DRAFT FINAL

CORRIDOR SYSTEM MANAGEMENT PLAN (CSMP)
ORANGE COUNTY SR-22
COMPREHENSIVE PERFORMANCE ASSESSMENT
AND
CAUSALITY ANALYSIS

May 4, 2009

System Metrics Group, Inc.

Table of Contents

List of Exhibits

1. INTRODUCTION

This document represents the draft for the sixth and seventh milestones of the Orange County State Route 22 (SR-22) Corridor System Management Plan (CSMP) development process, which is required by the California Transportation Commission (CTC) for corridors that have received funding from the Corridor Mobility Improvement Account (CMIA) approved by the voters in 2006. The CMIA will partially fund the construction of High Occupancy Vehicle (HOV) connectors between SR-22 and I-405 as well as I-405 and I-605. As a result, the SR-22 corridor defined for the CSMP includes SR-22 plus the sections of I-405 and I-605 found in Orange County. The section of I-605 is very small, so this comprehensive performance assessment concentrates on the other two freeways (collectively called “SR-22 Corridor”).

The two milestones reached in this document are called the Comprehensive Performance Assessment and the Causality of Performance Degradation. They build on the fourth milestone, the “Preliminary Performance Assessment” (already developed), and the fifth milestone, “Ensure Adequate Corridor Detection.” The milestones, eight in total, were documented in the CSMP guidelines distributed by Caltrans Headquarters.

The main purpose of the Comprehensive Performance Assessment is to detail the performance of the corridor so that future investment decisions can build on its findings and conclusions, and investment alternatives are tested to ensure reasonable returns on investment for public funds.

This report is very long and presents performance measurement findings, identifies bottlenecks that lead to less than optimal performance, and diagnoses the causes for these bottlenecks in detail. Once this report has been finalized, alternative investment strategies will be modeled and evaluated to understand their relative benefits and eventually develop a recommended implementation plan for existing and potential future funding.

This report and the associated CSMP (eighth milestone in the CSMP guidelines) should be updated 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 among others. Such changes could influence the conclusions of the CSMP and the relative priorities in investments.

Therefore, updates should probably occur no less than every two to three years. To the extent possible, this document has been organized to facilitate such updates so that Caltrans can insert new update sections without re-writing the entire document.

The remainder of this report is organized into four sections (Section 1 is this introduction):

2. *Corridor Description*
   This section describes the corridor, including the roadway facility, major interchanges and relative demands at these interchanges, rail and transit services along the freeway facility, major Intermodal facilities around the corridor, and special event facilities/trip generators. This section has been expanded since the Preliminary Performance Assessment milestone to include a subsection on corridor demand profiles.

3. *Corridor-Wide Performance and Trends*
   The section presents multiple years of performance data for the defined CSMP freeway facility of the corridor, including mobility, reliability, safety, and productivity performance measures. The section has also been augmented to include the performance of the HOV facility and the pavement condition of the freeway. When available, the performance data has been updated to reflect conditions up to December 2008.

4. *Bottleneck Identification and Analysis*
   This section identifies the locations of bottlenecks, or choke points, on the freeway facility. These bottlenecks are generally the major cause for mobility and productivity performance degradations and are often related to safety degradations as well. This section has also been augmented. It now has performance results for delay, productivity, and safety by major "bottleneck area." This addition allows for the relative prioritization of bottlenecks in regards to their contribution to corridor performance degradation.

5. *Bottleneck Causality Analysis*
   This section diagnoses the bottlenecks identified in Section 4 and identifies the causes of each bottleneck through additional data analysis and significant field observations. Electronic videos were taken for many of the major bottlenecks (to the extent possible) to verify our conclusions. Sections 4 and 5 provide valuable input in selecting projects to address the critical bottlenecks. Moreover, they provide the baseline against which the micro-simulation models will be validated. Finally, this section represents the seventh milestone of the CSMP development process.

The remainder of this introduction provides some background on system management, a framework that eventually led to the CSMP requirement. It also includes a discussion on data sources and the state of detection on both the SR-22 and I-405 freeway facilities.

Background

Over the last few years, Caltrans and its stakeholders and partner agencies have been developing and committing to a framework called “System Management” which is depicted in Exhibit 1-1. This framework aims to get the most of our transportation infrastructure through a variety of strategies, not just through the traditional and increasingly expensive expansion projects. System Management has been embraced by the Administration as part of their Strategic Growth Plan and by the Southern California Association of Governments (SCAG), the Metropolitan Planning Organization for Southern California and Orange County.

One major new aspect of system management is an increased focus on operational strategies and investments. Operational solutions are generally less expensive, can often be implemented much faster, and can produce results that, when compared to traditional expansion projects, often provide much higher returns on the scarce transportation funding available. Partly because of the focus on operational strategies, system management relies on much more detailed data.

Exhibit 1-1: System Management Pyramid

The base of the system management “pyramid” is titled “System Monitoring and Evaluation.” It is the foundation of all other decisions, and it includes identifying problems, evaluating solutions (and combinations thereof), and eventually funding the most promising strategies. This document represents the first version of this foundation for the SR-22 CSMP Corridor.

Existing Data Sources

The existing available data analyzed for the preliminary performance assessment includes the following sources:

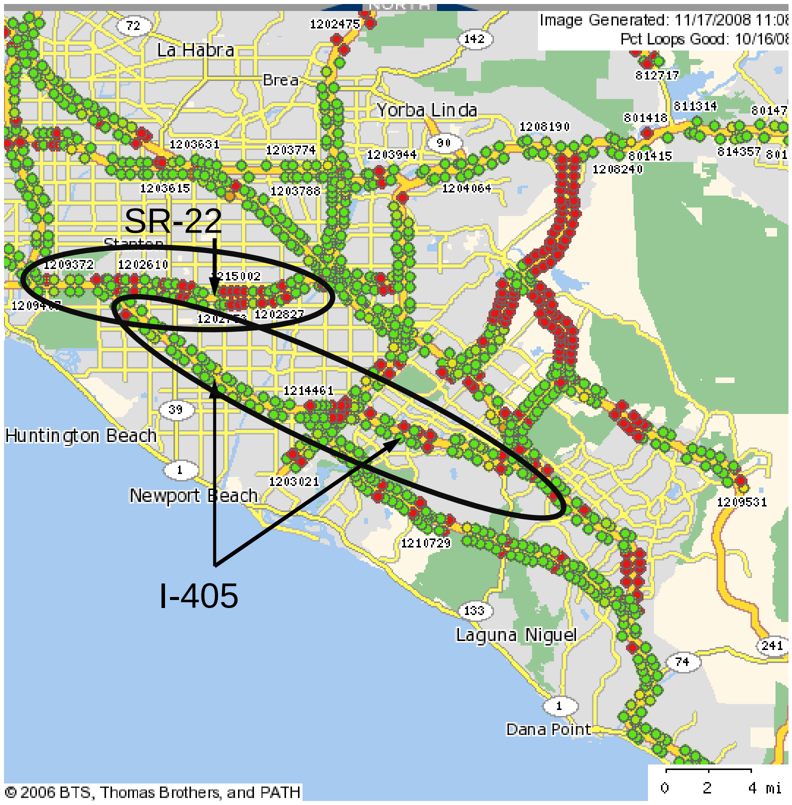
- Caltrans Highway Congestion Monitoring Program (HICOMP) report and data files (2004 – 2007)
- Caltrans Freeway Performance Measurement System (PeMS)
- Caltrans District 12 probe vehicle runs (electronic tachometer runs)
- Caltrans Traffic Accident Surveillance and Analysis System (TASAS) from PeMS
- Signal Timing Plans from the Cities of Garden Grove, Seal Beach, Costa Mesa, and Irvine
- Traffic study reports (various)
- Aerial photographs (Google Earth) and Caltrans photologs
- Internet (i.e. OCTA website, Metrolink website, SCAG website, etc).

