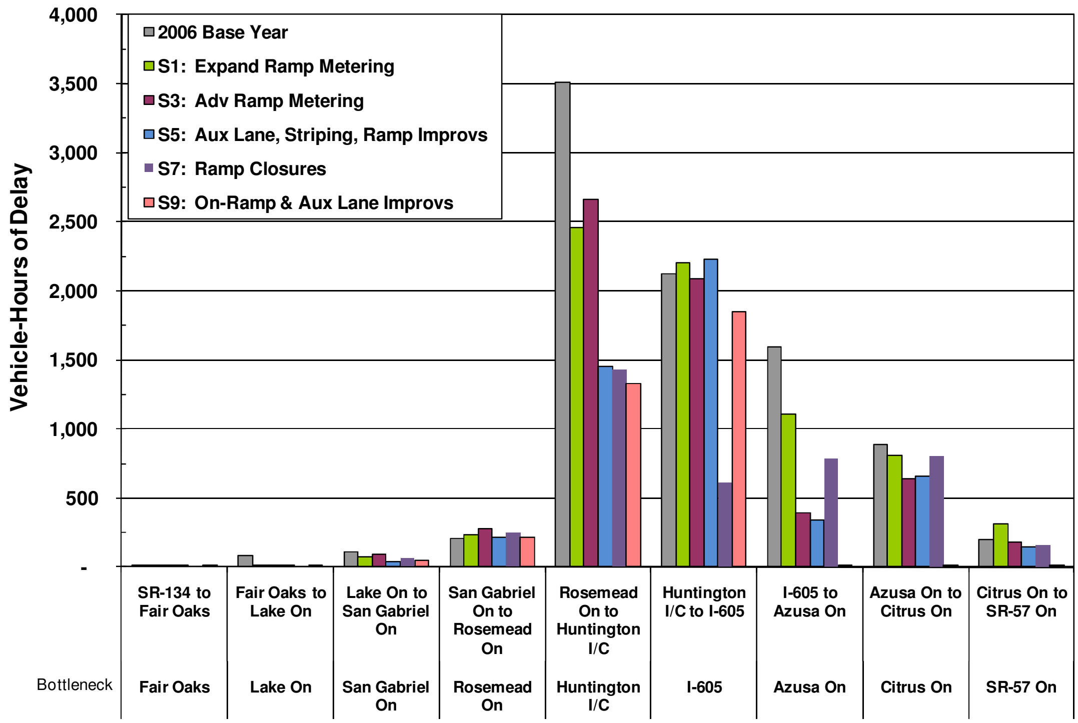


Exhibit 5-9: 2006 Westbound AM Delay Results by Scenario and Bottleneck Area

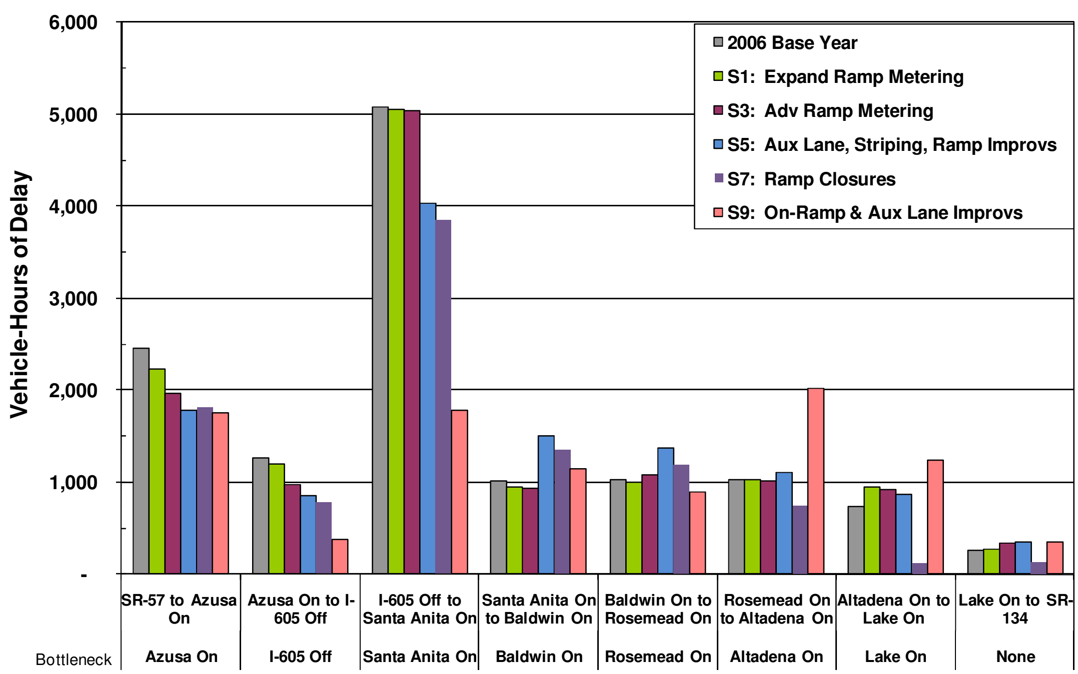


Exhibit 5-10: 2006 Westbound PM Delay Results by Scenario and Bottleneck Area

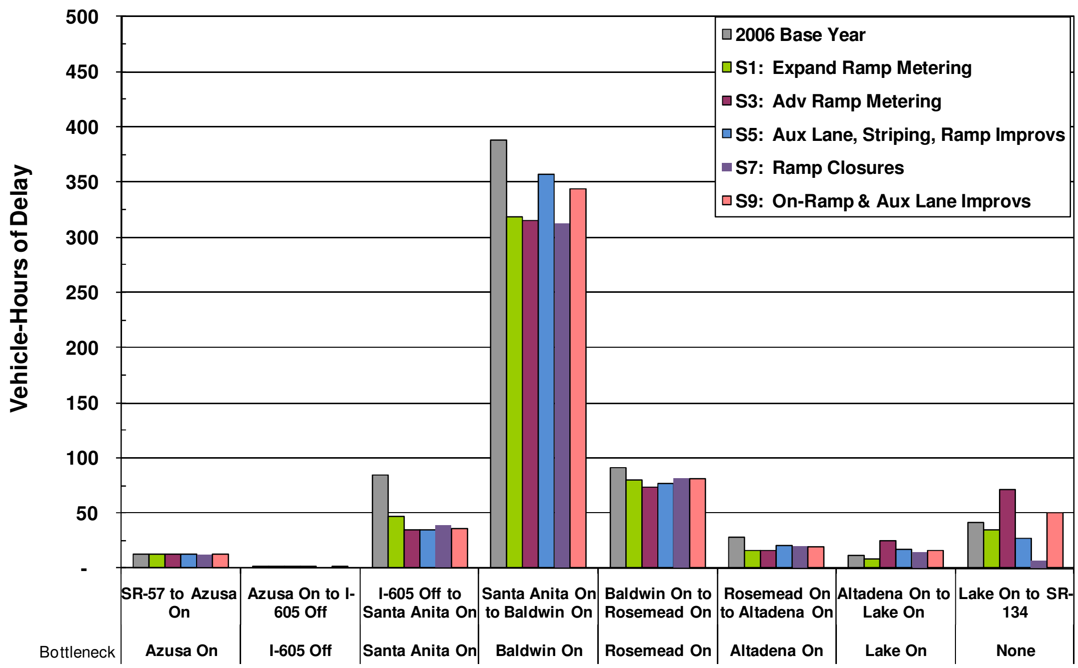


Exhibit 5-11: 2020 Eastbound AM Delay Results by Scenario and Bottleneck Area

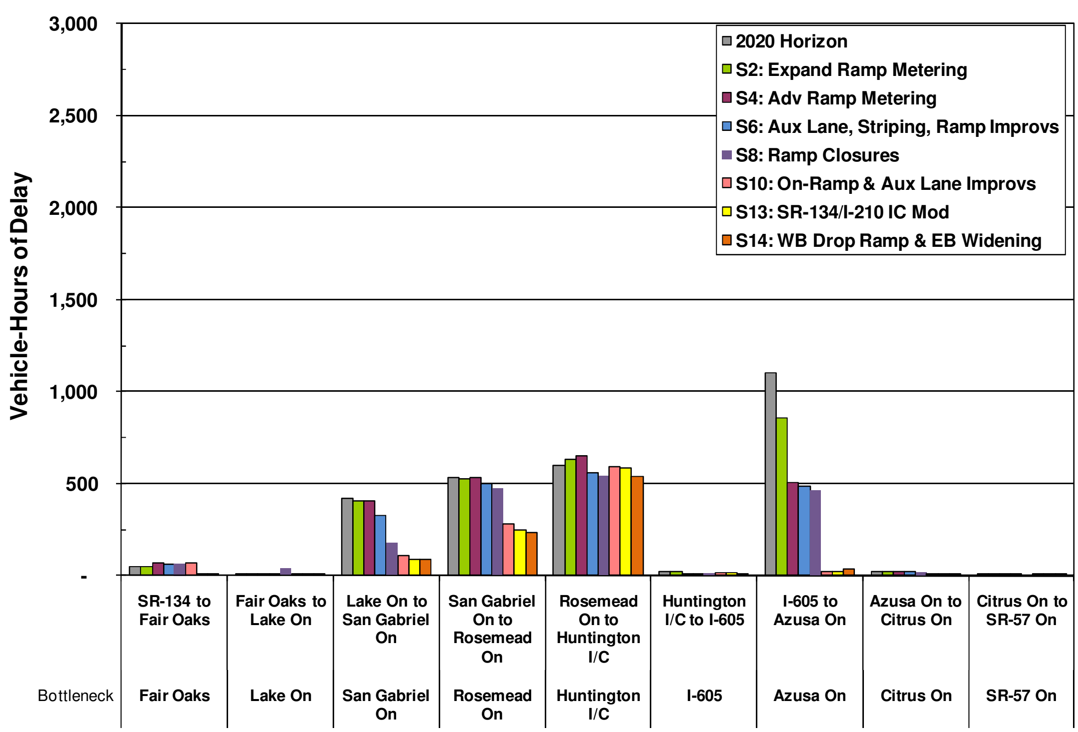


Exhibit 5-12: 2020 Eastbound PM Delay Results by Scenario and Bottleneck Area

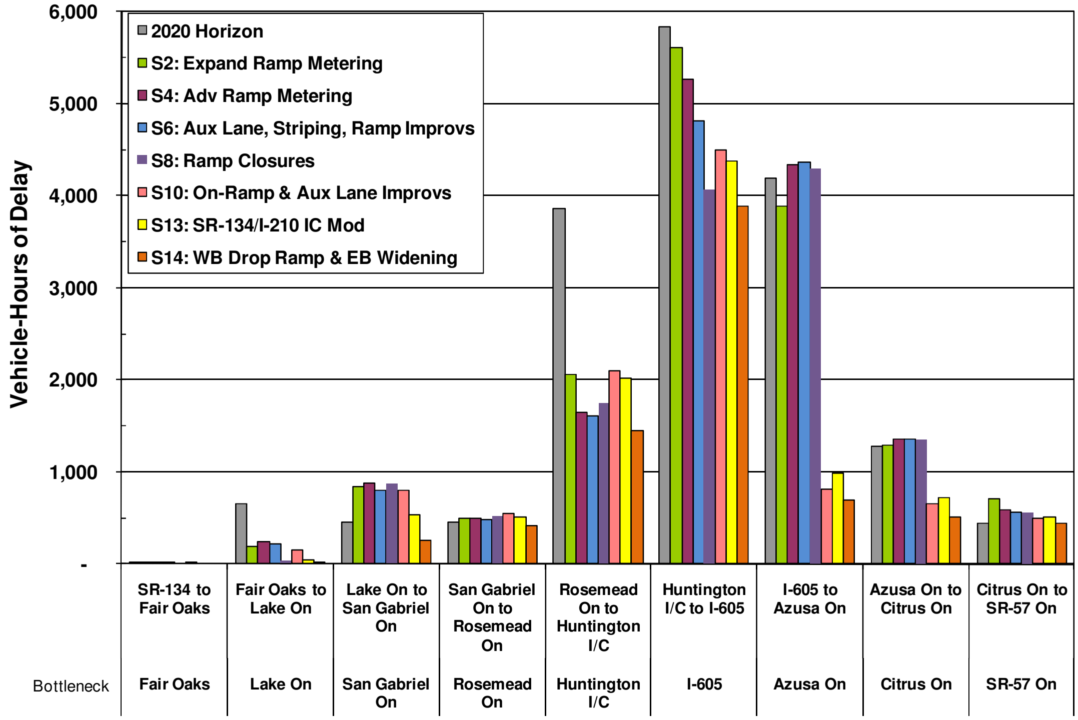


Exhibit 5-13: 2020 Westbound AM Delay Results by Scenario and Bottleneck Area

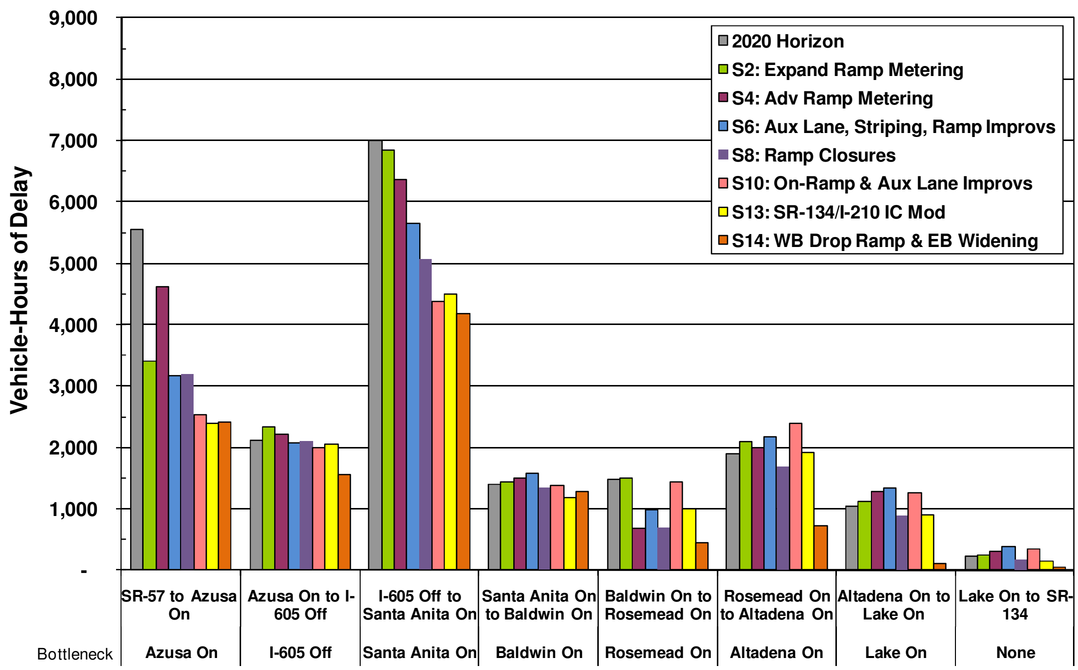
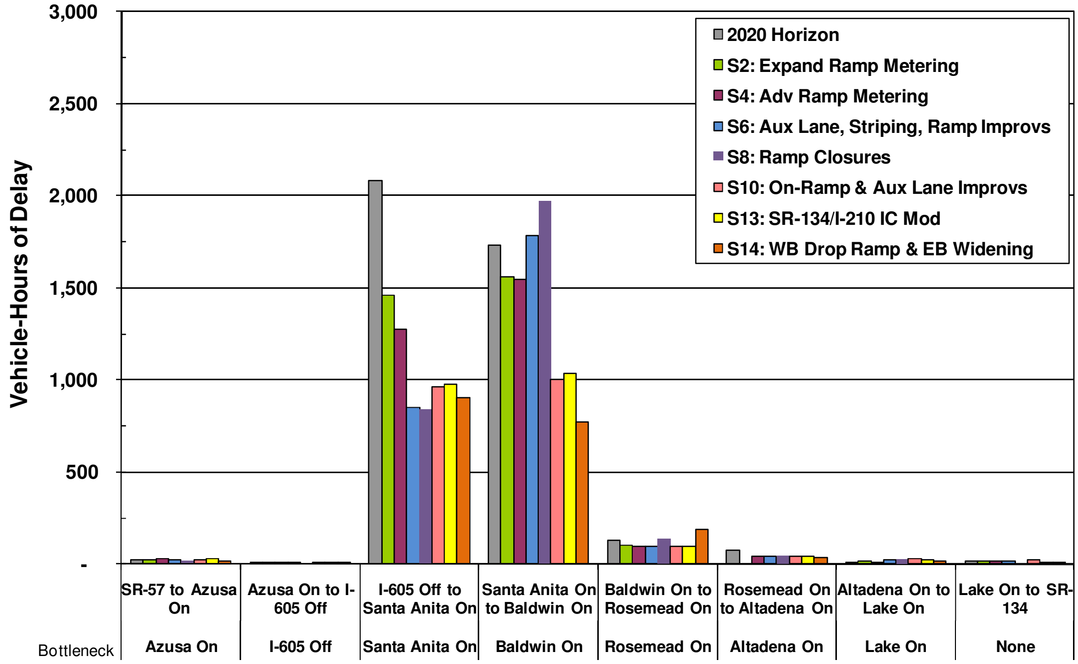


Exhibit 5-14: 2020 Westbound PM Delay Results by Scenario and Bottleneck Area



Base Year and "Do Minimum" Horizon Year

Absent any physical improvements, the modeling team estimates that by 2020, total delay (mainline, HOV, ramps, and arterials) would double compared to 2006 (from a total of around 22,000 vehicle-hours daily to just fewer than 45,000 vehicle-hours) in the combined AM and PM peak.

Scenarios 1 and 2 (Expand Ramp Metering)

Scenarios 1 and 2 test the only project on the corridor that was fully constructed and completed. The project installed new connector metering at the SR-57 and I-605 to I-210 freeway connector ramps. The project also widened various ramps, removed various HOV meter bypasses, and upgraded the ramp metering system.

The 2006 model estimates that Scenario 1 would reduce delay on the corridor by around 17 percent (or 1,600 daily vehicle-hours) in the PM peak period, but only around two percent (or 200 vehicle-hours) in the AM peak period. The biggest benefits occur in the PM eastbound direction from Rosemead On-Ramp to Huntington interchange (with a delay reduction of over 1,000 vehicle-hours) as well as from I-605 to the Azusa On-Ramp (delay reduction of 500 vehicle-hours) for single occupant vehicles. The westbound reductions in freeway delay are largely offset by increased on-ramp delay mostly from new connector metering at SR-57 and I-605.