There are numerous documents that describe these data sources, so they are not discussed in detail here. 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 1-2 depicts the detectors in place on the SR-22 CSMP Corridor (including SR-22 and I-405) as of October 16, 2008 (chosen randomly). The exhibit shows that there are many detectors on the mainline and most are functioning well (shown as the green color). Furthermore, it illustrates some seemingly small gaps between detectors at some locations.

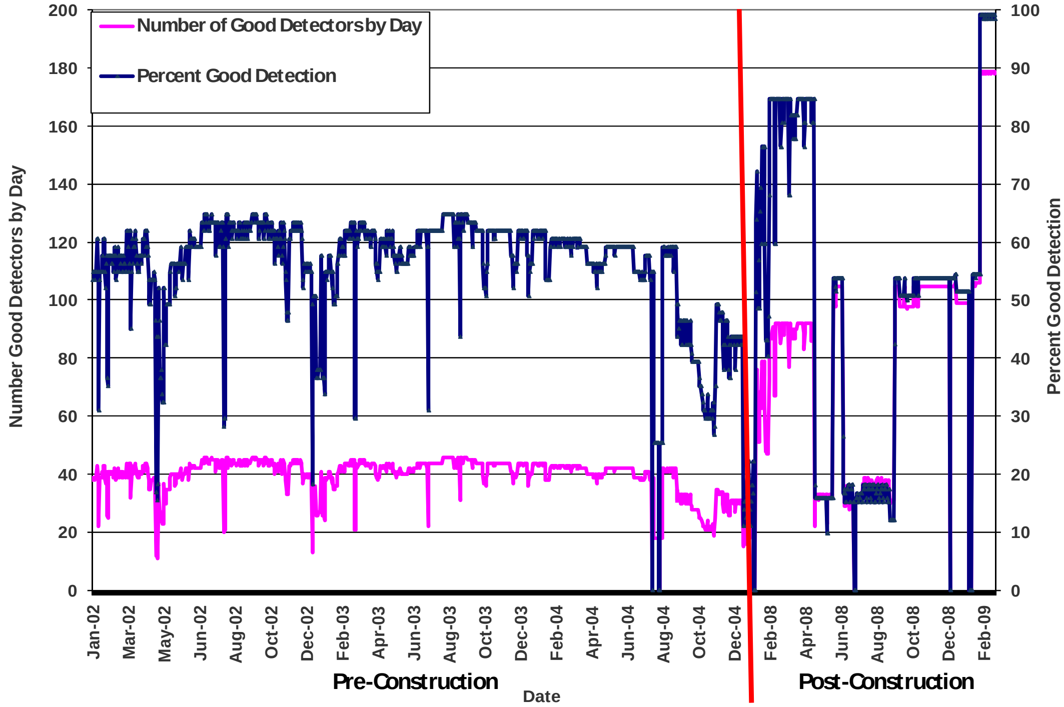
Exhibit 1-2: PeMS Sensor Data Quality (October 16, 2008)



Source: PeMS data

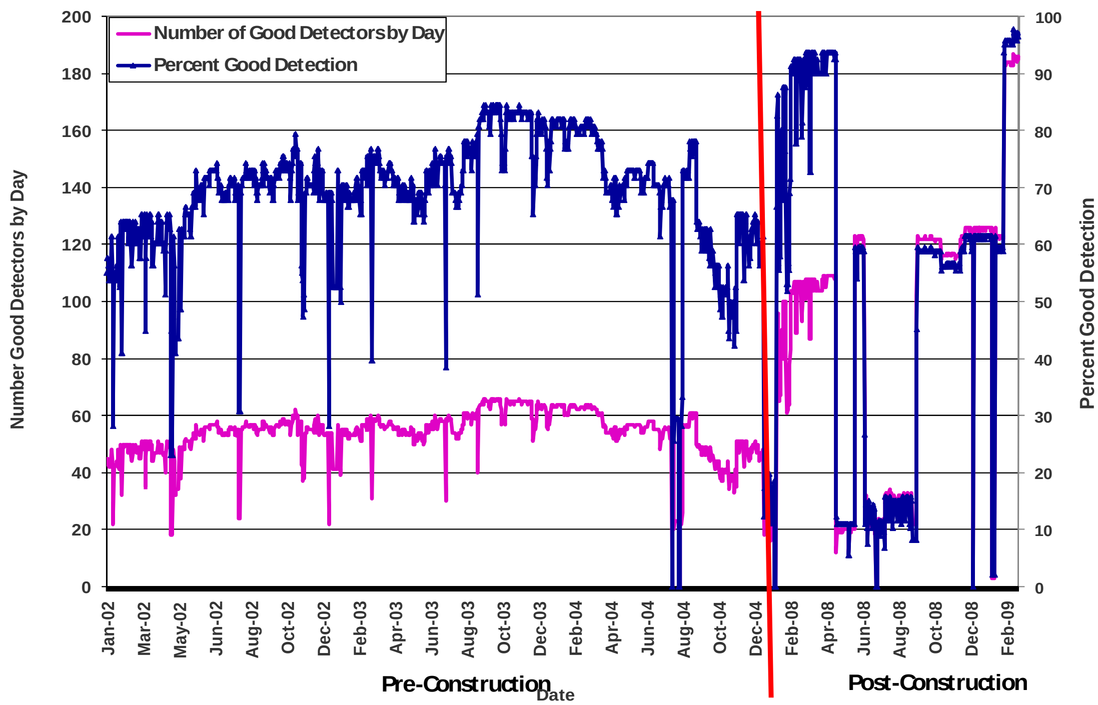
To see how well the detectors performed over a longer period of time, Exhibits 1-3 and 1-4 show the number and percentage of good detectors on the SR-22 mainline facility for the years analyzed, 2002-2004 (pre-construction), and 2008 and February 2009 (post-construction). The exhibits report the number and percentage of "good" detectors each day during the period of analysis. These include mainline detectors as well as ramp detectors. 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. Exhibits 1-3 and 1-4 suggest that detection in the westbound direction was slightly better than the eastbound direction, particularly during the pre-construction years when the percentage of good detectors in the westbound direction reported roughly 70 percent compared to 60 percent in the eastbound direction. In 2008, Caltrans installed new and fixed existing detectors. In February, 2009, detection significantly improved, achieving almost 100 percent of good data in both directions.