The 2020 model estimates that Scenario 2 will reduce delay by around 8 percent in the AM peak and 14 percent in the PM peak, for a combined total reduction of 5,000 daily vehicle-hours. The long-term improvements are less than the short-term improvements due to the increase in demand.

Scenarios 3 and 4 (Advanced Ramp Metering)

Scenarios 3 and 4 build on Scenarios 1 and 2 by adding advanced ramp metering system such as dynamic or adaptive ramp metering system.

The 2006 model shows that Scenario 3 would reduce delay by an additional 850 daily vehicle-hours (or 11 percent) in the PM peak with a marginal reduction in the AM peak period. However, in conjunction with Scenario 1, Scenario 3 reduces delay in total by over 600 vehicle-hours in the AM peak. These results suggest that queue control provides additional benefits beyond SWARM.

The 2020 model estimates that Scenario 4 will modestly reduce delay by about 2 percent in either the AM and PM peaks, or a combined total of 800 daily vehicle-hours. Again, the benefits are lower in percentage terms due to the increase in demand.

Note that there are various types of advanced ramp metering systems deployed around the world, including System-wide Adaptive Ramp Metering System or SWARM tested recently in Los Angeles I-210 freeway corridor. For the I-210 model, the Asservissement Lineaire d'Entrée Autoroutiere (ALINEA system) was tested as a proxy for any advanced ramp metering system, as its algorithm for the model was readily available. It is not necessarily recommended that ALINEA be deployed but rather some type of advanced ramp metering system that would produce similar, if not better results.