Exhibit 1-3: Eastbound SR-22 ML Number & Percentage of Daily Good Detectors



Source: SMG analysis of PeMS data

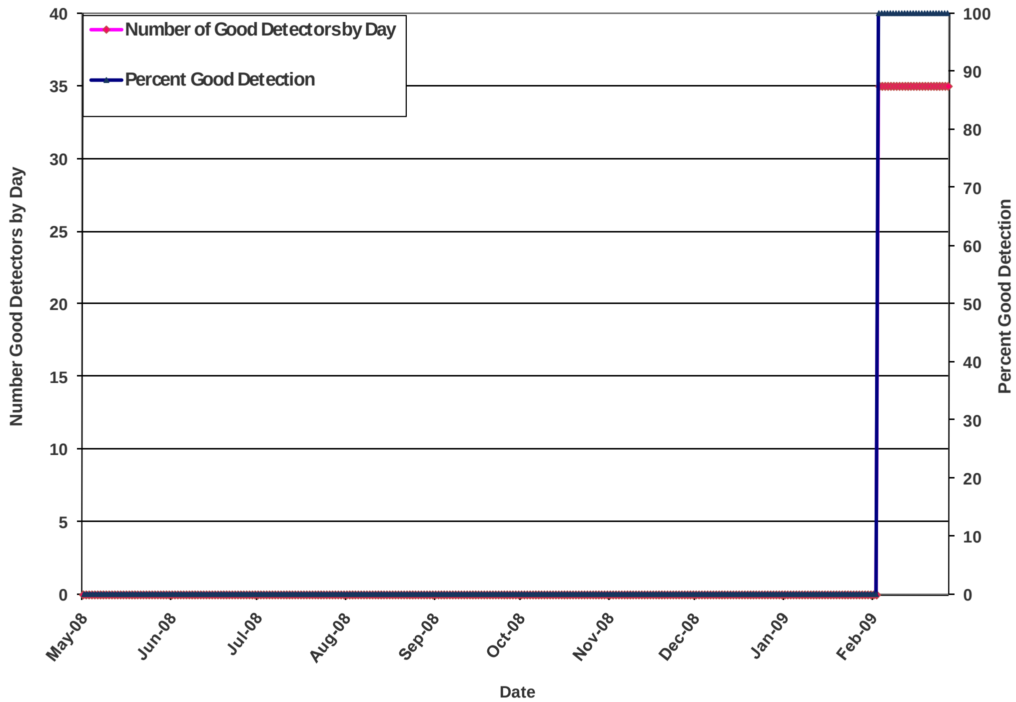
Exhibit 1-4: Westbound SR-22 ML Number & Percentage of Daily Good Detectors



Source: SMG analysis of PeMS data

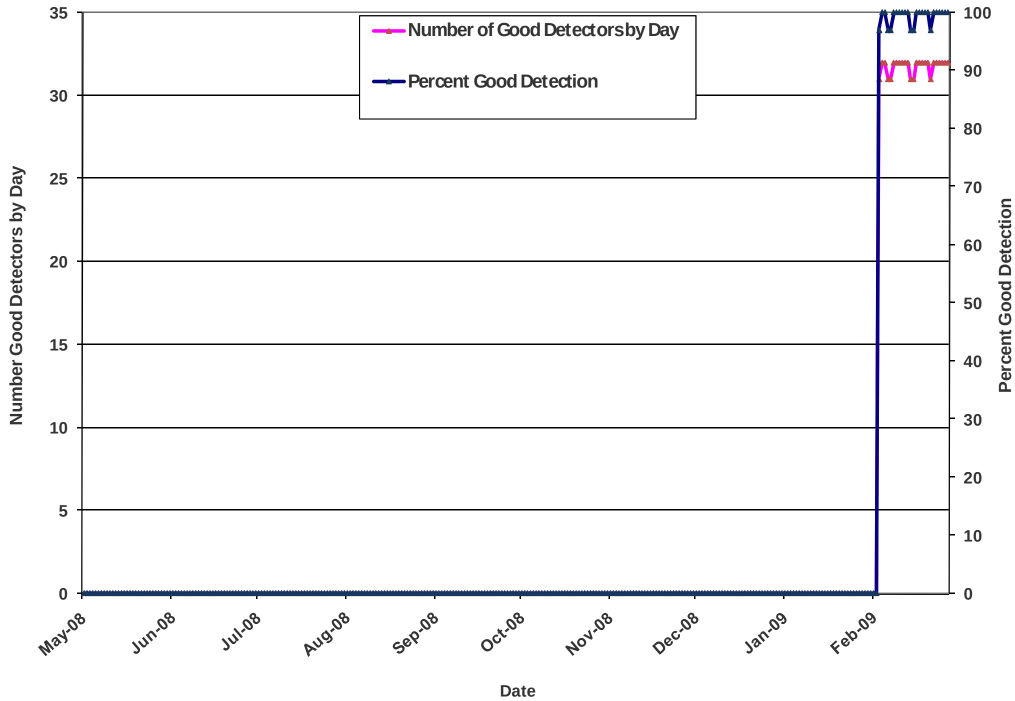
Exhibits 1-5 and 1-6 separately illustrates the number and percentage of good detection on the SR-22 HOV facility by direction. These exhibits clearly show that good detection for the HOV facility was not available until February 2009. In February 2009, both directions of the HOV facility reported almost 100 percent of good data. It is important to note that many detectors were added to SR-22 as part of a widening project that added an HOV lane in each direction. Project construction started in September 2004 and was completed during the spring of 2007. The detectors that were added to the mainline facility post construction are listed in Exhibit 1-7. Additionally, Exhibits 1-8 and 1-9 list all of the detectors added to the HOV facility post construction.