Scenarios 5 and 6 (Auxiliary Lane, Striping, Ramp Improvements)

Scenarios 5 and 6 build on Scenarios 3 and 4 that include several relatively lower-cost operational improvements that could be implemented by 2015:

- Building a westbound auxiliary lane from Santa Anita to Baldwin and an eastbound auxiliary lane from Santa Anita to Huntington
- Extending a lane to Lincoln on the westbound I-210 connector
- Connecting and converging the Altadena on-ramps into a single on-ramp
- Connecting and converging the Santa Anita on-ramps into a single on-ramp
- Connecting and converging the Irwindale on-ramps into a single on-ramp
- Restriping to add a lane in the eastbound direction from San Dimas to Fruit.

The 2006 model shows that Scenario 5 reduces delay by 3 percent (nearly 400 vehicle-hours) in the AM peak and 18 percent (1,200 vehicle-hours) in the PM peak. The segment that experienced the largest improvement in the eastbound during the PM peak was from Rosemead to Huntington. This segment experienced a 45 percent improvement in delay (from 2,700 vehicle-hours to 1,500 vehicle-hours), which is likely attributed to the eastbound auxiliary lane from Santa Anita to Huntington. In the westbound direction, the auxiliary lane from Santa Anita to Baldwin shifts some traffic downstream to cause increased congestion at Michillinda (i.e., bottleneck shift) during the westbound AM peak. However, the auxiliary lane helps reduce both queue length and queue duration for the Santa Anita bottleneck.

The 2020 model estimates that Scenario 6 would reduce delay by 8 percent in the AM peak and 5 percent in the PM peak, for a total reduction of 2,500 daily vehicle-hours. A reduction in PM delay is expected to occur mostly in the westbound direction.

Scenarios 7 and 8 (Ramp Closures)

Scenarios 7 and 8 build on Scenarios 5 and 6 and test the closure of several ramps:

- Eastbound Marengo on-ramp and westbound Lake on-ramp with signalization of the eastbound I-210 off-ramp at Maple and improvement to alternate routes along Corson and Maple
- Eastbound Mount Olive ramps.

Note that subsequent scenarios are not built on top of these scenarios, as these are isolated to test ramp closure alternatives.

The 2006 model shows that Scenario 7 would reduce delay significantly by 16 percent in the AM peak and 18 percent in the PM peak, for a total delay reduction of nearly 3,000 daily vehicle-hours. The delay reductions are significant on the mainline during the peak direction of travel – 1,400 vehicle-hours in the westbound AM and 912 vehicle-hours in the eastbound PM. In the westbound direction and AM peak period, the segment from Altadena to Lake experienced over an 85 percent decrease in congestion (from 860 to 120 vehicle-hours of delay). This is likely attributed to the closure of the westbound Lake on-ramp. In the eastbound direction and PM peak period, the segment from Huntington to I-605 experienced a delay reduction of over 70 percent (from 2,200 vehicle-hours to 600 vehicle-hours), which is likely attributed to the closure of the Mount Olive ramp.

The 2020 model also shows that Scenario 8 improved delay by 12 percent in the AM and 3 percent in the PM, for a total delay reduction of almost 3,000 daily vehicle-hours. On the mainline facility, delay also improved for each peak direction of travel – by 1,600 daily vehicle-hours in the westbound AM and by 750 vehicle-hours in the eastbound PM. Delay reductions in the non-peak direction were not as significant.

Scenarios 9 and 10 (On-ramp and Auxiliary Lane Improvements)

Scenarios 9 and 10 build on Scenarios 5 and 6 and test four operational improvements that can be implemented in the short- to medium-term range:

- Modify the Rosemead/Michillinda interchange and converge the westbound I-210 on-ramps
- Modify the north side of the Baldwin interchange and eliminate the collector-distributor
- Construct an eastbound auxiliary lane from Azusa to Citrus
- Converge the eastbound Citrus on-ramps and add an auxiliary lane to Grand

The 2006 model estimates that Scenario 9 will reduce delay by 20 percent (or 2,400 daily vehicle-hours) in the AM peak and 28 percent (or 1,600 daily vehicle-hours) in the PM peak compared to Scenario 5. In both AM and PM peak period, the eastbound direction experienced the largest reduction in delay.

The 2020 model estimates that Scenario 10 will reduce delay by 13 percent (or 2,500 vehicle-hours) in the AM peak and 28 percent in the PM peak (or 4,800 vehicle-hours) compared to Scenario 6. Similar to the 2006 model, the 2020 model shows that these improvements produced a greater reduction in delay in the eastbound direction than the westbound direction.

Scenarios 11 and 12 (Enhanced Incident Management)

Two incident scenarios were tested on top of Scenario 10 to evaluate the non-recurrent delay reductions resulting from enhanced incident management strategies. An enhanced incident management system would entail upgrading or enhancing the current Caltrans incident management system that includes deployment of intelligent transportation system (ITS) field devices, central control/communications software, communications medium (i.e. fiber optic lines), advanced traveler information system, and/or freeway service patrol (FSP) program to reduce incident detection, verification, response, and clearance times.

In the first scenario, Scenario 11, one collision incident with one lane closure was simulated in the westbound direction in the AM peak period model and one in the eastbound direction in the PM peak period model. The incident simulation location and duration were selected based on review of the 2010 actual incident data, at one of the high frequency locations. The following are the Scenario details:

- Westbound AM peak period starting at 8:00 AM, close mainline lane #2 for 40 minutes at absolute post mile 26.12 (at Lake Avenue)
- Eastbound PM peak period starting at 5:00 PM, close mainline lane #2 for 50 minutes at absolute post mile 32.07 (west of Santa Anita)

In the second scenario, Scenario 12, the same collision incidents were simulated with a reduction in duration by 10 minutes in the westbound direction and by 12 minutes in the eastbound direction. 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. This scenario represents a typical moderate level 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 lasting only a few minutes without lane closures that can result in congestion. Many other incidents also occur during off-peak hours.

As indicated in Exhibits 5-15 and 5-16, without enhanced incident management, Scenario 11 produced an 8 percent increase in congestion in both peak periods over Scenario 10, an increase of over 2,300 hours of vehicle delay. With enhanced incident management, Scenario 12 evaluation resulted in delay decrease by 2 percent in the AM peak and 3 percent in the PM peak against Scenario 11 results, a reduction of nearly 750 vehicle-hours for improving the incident detection, verification, response, and clearance time of one moderate level incident for both of the peak hours.

Exhibit 5-15: 2020 AM Delay Results for Enhanced Incident Management Scenarios

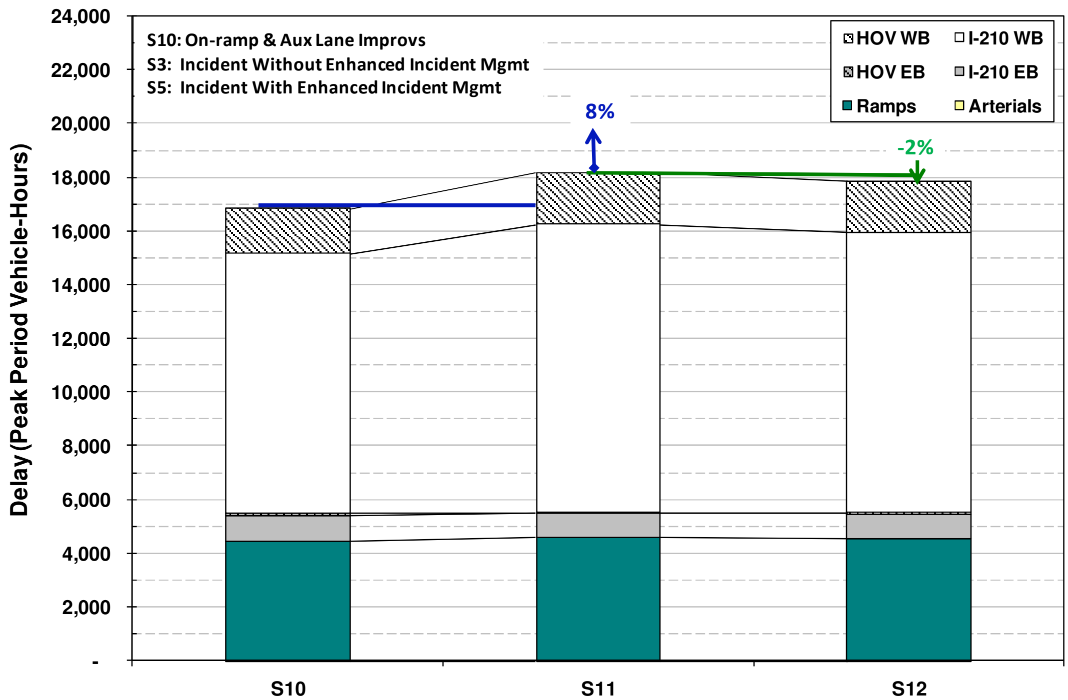
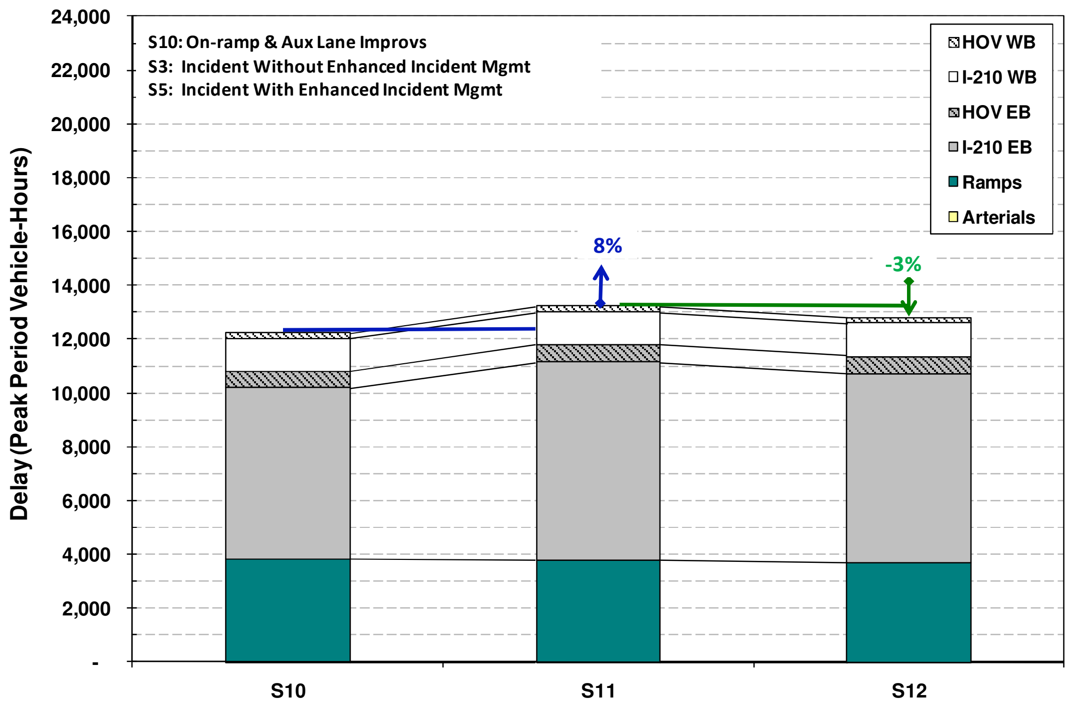


Exhibit 5-16: 2020 PM Delay Results for Enhanced Incident Management Scenarios



Scenario 13 (SR-134/I-210 Interchange Modification)

Scenario 13 tests an improvement to modify the SR-134/I-210 interchange to provide a direct connection for vehicles to continue on I-210 with three lanes in each direction. This improvement was tested with the 2020 model since it is not likely to be implemented in the short-term.

The 2020 model estimates that delay would be reduced by 11 percent (or 1,800 daily vehicle-hours) in the AM and 3 percent in the PM (320 daily vehicle-hours) compared to Scenario 10. The westbound mainline experienced the greatest reduction in delay in the AM peak from 9,600 vehicle-hours to 8,600 vehicle hours after the interchange modification.

Scenario 14 (Westbound Drop Ramp and Eastbound Widening)

Scenario 14 builds on Scenario 13 and tests Lake Avenue drop ramp to westbound I-210 center lanes (one HOV lane and one mainline) and eastbound I-210 widening from Myrtle to I-605. This improvement was tested with the 2020 model.

The 2020 model estimates that delay would be reduced by about 20 percent in the AM or 3,400 vehicle-hours and 20 percent in the PM or 2,300 vehicle-hours, compared to Scenario 13. The mobility improvements are significant with the westbound drop ramp that reduces weaving between traffic destined for SR-134 and I-210 and with the eastbound capacity addition to I-605 off that moves the off-ramp traffic away from the mainline and provides more room for the mainline through traffic.

Post Scenario 14 Conditions

By 2020, with the inclusion of all the projects tested, the model reveals some residual congestion that remains to be addressed with future improvements. According to the model results, the total remaining delay on the corridor is around 21,000 daily vehicle-hours.

Benefit-Cost Analysis

Following an in-depth review of model results by the study team and the SCAG technical committee, the study team performed a benefit-cost analysis (BCA) for each scenario.

Using the California Benefit-Cost Model (Cal-B/C) developed on behalf of Caltrans by the study team; benefits in three key areas were estimated: travel time savings, vehicle operating cost savings, and emission reduction savings. The benefits generated from this exercise are based solely on congestion relief related benefits. However, these results are conservative since there are other benefits not captured by this analysis, including benefits from deploying bus rapid transit, which will achieve other accessibility benefits.

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 greater than one means that a scenario's projects return greater benefits than it costs to construct or implement. It is important to consider the total benefits that a project brings. For example, a large capital expansion project can cost a great deal and have a low B/C ratio, but brings much higher absolute benefits to the I-210 users.

Exhibit 5-17 illustrates typical benefit-cost ratios for different project types. Large capital expansion improvements generally produce low benefit-cost ratios because the costs are so high. Conversely, transportation management strategies such as ramp metering produce high benefit-cost ratios given their low costs.

The benefit-cost results for the I-210 scenarios are shown in Exhibit 5-18.

Exhibit 5-17: Benefit-Cost Ratios for Typical Projects

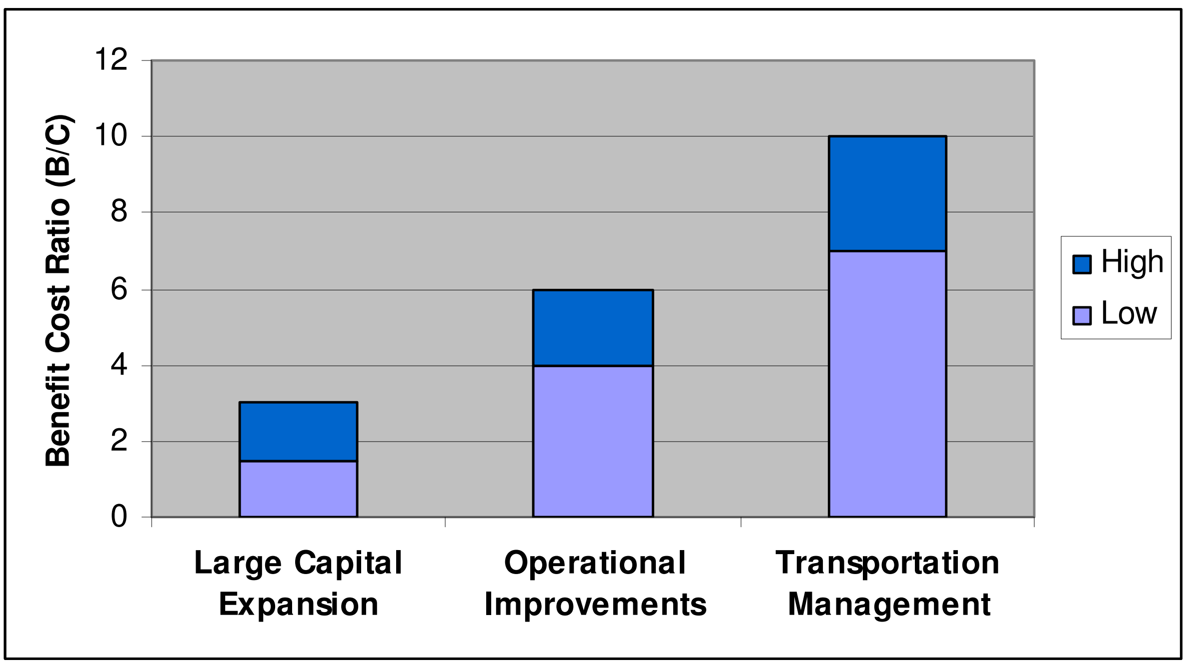
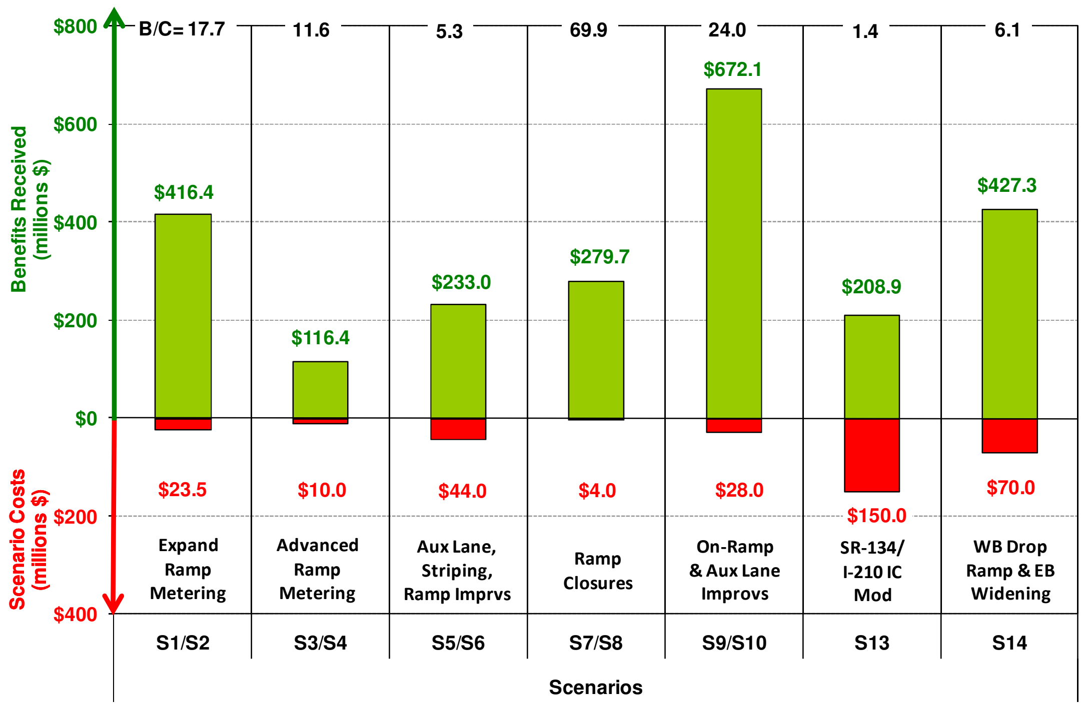


Exhibit 5-18: I-210 Scenario Benefit/Cost (B/C) Results



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

- Scenarios 1 and 2 (ramp metering expansion) shows a high benefit-cost ratio of over ten. The relatively high benefit-cost ratio is due to the low cost of expanding ramp metering ($23.5 million).
- Scenarios 3 and 4 (advanced ramp metering) resulted in an incremental benefit-cost ratio of over ten. This is relatively high as compared to that of typical transportation management system projects.
- Scenarios 5 and 6 (operational improvements) produced a benefit-cost ratio of over five. This is relatively consistent with other typical operational improvement projects. The benefits are substantial. At an estimated total cost of about $44 million, these projects produced benefits of over $233 million.
- Scenarios 7 and 8 tested the ramp closures at eastbound Marengo, westbound Lake, and eastbound Mount Olive. These ramp closures produced an extremely high incremental benefit-cost ratio of over ten, due to the relatively very low cost. However, this benefit-cost calculation does not account for any potential increase in delay on various local arterials because of detours from the closed ramps.
- Scenarios 9 and 10 also produced a relatively high benefit-cost ratio of over ten. The four operational projects in these scenarios are collectively estimated to cost under $30 million and provide a substantial and optimistic benefit of over $670 million.