Exhibit 1-5: Eastbound SR-22 HOVL
Number & Percentage of Daily Good Detectors



Source: SMG analysis of PeMS data

**Exhibit 1-6: Westbound SR-22 HOVL
Number & Percentage of Daily Good Detectors**



Source: SMG analysis of PeMS data

Exhibit 1-7: SR-22 ML and Ramp Detectors Added (2008)

VDS	Location	Type	CA PM	Abs PM	Date Online
EASTBOUND					
1215205	VALLEY V1	Off Ramp	R.89	2.347	5/2/2008
1214838	VALLEY V2	Off Ramp	R1.08	2.537	5/2/2008
1214853	VIA LOS ALISOS	Mainline	R1.41	2.867	5/2/2008
1214869	YUMA	Mainline	R2.07	3.527	5/2/2008
1215092	GARDEN GROV	Mainline	R3.27	4.727	5/2/2008
1214938	WILSON	Mainline	R4.03	5.487	5/2/2008
1214955	NEWLAND	Mainline	R4.34	5.797	5/2/2008
1215208	BROOKHURST 1	Off Ramp	R5.57	7.027	5/2/2008
1214988	HOPE	Mainline	R6.05	7.507	5/2/2008
1215003	WARD	Mainline	R6.34	7.797	5/2/2008
1214805	TAFT	Mainline	R6.61	8.067	5/2/2008
1214807	EUCLID	Off Ramp	R6.61	8.067	5/2/2008
1214894	HARBOR 1	Mainline	R7.72	9.177	5/2/2008
1215017	PEARCE	Mainline	R8.3	9.757	5/2/2008
1215109	22E CD AT CITY DRIVE	Fwy-Fwy	R9.7	11.261	5/2/2008
1214715	HESPERIAN	Mainline	R9.9	11.461	5/2/2008
1215043	LEWIS	Mainline	R10	11.561	5/2/2008
1214724	22E CD AT BRISTOL	Fwy-Fwy	R10.13	11.691	5/2/2008
1215111	22E CD ON AT 5	Fwy-Fwy	R10.53	12.091	5/2/2008
1214881	CONCORD	Mainline	R12.25	13.811	5/2/2008
1215026	TUSTIN	Mainline	R12.7	14.261	5/2/2008
VDS	Location	Type	CA PM	Abs PM	Date Online
WESTBOUND					
1214842	VALLEY V2	Off Ramp	R.89	2.347	5/2/2008
1214854	VIA LOS ALISOS	Mainline	R1.41	2.867	5/2/2008
1215248	SPRINGDALE CENSUS	Mainline	R1.74	3.197	5/2/2008
1214871	YUMA	Mainline	R2.07	3.527	5/2/2008
1215091	GARDEN GROV	Mainline	R3.27	4.727	5/2/2008
1214939	WILSON	Mainline	R4.03	5.487	5/2/2008
1214954	NEWLAND	Mainline	R4.34	5.797	5/2/2008
1214972	BROOKHURST 2	Mainline	R5.77	7.227	5/2/2008
1214987	HOPE	Mainline	R6.05	7.507	5/2/2008
1215002	WARD	Mainline	R6.34	7.797	5/2/2008
1214806	TAFT	Mainline	R6.61	8.067	5/2/2008
1215018	PEARCE	Mainline	R8.3	9.757	5/2/2008
1214743	5S/57S TO 22W	Fwy-Fwy	R9.69	11.251	5/2/2008
1215044	LEWIS	Mainline	R10	11.561	5/2/2008
1215122	22W to 5/57N	Fwy-Fwy	R10.53	12.091	5/2/2008
1215123	22E to 5/57N	Fwy-Fwy	R10.53	12.091	5/2/2008
1214882	CONCORD	Mainline	R12.25	13.811	5/2/2008

Source: PeMS data

Exhibit 1-8: Eastbound SR-22 Detection Added to HOV Facility (2008)

VDS	Location	Type	CA PM	Abs PM	Date Online
EASTBOUND					
1214852	VIA LOS ALISOS	HOV	R1.41	2.867	5/2/2008
1215235	SPRINGDALE CENSUS	HOV	R1.74	3.197	5/2/2008
1214857	SPRINGDALE	HOV	R1.75	3.207	5/2/2008
1214868	YUMA	HOV	R2.07	3.527	5/2/2008
1215078	KNOTT 1	HOV	R2.49	3.947	5/2/2008
1215096	KNOTT 2	HOV	R2.88	4.337	5/2/2008
1215090	GARDEN GROV	HOV	R3.27	4.727	5/2/2008
1214763	BEACH 1	HOV	R3.44	4.897	5/2/2008
1214821	BEACH 2	HOV	R3.73	5.187	5/2/2008
1214936	WILSON	HOV	R4.03	5.487	5/2/2008
1214953	NEWLAND	HOV	R4.34	5.797	5/2/2008
1214781	MAGNOLIA 1	HOV	R4.6	6.057	5/2/2008
1214826	MAGNOLIA 2	HOV	R4.99	6.447	5/2/2008
1215072	BROOKHUR1	HOV	R5.57	7.027	5/2/2008
1214970	BROOKHUR2	HOV	R5.77	7.227	5/2/2008
1214986	HOPE	HOV	R6.05	7.507	5/2/2008
1215001	WARD	HOV	R6.34	7.797	5/2/2008
1214803	TAFT	HOV	R6.61	8.067	5/2/2008
1214790	EUCLID	HOV	R6.94	8.397	5/2/2008
1215063	NEWHOPE	HOV	R7.29	8.747	5/2/2008
1215251	NEWHOPE CENSUS	HOV	7.3	8.757	5/2/2008
1214892	HARBOR 1	HOV	R7.72	9.177	5/2/2008
1215055	HARBOR 2	HOV	R8.02	9.477	5/2/2008
1215015	PEARCE	HOV	R8.3	9.757	5/2/2008
1214771	GARDEN G1	HOV	R8.68	10.137	5/2/2008
1215051	GARDEN G2	HOV	R9.04	10.497	5/2/2008
1215052	GARDEN G2	HOV	R9.04	10.497	5/2/2008
1215041	LEWIS	HOV	R9.44	10.897	5/2/2008
1215108	THE CITY DRIVE	HOV	R9.7	11.261	5/2/2008
1214714	HESPERIAN	HOV	R9.9	11.461	5/2/2008
1214723	BRISTOL	HOV	R10.13	11.691	5/2/2008
1215115	W OF 5	HOV	R10.35	11.911	5/2/2008
1215128	E OF 5	HOV	R10.71	12.271	5/2/2008
1214752	MAIN	HOV	R11.25	12.811	5/2/2008
1214729	GLASSELL1	HOV	R11.68	13.241	5/2/2008

Source: PeMS data

Exhibit 1-9: Westbound SR-22 Detection Added to HOV Facility (2008)