- Scenario 13 tested the SR-134/I-210 interchange modification. This project produced a benefit-cost ratio of between one and two, consistent with other typical capital expansion projects. This project produced benefits of over $200 million at a rough-estimate cost of about $150 million.
- Scenario 14 tested the westbound center drop ramp from Lake Avenue interchange and eastbound lane addition from Myrtle to I-605. These projects produced a relatively high benefit-cost ratio of about six to one, as compared to other capital improvement projects. These two capital projects are unique in that they have specific operational improvement elements that address major bottleneck locations. For an estimated total combined cost of about $70 million, the projected benefits exceed $420 million.

6. CONCLUSIONS AND RECOMMENDATIONS

This section summarizes the conclusions and recommendations based on the analysis discussed in the previous section. It is important to note that many of these conclusions are based primarily on the micro-simulation model results. The model was developed using the best available data at the time. The study team reviewed the model results and believes that the calibrated base year, forecast year, and scenario results are reasonable. However, caution should always be used when making decisions based on modeling alone, especially complex micro-simulation models.

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 below 2006 levels in both the AM and PM peak period. In the AM peak period, the model projects total 2020 delay to be less than 11,700 vehicle-hours compared to the 2006 base year delay of 13,000 vehicle-hours. This represents a reduction of over 10 percent. In the PM peak period, the model projects total delay in 2020 after project delivery to be around 9,500 vehicle-hours compared to the 2006 base year delay of almost 9,300 vehicle-hours. This represents a slight increase of two 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 2006.
- The completed ramp metering expansion project is expected to produce substantial mobility benefits of over $400 million. Delay has been significantly reduced since 2006.
- Advanced ramp metering could provide additional mobility improvements by significantly reducing congestion and returning over $100 million in benefits.
- Ramp closures at Marengo, Lake, and Mount Olive as alternatives seem promising by reducing delay up to 3,000 vehicle-hours per day and providing substantial benefits of $280 million at an extremely low cost.
- Operational improvements such as auxiliary lanes and ramp improvements could leverage on the ramp metering projects by making the corridor more efficient and productive that could result in additional mobility benefits of over $230 million.
- Additional capital improvements with specific operational elements to address weaving at major bottleneck locations could produce significant mobility benefits of over $420 million.
- Enhanced incident management system associated with Scenarios 11 and 12 to address non-recurrent congestion proved effective with a delay reduction of over 300 vehicle-hours for one modest level incident with a typical duration of 35

minutes reduced to 25 minutes. With the I-210 corridor experiencing up to 2,400 collisions per year, this translates to a total annual delay savings of over 700,000 vehicle-hours for the study corridor.

- The benefit-cost ratio of all scenarios combined is about 6.4 to 1. If all projects were delivered at current cost estimates, the public would get over six dollars of benefits for each dollar expended. In current dollars, costs total to over $1.7 billion whereas the benefits are estimated to be over $2.0 billion.
- The projects also alleviate greenhouse gas (GHG) emissions by over 1.5 million tons over 20 years, averaging over a 75,000-ton reduction per year. The emissions are estimated using data from the California Air Resources Board (CARB) EMFAC model.

Speed Contour Maps

Exhibits 6-1 and 6-2 are the westbound and eastbound I-210 corridor speed contour maps produced by the model for the 2020 baseline year. This represents 2020 conditions with only minimal improvements such as signal improvements at intersections. As shown, by 2020 there is significant congestion throughout the westbound corridor in the AM peak and eastbound corridor in the PM peak.

Exhibits 6-3 and 6-4 illustrate the westbound and eastbound I-210 corridor speed contour maps produced by the model at the conclusion of Scenario 14, the final scenario tested on recurrent congestion. These maps indicate the last remaining residual congestion and bottleneck locations. As shown, by 2020 there is still noticeable congestion in the westbound corridor from Citrus to Baldwin, although speeds have improved considerably throughout the corridor, in the AM peak. Along the eastbound corridor in the PM peak, there is still noticeable congestion at San Gabriel, Baldwin, I-605, and Azusa, although speeds have increased in this direction as well.

This is the first generation CSMP for the I-210 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.