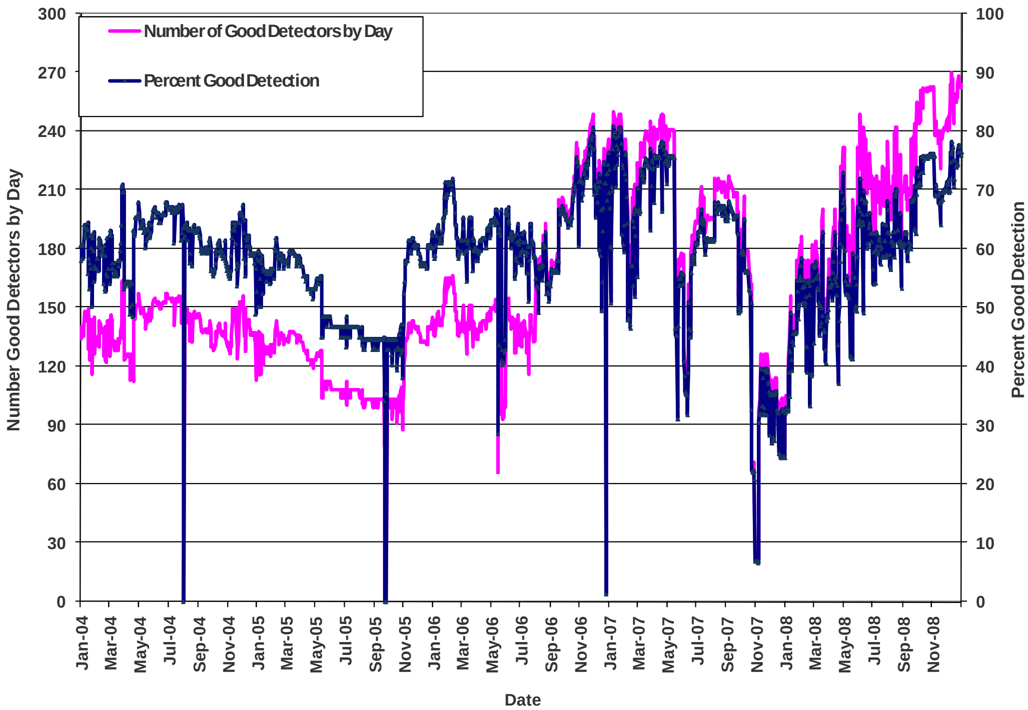
VDS	Location	Type	CA PM	Abs PM	Date Online
WESTBOUND					
1214870	YUMA	HOV	R2.07	3.527	5/2/2008
1215077	KNOTT 1	HOV	R2.49	3.947	5/2/2008
1215097	KNOTT 2	HOV	R2.88	4.337	5/2/2008
1215089	GARDEN GROV	HOV	R3.27	4.727	5/2/2008
1214816	BEACH 1	HOV	R3.45	4.907	5/2/2008
1214811	BEACH 2	HOV	R3.73	5.187	5/2/2008
1214937	WILSON	HOV	R4.03	5.487	5/2/2008
1214952	NEWLAND	HOV	R4.34	5.797	5/2/2008
1214780	MAGNOLIA 1	HOV	R4.6	6.057	5/2/2008
1214832	MAGNOLIA 2	HOV	R4.99	6.447	5/2/2008
1215071	BROOKHUR1	HOV	R5.57	7.027	5/2/2008
1214971	BROOKHUR2	HOV	R5.77	7.227	5/2/2008
1214985	HOPE	HOV	R6.05	7.507	5/2/2008
1215000	WARD	HOV	R6.34	7.797	5/2/2008
1214804	TAFT	HOV	R6.61	8.067	5/2/2008
1214785	EUCLID	HOV	R6.94	8.397	5/2/2008
1215062	NEWHOPE	HOV	R7.29	8.747	5/2/2008
1215249	NEWHOPE CENSUS	HOV	7	8.757	5/2/2008
1214893	HARBOR 1	HOV	R7.72	9.177	5/2/2008
1214899	HARBOR 2	HOV	R7.93	9.387	5/2/2008
1215016	PEARCE	HOV	R8.3	9.757	5/2/2008
1214770	GARDEN G1	HOV	R8.68	10.137	5/2/2008
1215042	LEWIS	HOV	R9.44	10.897	5/2/2008
1214742	CITY DRIVE	HOV	R9.69	11.251	5/2/2008
1214713	HESPERIAN	HOV	R9.9	11.461	5/2/2008
1214706	BRISTOL	HOV	R10.14	11.701	5/2/2008
1215114	W OF 5	HOV	R10.35	11.911	5/2/2008
1215129	E OF 5	HOV	R10.71	12.271	5/2/2008
1214746	MAIN	HOV	R11.23	12.791	5/2/2008
1214727	GLASSELL1	HOV	R11.68	13.241	5/2/2008
1214734	GLASSELL2	HOV	R12.01	13.571	5/2/2008
1215212	CONCORD	HOV	R12.25	13.811	5/2/2008

Source: PeMS data

As of February 2009, the detection coverage on SR-22 is thorough with a detector station in at least every 0.75 miles of the corridor. The largest stretch of the corridor that does not have detection is approximately 0.60 miles and runs from Magnolia to Brookhurst.

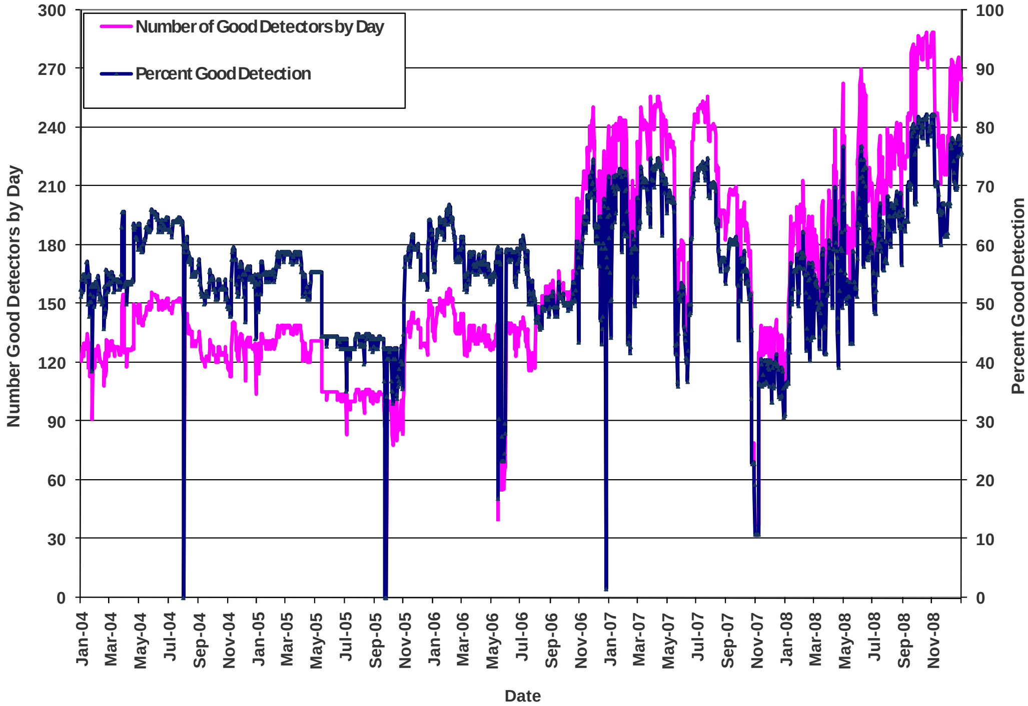
Detection along the I-405 Corridor was overall more consistent than detection on the SR-22 Corridor. The I-405 mainline and HOV facilities experienced similar detection quality patterns. As shown in Exhibits 1-10 through 1-13, both directions of the mainline and HOV facilities experienced mediocre detection quality in 2004, 2005, and 2006 with the majority of detectors reporting around 60 percent "good" data. In the first half of 2007, detection improved, reaching 70-80 percent of good data, but declined significantly in the autumn months of 2007 to less than 40 percent of good data. However, in 2008, detection gradually improved throughout the months, climbing up to and reporting over 70 percent of good data by the end of the year.