Exhibit 6-1: 2020 Westbound I-210 AM Model Speed Contours at Baseline

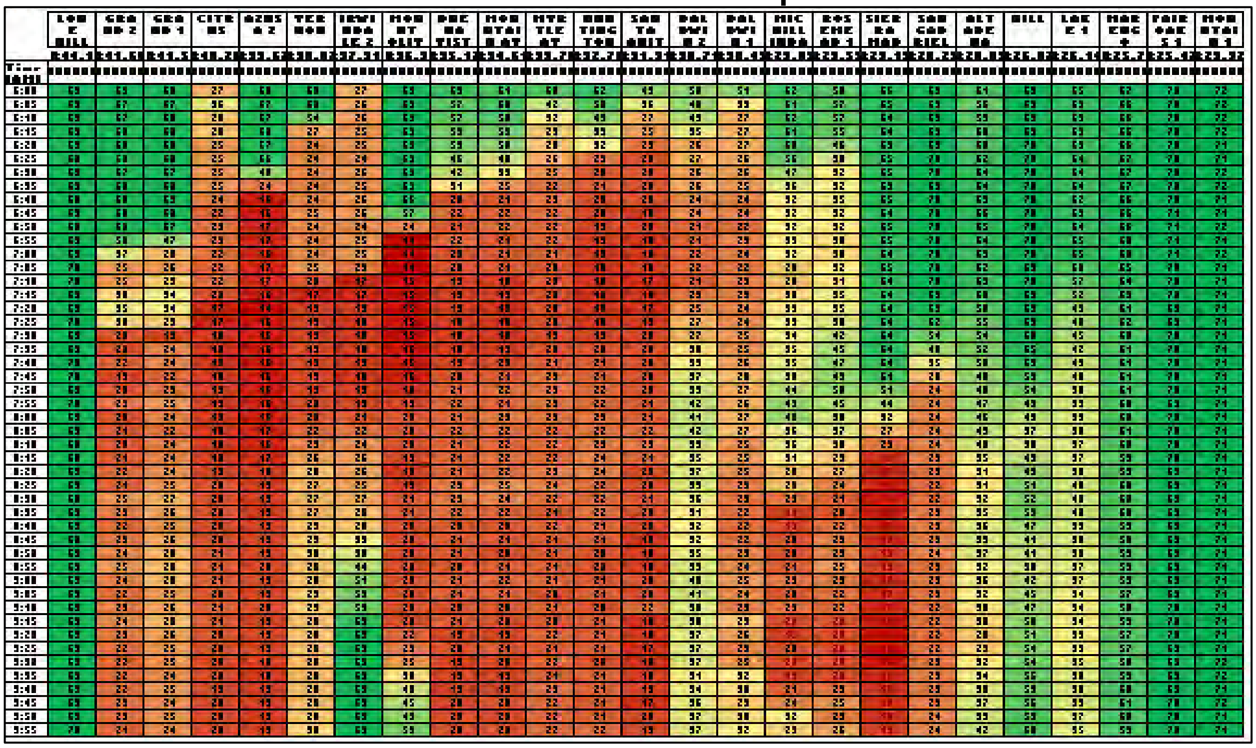


Exhibit 6-2: 2020 Eastbound I-210 PM Model Speed Contours at Baseline

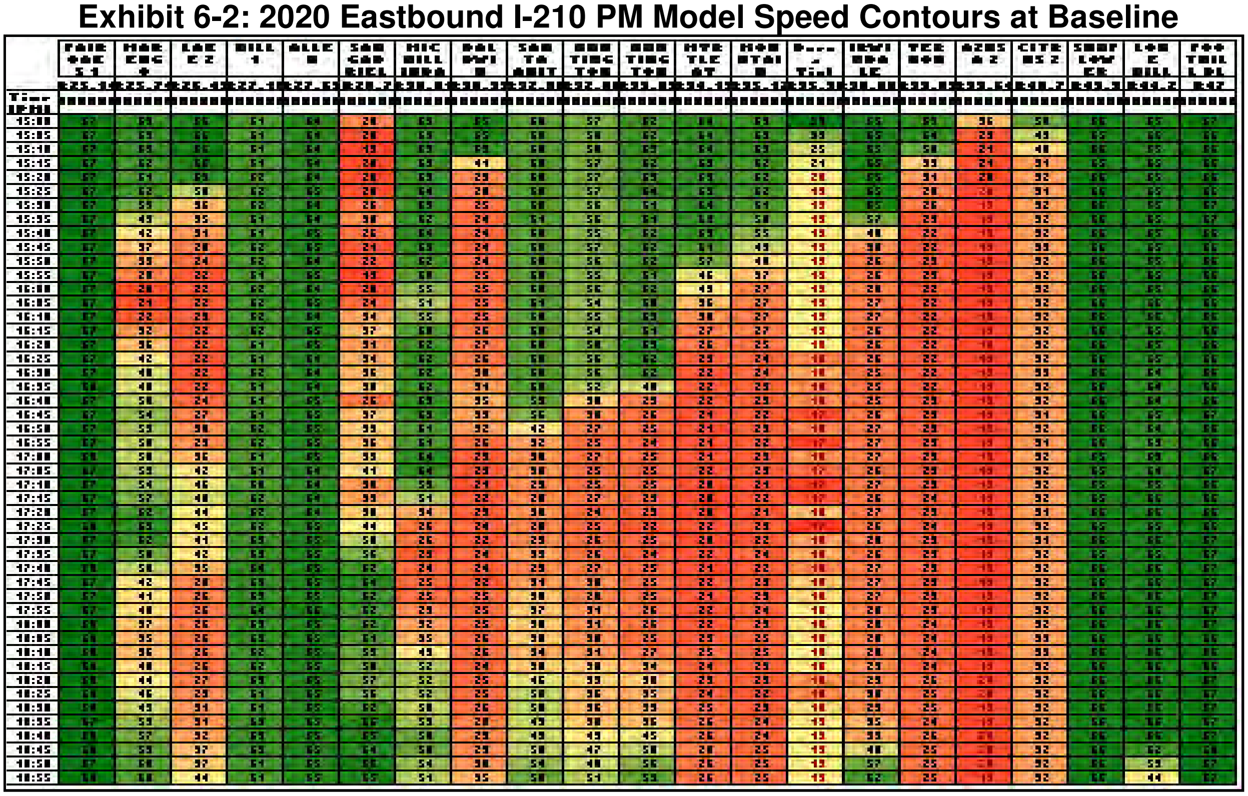


Exhibit 6-3: 2020 Westbound I-210 AM Model Speed Contours after Scenario 14

	LONE HILL AV	GRAND 2	GRAND 1	CITRUS	AZUSA 2	VERNON	IRWINDALE 2	MOUNT OLIVE DR / 605	BUENA VISTA	MOUNTAIN AV	MYRTLE AV	HUNTINGTON 1	SANTA ANITA 2	BALDWIN 2	BALDWIN 1	MICHILLINDA	ROSEMEAD 1	SIERRA MADRE V1	SAN GABRIEL	ALTADENA	HILL	LAKE 1	MARENGO	FAIR OAKS 1	MOUNTAIN 1
	R44.1	R41.68	R41.5	R40.26	R39.62	R38.87	R37.919	R36.3	R35.12	R34.61	R33.76	R32.76	R31.91	R30.71	R30.49	R29.85	R29.59	R29.19	R28.29	R28.05	R26.82	R26.14	R25.7	R25.42	R23.92
Time (AM)	718047	717688	717686	717685	717682	717676	717675	717673	761374	718210	761356	761342	764146	717664	717663	717661	717653	717649	717644	717642	717637	717634	764137	717630	717624
6:00	69	69	67	38	70	70	70	69	66	64	67	67	57	67	62	66	67	68	70	64	70	66	70	70	72
6:05	69	68	65	38	68	71	70	69	66	62	62	65	54	64	45	65	66	68	69	63	69	66	69	70	72
6:10	69	67	67	37	65	71	70	69	65	63	61	64	51	63	28	65	66	68	69	64	69	64	69	70	72
6:15	69	66	67	37	63	71	70	69	64	60	58	62	50	44	29	65	66	68	69	63	69	65	69	70	72
6:20	69	68	70	30	60	70	70	69	66	63	51	50	52	33	30	66	66	67	69	63	69	64	69	70	71
6:25	69	70	69	22	60	70	70	68	63	60	45	44	40	32	29	66	67	69	70	63	70	63	69	70	72
6:30	69	67	66	24	40	70	70	64	61	56	37	42	27	31	30	67	67	68	70	64	70	65	69	70	72
6:35	68	70	67	24	39	70	70	60	46	52	34	34	23	32	32	66	66	68	69	64	70	64	70	71	72
6:40	69	68	65	24	39	70	69	46	39	44	27	23	23	33	31	65	65	68	70	64	70	63	69	71	72
6:45	69	68	65	24	39	70	70	50	37	37	24	22	23	34	34	66	66	69	70	64	70	65	69	71	72
6:50	69	69	67	24	39	70	70	48	28	25	23	22	25	34	32	67	67	68	70	64	70	65	70	71	72
6:55	69	69	63	24	40	70	70	42	23	21	23	23	24	33	33	66	67	68	70	63	70	63	69	71	71
7:00	69	66	60	24	39	70	70	36	23	21	23	22	23	34	31	65	66	68	69	64	70	65	69	71	71
7:05	70	66	61	23	39	70	70	28	23	21	23	21	21	34	32	66	66	68	69	61	69	63	68	70	71
7:10	70	66	64	24	39	70	69	25	22	21	22	20	21	35	30	65	67	68	69	59	68	56	68	70	71
7:15	69	67	68	25	38	70	63	22	22	19	21	21	21	35	30	66	67	67	69	55	69	54	67	70	71
7:20	70	70	67	25	39	70	41	21	21	19	22	20	22	34	29	66	67	68	69	58	68	54	67	70	71
7:25	69	68	66	25	39	65	29	22	22	20	22	21	24	35	29	65	66	67	68	53	68	56	67	70	71
7:30	69	67	69	26	38	55	26	23	21	20	22	21	26	34	29	65	66	67	68	43	68	57	68	70	71
7:35	70	66	67	27	39	37	22	23	22	20	22	22	26	37	29	66	67	68	68	40	68	54	67	70	71
7:40	70	69	65	43	35	29	21	25	22	20	22	23	26	37	30	65	66	67	63	40	68	53	66	70	71
7:45	69	65	66	30	31	27	18	24	22	21	23	23	29	37	30	65	66	67	63	42	67	56	67	70	71
7:50	70	66	65	36	27	27	17	25	23	21	24	24	30	35	28	65	66	67	54	42	68	56	67	70	71
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8:15	68	69	67	30	26	30	21	27	26	34	27	26	34	37	30	64	66	67	39	44	62	52	65	70	71
8:20	69	69	67	31	25	36	26	30	26	35	27	28	37	36	30	65	66	67	41	47	63	52	65	70	71
8:25	69	67	68	27	23	38	31	28	26	42	33	31	34	36	29	66	67	68	43	45	63	51	65	70	72
8:30	69	66	68	24	24	42	30	29	27	50	30	32	30	35	29	65	67	67	43	42	62	50	65	70	71
8:35	69	66	66	27	31	48	35	31	27	50	31	30	29	36	29	66	66	68	42	44	63	51	65	70	71
8:40	69	68	67	35	37	47	38	31	28	51	33	33	28	35	30	66	66	66	50	47	63	52	65	70	71
8:45	69	67	67	38	39	50	43	34	31	53	34	32	27	36	30	65	66	67	52	45	62	51	66	70	71
8:50	69	68	67	39	45	53	45	42	33	52	34	31	30	36	29	65	66	67	53	47	55	50	64	70	71
8:55	69	67	68	40	48	59	52	45	36	55	38	27	35	37	29	65	67	67	55	46	56	50	65	70	71
9:00	68	68	68	40	48	67	54	50	44	56	41	28	30	36	30	64	66	67	56	47	55	50	64	70	71
9:05	69	67	66	39	47	70	59	57	47	58	45	33	32	36	29	66	67	67	56	45	55	50	64	70	71
9:10	69	66	67	39	47	70	66	57	55	60	55	36	40	39	29	65	66	68	56	47	57	52	64	70	71
9:15	68	67	68	39	47	70	70	56	60	65	58	40	40	42	31	65	66	68	58	48	60	52	65	70	71
9:20	69	67	67	39	47	70	70	60	64	66	59	48	46	47	37	66	67	68	60	51	60	53	66	70	71
9:25	69	67	61	39	46	70	70	64	69	68	64	57	49	47	44	66	67	68	65	61	61	54	66	70	71
9:30	68	64	57	41	47	70	71	67	69	69	68	63	53	47	49	68	68	69	69	63	66	54	66	70	71
9:35	68	67	62	49	47	70	70	70	69	69	69	66	55	54	50	67	68	69	70	65	69	59	68	71	72
9:40	70	67	67	47	46	70	70	70	69	69	69	69	61	58	51	68	68	69	70	65	69	64	68	71	71
9:45	69	67	67	49	47	70	70	70	69	68	69	69	63	62	54	68	68	69	70	65	68	65	69	70	71
9:50	69	67	69	52	47	70	70	70	69	69	69	69	65	68	59	68	68	69	70	66	69	65	69	71	71
9:55	69	68	68	61	48	70	71	70	69	69	69	69	65	69	66	69	69	69	70	66	69	64	68	71	71

Exhibit 6-4: 2020 Eastbound I-210 PM Model Speed Contours after Scenario 14

	FAIR OAKS 1	MARENGO	LAKE 2	HILL 1	ALLEN	SAN GABRIEL	MICHILLINDA	BALDWIN	SANTA ANITA 2	HUNTINGTON 1	HUNTINGTON 2	MYRTLE AV	MOUNTAIN	Buena Vista	IRWINDALE	VERNON	AZUSA 2	CITRUS 2	SUNFLOWER AV	LONE HILL AV	FOOTHILL BL
	R25.14	R25.74	R26.49	R27.16	R27.65	R28.7	R30.01	R30.95	R32.06	R32.86	R33.09	R34.15	R35.12	R35.36	R38.009	R39.05	R39.64	R40.7	R43.3	R44.2	R47
Time (PM)	717631	717633	717635	717638	717640	717646	717659	717667	717672	761128	761141	761152	761165	761177	761206	761220	717684	718469	716142	716143	767883
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15:05	65	63	66	61	64	38	65	65	60	59	62	66	65	65	65	64	58	59	66	65	67
15:10	66	63	66	62	64	29	65	65	59	59	62	65	65	66	65	64	46	59	65	65	67
15:15	66	63	66	62	64	28	65	62	60	59	63	65	64	64	65	64	28	56	65	65	67
15:20	66	63	66	62	65	23	65	51	59	58	62	65	64	60	65	64	22	57	65	65	67
15:25	66	63	66	61	62	18	65	46	60	58	60	65	65	54	65	63	20	59	66	66	67
15:30	66	62	66	61	64	19	65	36	60	58	61	66	64	41	65	59	20	57	65	65	67
15:35	66	64	66	62	60	19	65	30	60	59	62	66	64	38	65	50	20	59	65	65	67
15:40	66	63	66	62	59	19	65	28	60	58	62	66	63	23	65	37	20	59	65	65	67
15:45	66	63	66	61	57	19	65	25	60	58	61	65	60	24	65	30	20	56	65	65	67
15:50	66	63	65	62	57	19	65	25	60	58	60	61	51	25	65	28	19	54	64	64	67
15:55	67	63	61	61	56	19	65	24	60	58	62	52	41	25	65	25	20	57	65	64	67
16:00	66	64	62	62	51	19	65	25	60	56	62	47	33	24	64	24	21	54	65	64	67
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16:10	67	62	59	64	55	19	65	24	60	49	54	32	26	22	62	36	21	43	65	65	67
16:15	67	59	57	64	65	24	65	27	55	49	53	27	23	23	64	38	22	43	65	65	67
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16:25	67	54	55	64	65	28	65	27	53	47	50	26	24	21	65	41	28	40	65	65	67
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16:45	66	54	55	64	65	64	60	41	47	40	36	23	24	21	65	57	33	40	65	65	67
16:50	67	54	55	65	66	67	61	45	47	37	35	23	24	20	65	57	36	40	65	65	67
16:55	66	54	54	63	65	66	60	47	46	37	35	25	24	21	65	57	39	40	65	66	67
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17:05	66	54	55	63	65	66	59	50	48	43	42	24	25	21	63	53	37	38	65	65	67
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17:15	67	54	55	63	65	67	58	51	56	50	50	24	25	20	65	48	28	36	65	65	67
17:20	67	54	55	63	65	66	59	57	58	54	51	29	25	23	63	45	31	36	65	65	68
17:25	67	55	55	63	64	66	63	59	59	56	56	33	24	23	58	45	33	35	65	65	67
17:30	66	54	55	64	65	67	66	58	60	57	59	38	27	22	57	45	32	34	64	64	68
17:35	66	54	55	64	65	67	65	57	62	57	62	38	28	22	58	45	34	35	65	65	67
17:40	66	54	55	64	65	67	66	60	63	57	64	39	28	22	58	45	29	36	65	66	68
17:45	67	54	55	63	65	66	66	62	62	59	67	43	29	21	58	46	31	38	66	65	68
17:50	67	54	55	64	65	66	65	64	60	60	67	47	28	22	58	46	32	40	66	65	68
17:55	67	54	55	64	65	67	66	66	61	58	67	45	29	21	58	46	38	40	66	65	68
18:00	67	55	55	64	65	67	66	66	60	56	67	47	30	21	61	54	39	43	66	65	68
18:05	67	55	57	65	66	67	65	66	62	57	67	46	34	21	65	56	46	49	66	65	68
18:10	67	55	57	65	66	67	66	66	61	57	66	46	34	24	67	62	52	57	66	65	67
18:15	67	55	59	65	66	67	66	66	60	60	67	45	35	26	67	66	59	56	66	65	67
18:20	67	59	63	65	66	66	66	66	62	63	67	57	44	34	67	67	62	60	66	65	67
18:25	67	63	63	65	66	67	66	66	65	64	67	65	51	40	67	67	66	63	67	66	67
18:30	67	65	64	65	66	67	66	66	65	62	66	65	59	48	67	67	67	64	67	66	67
18:35	67	65	66	66	66	66	66	66	65	65	66	65	61	56	67	67	67	65	67	65	68
18:40	68	65	67	65	66	67	66	66	65	66	66	66	66	63	67	66	67	66	67	66	68
18:45	67	65	67	65	66	67	66	67	66	67	67	66	67	64	67	67	67	66	67	66	67
18:50	67	64	67	65	66	67	66	67	67	67	67	66	66	66	67	67	67	66	68	66	68
18:55	67	65	67	65	65	67	66	66	67	67	67	67	67	67	67	67	67	66	67	65	67

Appendix A: I-210 Scenario List

Scenario	Proj ID	Improvement	Lead Agency	Expected Compl Date	Source	Est Total Proj Cost (in 1,000s)*
1 (2006-1) 2 (2020-1)	EA25800 EA25740	Route 5 to Route 134 and from Rte 134 to SBD Co line- expand ramp metering and implement corridor management, and updated Local Mainline Reponsive (LMR) metering	Caltrans	Completed 2008-09	06/07 SHOPP	$14,470 $9,000
3 (2006-2) 4 (2020-2)	Proposed (SMG)	Advanced ramp metering system with queue control (Dynamic)				$10,000
5 (2006-3) 6 (2020-3)	Proposed (SMG)	Westbound auxiliary lane from Santa Anita to Baldwin, eastbound aux lane from Santa Anita to Huntington				$10,000
	EA 27230K	On WB 210 connector, extend the lane to Lincoln				$30,000
	Proposed (SMG/ SGVCOG)	WB-210: Connect & converge Altadena on-ramps into a single on-ramp				$1,000
		WB-210: Connect and converge Santa Anita on-ramps into a single on-ramp				$1,000
		WB-210: Connect and converge Irwindale on-ramps into single on-ramp				$1,000
	Proposed (CT)	EB-210: restripe to add lane from San Dimas to Fruit (remove lane drop)				$1,000
7 (2006-4) 8 (2020-4)	Proposed (CT)	Close eastbound Marengo on-ramp, close westbound Lake on-ramp, signalize eastbound I-210 off-ramp at Maple, and improve alternate routes along Corson and Maple				$3,000
	Proposed (SMG/ SGVCOG)	Close EB-210 Mt. Olive ramps				$1,000
9 (2006-5) 10 (2020-5) -Builds on Sc 5/6	Proposed (SMG/ SGVCOG)	Modify Rosemead/Michillinda interchange; converge WB-210 on-ramps				$3,000
		Modify northside Baldwin interchange - eliminate collector-distributor				$5,000
		EB-210 auxiliary lane from Azusa to Citrus				$10,000
		EB-210 converge Citrus on-ramps and add auxiliary lane to Grand				$10,000

*Total cost includes construction and support costs in current dollars

I-210 Scenario List (continued)

Scenario	Proj ID	Improvement	Lead Agency	Expected Compl Date	Source	Est Total Proj Cost (in 1,000s)*
11 (2020-6) 12 (2020-7) -Builds on Sc 10	Proposed (SMG)	Enhanced Incident Management System (incident clearance time reduction from current and with improvements)				$10,000
13 (2020-8) -Builds on Sc 10	Proposed (SMG/ SGVCOG)	SR-134/I-210 IC modification: 210 to 210 direct connection with 3 lanes in each direction				$150,000
14 (2020-9)	Proposed (SMG/ SGVCOG)	WB Lake Ave center drop ramp: Two drop ramps to serve HOV & GP vehicles heading toward SR-134				$50,000
		EB-210: Add one new outside lane from Myrtle Off to Myrtle On and from Shamrock to Buena Vista On-ramp. (New lane addition from Myrtle off to the I-605 Off)				$20,000

*Total cost includes construction and support costs in current dollars

Appendix B: Benefit-Cost Analysis Results

This appendix provides more detailed Benefit-Cost Analysis (BCA) results than found in Section 5 of the I-210 Corridor System Management Plan (CSMP) Final Report. The BCA results for this CSMP were estimated by using the *California Life-Cycle Benefit/Cost Analysis Model (Cal-B/C) Version 4.0* developed for Caltrans by System Metrics Group, Inc. (SMG).

Caltrans uses Cal-B/C to conduct investment analyses of projects proposed for the interregional portion of the State Transportation Improvement Program (STIP), the State Highway Operations and Protection Program (SHOPP), and other ad hoc analyses requiring BCA. Cal-B/C is a spreadsheet-based tool that can prepare analyses of highway, transit, and passenger rail projects. Users input data defining the type, scope, and cost of projects. The model calculates life-cycle costs, net present values, benefit-cost ratios, internal rates of return, payback periods, annual benefits, and life-cycle benefits. Cal-B/C can be used to evaluate capacity expansion projects, transportation management systems (TMS), and operational improvements.

Cal-B/C measures, in constant dollars, four categories of benefits:

- Travel time savings (reduced travel time and new trips)
- Vehicle operating cost savings (fuel and non-fuel operating cost reductions)
- Accident cost savings (safety benefits)
- Emission reductions (air quality and greenhouse gas benefits).

Each of these benefits was estimated for the peak period for the following categories:

- **Life-Cycle Costs** - present values of all net project costs, including initial and subsequent costs in real current dollars.
- **Life-Cycle Benefits** - sum of the present value benefits for the project.
- **Net Present Value** - life-cycle benefits minus the life-cycle costs. The value of benefits exceeds the value of costs for a project with a positive net present value.
- **Benefit/Cost Ratio** - benefits relative to the costs of a project. A project with a benefit-cost ratio greater than one has a positive economic value.
- **Rate of Return on Investment** - discount rate at which benefits and costs are equal. For a project with a rate of return greater than the discount rate, the benefits are greater than costs and the project has a positive economic value. The user can use rate of return to compare projects with different costs and different benefit flows over different time periods. This is particularly useful for project staging.

- **Payback Period** - number of years it takes for the net benefits (life-cycle benefits minus life-cycle costs) to equal the initial construction costs. For a project with a payback period longer than the life-cycle of the project, initial construction costs are not recovered. The payback period varies inversely with the benefit-cost ratio. A shorter payback period yields a higher benefit-cost ratio.

The model calculates these results over a standard 20-year project life-cycle, itemizes each user benefit, and displays the annualized and life-cycle user benefits. Below the itemized project benefits, Cal-B/C displays three additional benefit measures:

- **Person-Hours of Time Saved** - reduction in person-hours of travel time due to the project. A positive value indicates a net benefit.
- **Additional CO2 Emissions (tons)** -additional CO2 emissions that occur because of the project. The emissions are estimated using average speed categories using data from the California Air Resources Board (CARB) EMFAC model. This is a gross calculation because the emissions factors do not take into account changes in speed cycling or driver behavior. A negative value indicates a project benefit. Projects in areas with severe congestion will generally lower CO2 emissions.
- **Additional CO2 Emissions (in millions of dollars)** - valued CO2 emissions using a recent economic valuing methodology.

A copy of Cal-B/C v4.0, the User's Guide, and detailed technical documentation can be found at the Caltrans' Division of Transportation Planning, Office of Transportation Economics website at http://www.dot.ca.gov/hq/tpp/offices/ote/benefit.html.