Exhibit 1-10: Northbound I-405 ML Number & Percentage of Daily Good Detectors



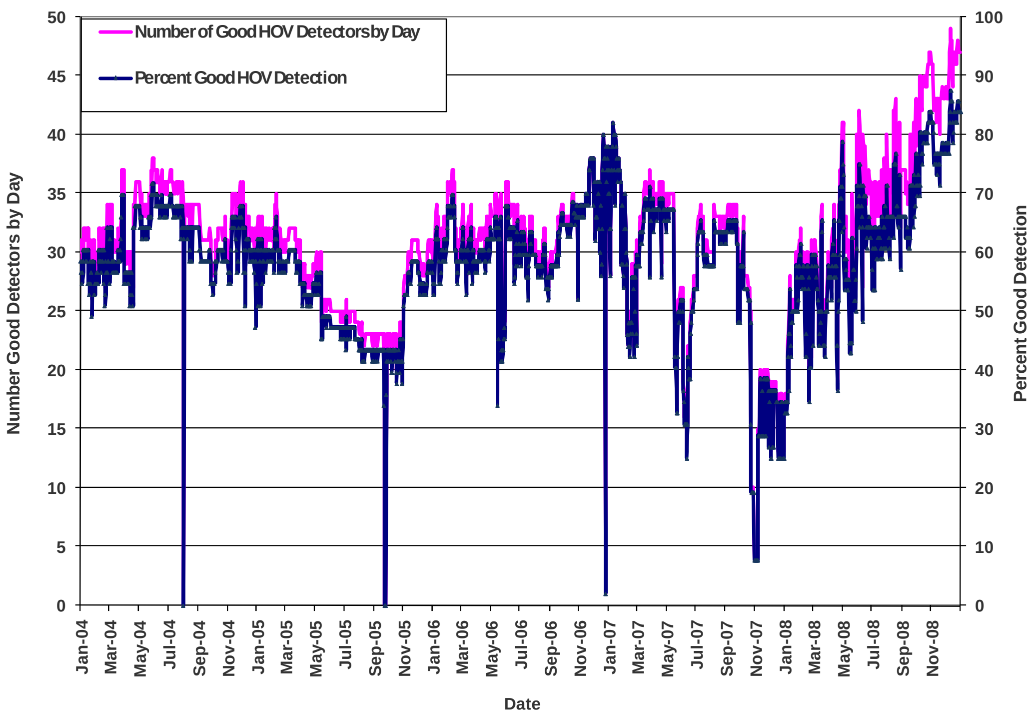
Source: SMG analysis of PeMS data

Exhibit 1-11: Southbound I-405 ML Number & Percentage of Daily Good Detectors



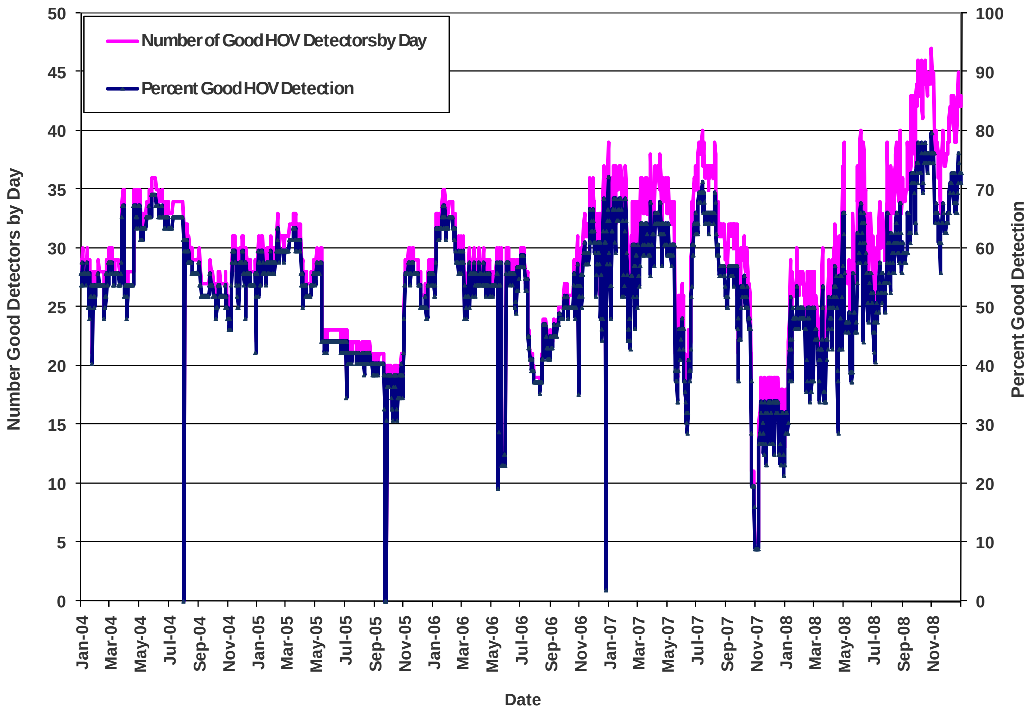
Source: SMG analysis of PeMS data

Exhibit 1-12: Northbound I-405 HOVL
Number & Percentage of Daily Good Detectors



Source: SMG analysis of PeMS data

Exhibit 1-13: Southbound I-405 HOVL
Number & Percentage of Daily Good Detectors



Source: SMG analysis of PeMS data

Unlike SR-22, the I-405 freeway did not experience major construction. Exhibit 1-14 identifies the new detectors added to I-405 in 2007 and 2008, and Exhibit 1-15 identifies the new detectors added to the HOV facility.