The exhibits in this appendix are listed as follows:

- Exhibit B-1: I-210 Corridor Scenarios 1 & 2 (Expand Ramp Metering) Benefit-Cost Analysis Results
- Exhibit B-2: I I-210 Corridor Scenarios 3 & 4 (Advanced Ramp Metering) Benefit-Cost Analysis Results
- Exhibit B-3: I-210 Corridor Scenarios 5 & 6 (Aux Lane, Striping, Ramp Improvements) Benefit-Cost Analysis Results
- Exhibit B-4: I-210 Corridor Scenarios 7 & 8 (Ramp Closures) Benefit-Cost Analysis Results
- Exhibit B-5: I-210 Corridor Scenarios 9 & 10 (On-ramp and Aux Lane Improvements) Benefit-Cost Analysis Results
- Exhibit B-6: I-210 Corridor Scenario 13 (SR-134/I-210 IC Modification) Benefit-Cost Analysis Results
- Exhibit B-7: I-210 Corridor Scenario 14 (Westbound Drop Ramp and Eastbound Widening) Benefit-Cost Analysis Results
- Exhibit B-8: I-210 Corridor Cumulative Benefit-Cost Analysis Results

Exhibit B-1: I-210 Corridor Scenarios 1 & 2 (Expand Ramp Metering) Benefit-Cost Analysis Results

3

INVESTMENT ANALYSIS

SUMMARY RESULTS

Life-Cycle Costs (mil. $)	$23.5
Life-Cycle Benefits (mil. $)	$416.4
Net Present Value (mil. $)	$392.9
Benefit / Cost Ratio:	17.7
Rate of Return on Investment:	80.6%
Payback Period:	2 years

ITEMIZED BENEFITS (mil. $)	Average Annual	Total Over 20 Years
Travel Time Savings	$14.3	$286.7
Veh. Op. Cost Savings	$4.8	$95.5
Accident Cost Savings	$0.0	$0.0
Emission Cost Savings	$1.7	$34.2
TOTAL BENEFITS	$20.8	$416.4
Person-Hours of Time Saved	1,803,292	36,065,831
Additional CO_2 Emissions (tons)	-23,818	-476,368
Additional CO_2 Emissions (mil. $)	-$0.7	-$13.9

Incremental Costs (mil. $)	$23.5
Incremental Benefits (mil. $)	$416.4
Incremental Benefit / Cost Ratio	17.7

Exhibit B-2: I I-210 Corridor Scenarios 3 & 4 (Advanced Ramp Metering) Benefit-Cost Analysis Results

3

INVESTMENT ANALYSIS

SUMMARY RESULTS

Life-Cycle Costs (mil. $)	$33.5
Life-Cycle Benefits (mil. $)	$532.7
Net Present Value (mil. $)	$499.3
Benefit / Cost Ratio:	15.9
Rate of Return on Investment:	85.0%
Payback Period:	2 years

ITEMIZED BENEFITS (mil. $)	Average Annual	Total Over 20 Years
Travel Time Savings	$18.7	$374.5
Veh. Op. Cost Savings	$5.8	$115.5
Accident Cost Savings	$0.0	$0.0
Emission Cost Savings	$2.1	$42.7
TOTAL BENEFITS	$26.6	$532.7
Person-Hours of Time Saved	2,317,725	46,354,490
Additional CO_2 Emissions (tons)	-28,283	-565,668
Additional CO_2 Emissions (mil. $)	-$0.8	-$16.7

Incremental Costs (mil. $)	$10.0
Incremental Benefits (mil. $)	$116.4
Incremental Benefit / Cost Ratio	11.6

Exhibit B-3: I-210 Corridor Scenarios 5 & 6 (Aux Lane, Striping, Ramp Improvements) Benefit-Cost Analysis Results

3

INVESTMENT ANALYSIS
SUMMARY RESULTS

Life-Cycle Costs (mil. $)	$77.5
Life-Cycle Benefits (mil. $)	$765.7
Net Present Value (mil. $)	$688.2
Benefit / Cost Ratio:	9.9
Rate of Return on Investment:	55.4%
Payback Period:	2 years

ITEMIZED BENEFITS (mil. $)	Average Annual	Total Over 20 Years
Travel Time Savings	$28.4	$567.4
Veh. Op. Cost Savings	$7.3	$145.3
Accident Cost Savings	$0.0	$0.0
Emission Cost Savings	$2.6	$52.9
TOTAL BENEFITS	$38.3	$765.7
Person-Hours of Time Saved	3,512,268	70,245,357
Additional CO_2 Emissions (tons)	-35,758	-715,160
Additional CO_2 Emissions (mil. $	-$1.1	-$21.0

Incremental Costs (mil. $)	$44.0
Incremental Benefits (mil. $)	$233.0
Incremental Benefit / Cost Ratio	5.3

Exhibit B-4: I-210 Corridor Scenarios 7 & 8 (Ramp Closures) Benefit-Cost Analysis Results

3

INVESTMENT ANALYSIS
SUMMARY RESULTS

Life-Cycle Costs (mil. $)	$81.5
Life-Cycle Benefits (mil. $)	$1,045.4
Net Present Value (mil. $)	$963.9
Benefit / Cost Ratio:	12.8
Rate of Return on Investment:	76.4%
Payback Period:	2 years

ITEMIZED BENEFITS (mil. $)	Average Annual	Total Over 20 Years
Travel Time Savings	$39.9	$797.6
Veh. Op. Cost Savings	$9.1	$182.2
Accident Cost Savings	$0.0	$0.0
Emission Cost Savings	$3.3	$65.6
TOTAL BENEFITS	$52.3	$1,045.4
Person-Hours of Time Saved	4,906,314	98,126,277
Additional CO_2 Emissions (tons)	-44,347	-886,938
Additional CO_2 Emissions (mil. $	-$1.3	-$26.3

Incremental Costs (mil. $)	$4.0
Incremental Benefits (mil. $)	$279.7
Incremental Benefit / Cost Ratio	69.9

Exhibit B-5: I-210 Corridor Scenarios 9 & 10 (On-ramp and Aux Lane Improvements) Benefit-Cost Analysis Results

3

INVESTMENT ANALYSIS
SUMMARY RESULTS

Life-Cycle Costs (mil. $)	$105.5
Life-Cycle Benefits (mil. $)	$1,437.8
Net Present Value (mil. $)	$1,332.3
Benefit / Cost Ratio:	13.6
Rate of Return on Investment:	74.0%
Payback Period:	2 years

ITEMIZED BENEFITS (mil. $)	Average Annual	Total Over 20 Years
Travel Time Savings	$55.1	$1,102.5
Veh. Op. Cost Savings	$12.3	$246.9
Accident Cost Savings	$0.0	$0.0
Emission Cost Savings	$4.4	$88.4
TOTAL BENEFITS	$71.9	$1,437.8
Person-Hours of Time Saved	6,865,134	137,302,682
Additional CO_2 Emissions (tons)	-60,736	-1,214,710
Additional CO_2 Emissions (mil. $	-$1.8	-$35.8

Incremental Costs (mil. $)	$28.0
Incremental Benefits (mil. $)	$672.1
Incremental Benefit / Cost Ratio	24.0

Exhibit B-6: I-210 Corridor Scenario 13 (SR-134/I-210 IC Modification) Benefit-Cost Analysis Results

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INVESTMENT ANALYSIS
SUMMARY RESULTS

Life-Cycle Costs (mil. $)	$150.0
Life-Cycle Benefits (mil. $)	$208.9
Net Present Value (mil. $)	$58.9
Benefit / Cost Ratio:	1.4
Rate of Return on Investment:	8.1%
Payback Period:	10 years

ITEMIZED BENEFITS (mil. $)	Average Annual	Total Over 20 Years
Travel Time Savings	$8.6	$172.5
Veh. Op. Cost Savings	$1.4	$27.1
Accident Cost Savings	$0.0	$0.0
Emission Cost Savings	$0.5	$9.2
TOTAL BENEFITS	$10.4	$208.9
Person-Hours of Time Saved	1,041,965	20,839,294
Additional CO_2 Emissions (tons)	-6,285	-125,690
Additional CO_2 Emissions (mil. $	-$0.2	-$3.8

Exhibit B-7: I-210 Corridor Scenario 14 (Westbound Drop Ramp and Eastbound Widening) Benefit-Cost Analysis Results

3

INVESTMENT ANALYSIS
SUMMARY RESULTS

Life-Cycle Costs (mil. $)	$70.0
Life-Cycle Benefits (mil. $)	$427.3
Net Present Value (mil. $)	$357.3
Benefit / Cost Ratio:	6.1
Rate of Return on Investment:	44.9%
Payback Period:	3 years

ITEMIZED BENEFITS (mil. $)	Average Annual	Total Over 20 Years
Travel Time Savings	$19.0	$379.1
Veh. Op. Cost Savings	$1.8	$36.0
Accident Cost Savings	$0.0	$0.0
Emission Cost Savings	$0.6	$12.3
TOTAL BENEFITS	$21.4	$427.3
Person-Hours of Time Saved	2,265,802	45,316,047
Additional CO_2 Emissions (tons)	-8,344	-166,875
Additional CO_2 Emissions (mil. $	-$0.3	-$5.1

Exhibit B-8: I-210 Corridor Cumulative Benefit-Cost Analysis Results

3

INVESTMENT ANALYSIS
SUMMARY RESULTS

Life-Cycle Costs (mil. $)	$325.5
Life-Cycle Benefits (mil. $)	$2,074.0
Net Present Value (mil. $)	$1,748.5
Benefit / Cost Ratio:	6.4
Rate of Return on Investment:	n/a
Payback Period:	n/a

ITEMIZED BENEFITS (mil. $)	Average Annual	Total Over 20 Years
Travel Time Savings	$82.7	$1,654.0
Veh. Op. Cost Savings	$15.5	$310.0
Accident Cost Savings	$0.0	$0.0
Emission Cost Savings	$5.5	$109.9
TOTAL BENEFITS	$103.7	$2,074.0
Person-Hours of Time Saved	10,172,901	203,458,023
Additional CO_2 Emissions (tons)	-75,364	-1,507,276
Additional CO_2 Emissions (mil. $	-$2.2	-$44.6