Exhibit 1-14: I-405 ML & Ramps Detectors Added (2007-2008)

VDS	Location	Type	CA PM	Abs PM	Date Online
NORTHBOUND					
1211066	N of 5	Mainline	0.6	0.37	5/2/2008
1213963	Sand Canyon 1	Mainline	2.66	2.89	2/14/2007
1213964	Sand Canyon 1	On Ramp	2.66	2.89	2/14/2007
1213965	Sand Canyon 1	Off Ramp	2.66	2.89	2/14/2007
1209076	Spruce	Mainline	5.05	4.82	5/2/2008
1214212	Anton	Mainline	8.7	8.47	5/2/2008
1214265	Anton	On Ramp	8.7	8.47	5/2/2008
1214268	Anton	Fwy-Fwy	8.7	8.47	5/2/2008
1214270	Anton	Off Ramp	8.7	8.47	5/2/2008
1214273	Anton	Fwy-Fwy	8.7	8.47	5/2/2008
1214274	Anton	Fwy-Fwy	8.7	8.47	5/2/2008
1209144	N of 55	Mainline	8.9	8.67	5/2/2008
1209483	N of 55	Fwy-Fwy	8.9	8.67	5/2/2008
1214238	Ave. of Art	Mainline	9.2	8.97	5/2/2008
1214241	Ave. of Art	On Ramp	9.2	8.97	5/2/2008
1214282	Ave. of Art	Off Ramp	9.2	8.97	5/2/2008
1214080	Bear	Mainline	9.9	9.67	2/14/2007
1214461	N of 73	Mainline	10.1	9.87	5/2/2008
SOUTHBOUND					
1201118	N of 5	Mainline	0.60	0.37	5/2/2008
1209070	Spruce	Mainline	5.05	4.82	5/2/2008
1201410	N of 55	Mainline	8.90	8.67	5/2/2008
1209482	N of 55	Fwy-Fwy	8.90	8.67	5/2/2008
1214209	Ave. of Art	Mainline	9.20	8.97	5/2/2008
1214237	Ave. of Art	Mainline	9.20	8.97	5/2/2008
1214240	Ave. of Art	Fwy-Fwy	9.20	8.97	5/2/2008
1214081	Bear	Mainline	9.90	9.67	2/14/2007

Source: PeMS data

Exhibit 1-15: I-405 Detection Added to HOV Facility (2007-2008)

VDS	Location	Type	CA PM	Abs PM	Date Online
NORTHBOUND					
1211067	N of 5	HOV	0.6	0.37	5/2/2008
1213966	Sand Canyon 1	HOV	2.66	2.89	2/14/2007
1209075	Spruce	HOV	5.05	4.82	5/2/2008
1214260	Anton	HOV	8.7	8.47	5/2/2008
1214243	Ave. of Art	HOV	9.2	8.97	5/2/2008
1214082	Bear	HOV	9.9	9.67	2/14/2007
SOUTHBOUND					
1211065	N of 5	HOV	0.60	0.37	5/2/2008
1213967	Sand Canyon 1	HOV	2.89	2.66	2/14/2007
1209068	Spruce	HOV	5.05	4.82	5/2/2008
1214242	Ave. of Art	HOV	9.20	8.97	5/2/2008
1214083	Bear	HOV	9.90	9.67	2/14/2007

Source: PeMS data

Exhibit 1-16 reveals that there are several segments extending over 0.75 miles without detection in each direction on the I-405. These should be considered for deployment of additional detection when funding becomes available.

Exhibit 1-16: I-405 Gaps In Detection (October 16, 2008)

Location	Abs PM		Length (Miles)
	From	To	
NORTHBOUND			
Jeffrey 2 (ML) to Yale (ML)	3.8	4.78	0.98
N of 73 (ML) to Fairview (ML)	9.87	10.67	0.8
SOUTHBOUND			
N of 22 (ML) to Bolsa Chica (ML)	21.33	20.46	0.87
McFadden (ML) to Beach 1 (ML)	17.22	16.37	0.85
Yale (ML) to Jeffrey 2 (ML)	4.78	3.8	0.98

Source: PeMS data

NOTE: The next page is intentionally left blank so that Caltrans can insert updates to the detection analysis results presented in the last four exhibits (Exhibits 1-3 through 1-6) and discuss the ramifications of its findings (e.g., have the gaps been filled, is detector reliability improving or diminishing). Similar place holder pages have been inserted throughout the document to insert future updates.

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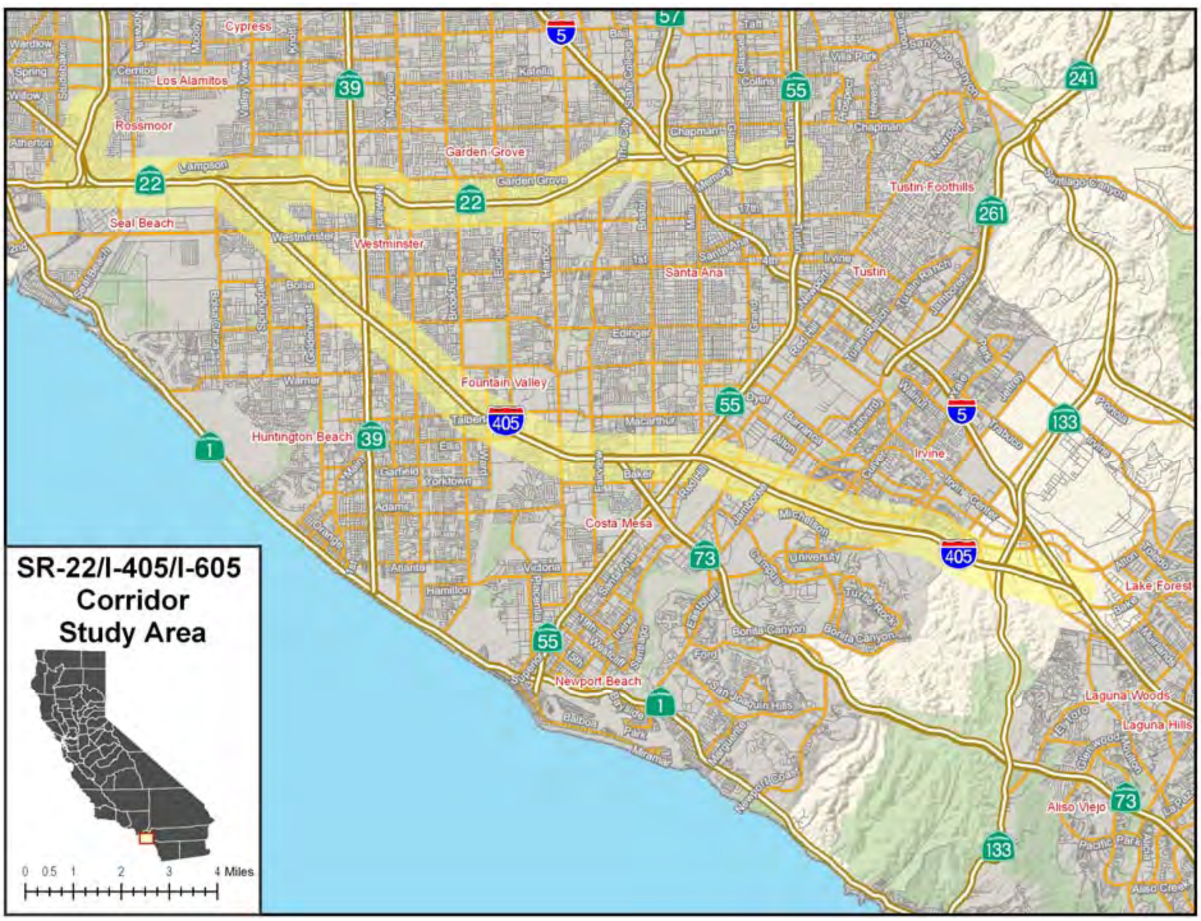
2. CORRIDOR DESCRIPTION

The study corridor includes portions of three state routes, SR-22, I-405, and I-605 in Orange County. The corridor begins at an interchange involving all three freeways at the Los Angeles County border. From there, the corridor runs east along SR-22 (Garden Grove Freeway) to SR-55. The corridor also runs southeast along I-405 (San Diego Freeway) until it reaches I-5 (Golden State Freeway) just outside Irvine. The corridor includes a short, one-mile section of I-605 (San Gabriel River Freeway) as it heads north from the Los Alamitos Curve (SR-22/I-405/I-605) interchange to the Los Angeles County border. The study corridor is highlighted in Exhibit 2-1.

Exhibit 2-1: Map of SR-22 Corridor Study Area



Corridor Roadway Facility

The portion of SR-22 in the study corridor traverses a large part of Orange County and includes all 13 miles of the freeway from its beginning in Seal Beach (Post Mile R0.000) through Westminster, Garden Grove, and Santa Ana to SR-55 (Post Mile R13.164).

SR-22 intersects most of the north-south corridors in Orange County. As Exhibit 2-1 shows, the SR-22 portion of the study corridor includes four major freeway-to-freeway interchanges:

- I-605 provides access to Bellflower, Norwalk, El Monte, Baldwin Park, and other communities in Los Angeles County, while I-405 provides access north to the coastal communities in Los Angeles County and the Los Angeles International Airport.

- I-405 also provides access south in Orange County and this portion is included in the corridor.

- I-5 runs north-to-south, connecting Orange County to Canada, Mexico, Washington State, Oregon, Los Angeles, and San Diego. SR-57 connects the area regionally to Anaheim and eastern Los Angeles County.

- SR-55 forms the north-south spine among Orange County freeways.

According to annual traffic reports from the Caltrans Traffic and Vehicle Data Systems Unit, SR-22 carries between 95,000 and 226,000 annual average daily traffic (AADT)[1] as shown in Exhibit 2-2. The highest traffic occurs near the junction with I-5 and SR-57 in Orange and Santa Ana. Traffic volumes are much less at the eastern and western ends of the corridor.

The portion of the study corridor along I-405 extends 24 miles (Post Mile 0.230 to Post Mile 24.178), paralleling the Orange County coastline from I-5 to SR-22. The I-405 Corridor includes four major freeway-to-freeway interchanges:

- I-5 provides interstate north-south access and continues south to San Diego.

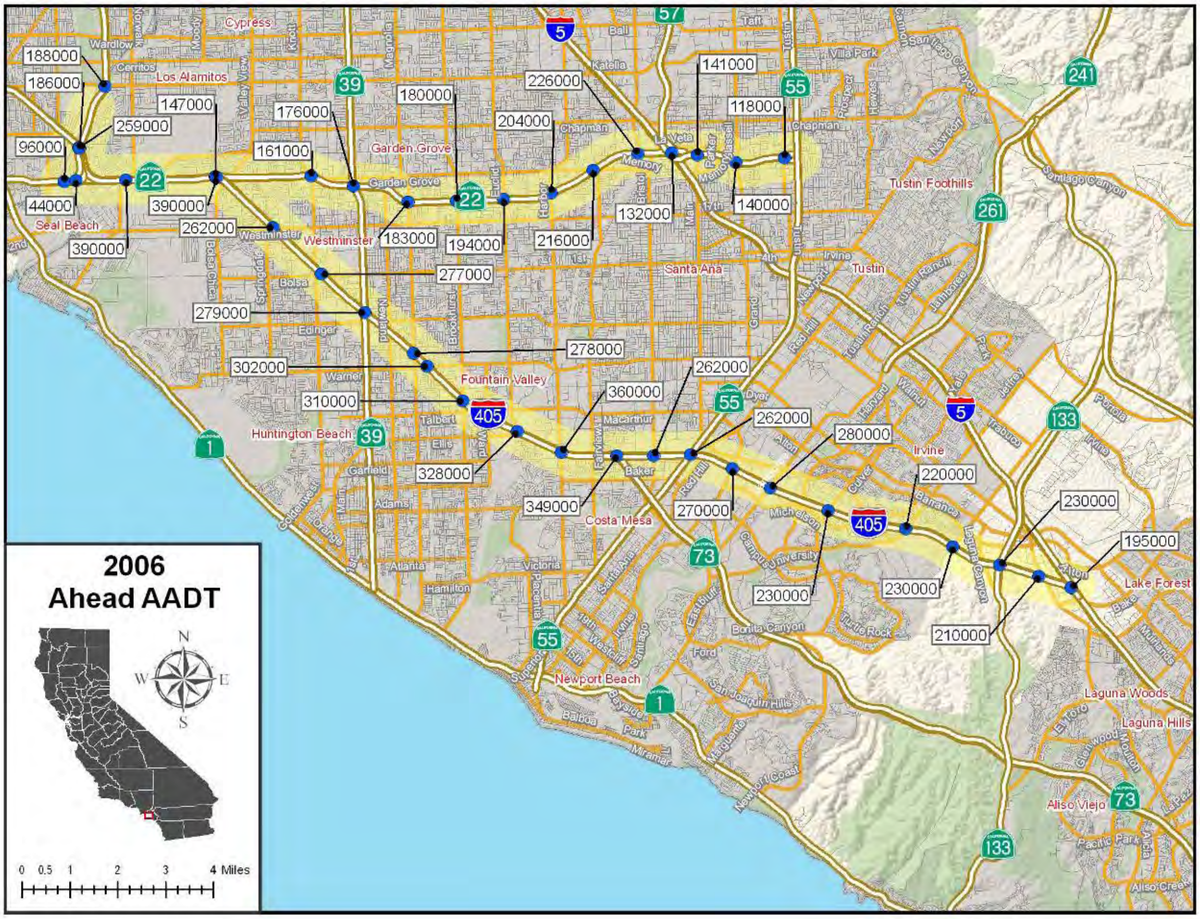
- SR-133 provides access to the Eastern Transportation Corridor.

- SR-55 also connects with SR-22. According to the Orange County Transportation Authority (OCTA), this interchange handles more than 433,000 vehicles daily and is one of the ten busiest in the United States.[2]

- SR-73 runs near the coast and through the University of California at Irvine.

[1] AADT is the total annual volume of vehicles counted divided by 365 days.
[2] http://www.octa.net/I405.aspx

Exhibit 2-2: Major Interchanges and AADT on the SR-22 Corridor



Source: AADT is from the Caltrans Traffic and Vehicle Data Systems Unit[3]

AADT along I-405 ranges from 390,000 at the SR-22/I-405/I-605 interchange to 195,000 where the freeway merges with I-5 in southern Orange County. Traffic steadily declines from north to south, with the exception of a slight increase near Fountain Valley. Traffic is also less in the short corridor section just north of Los Alamitos north to Los Angeles County.

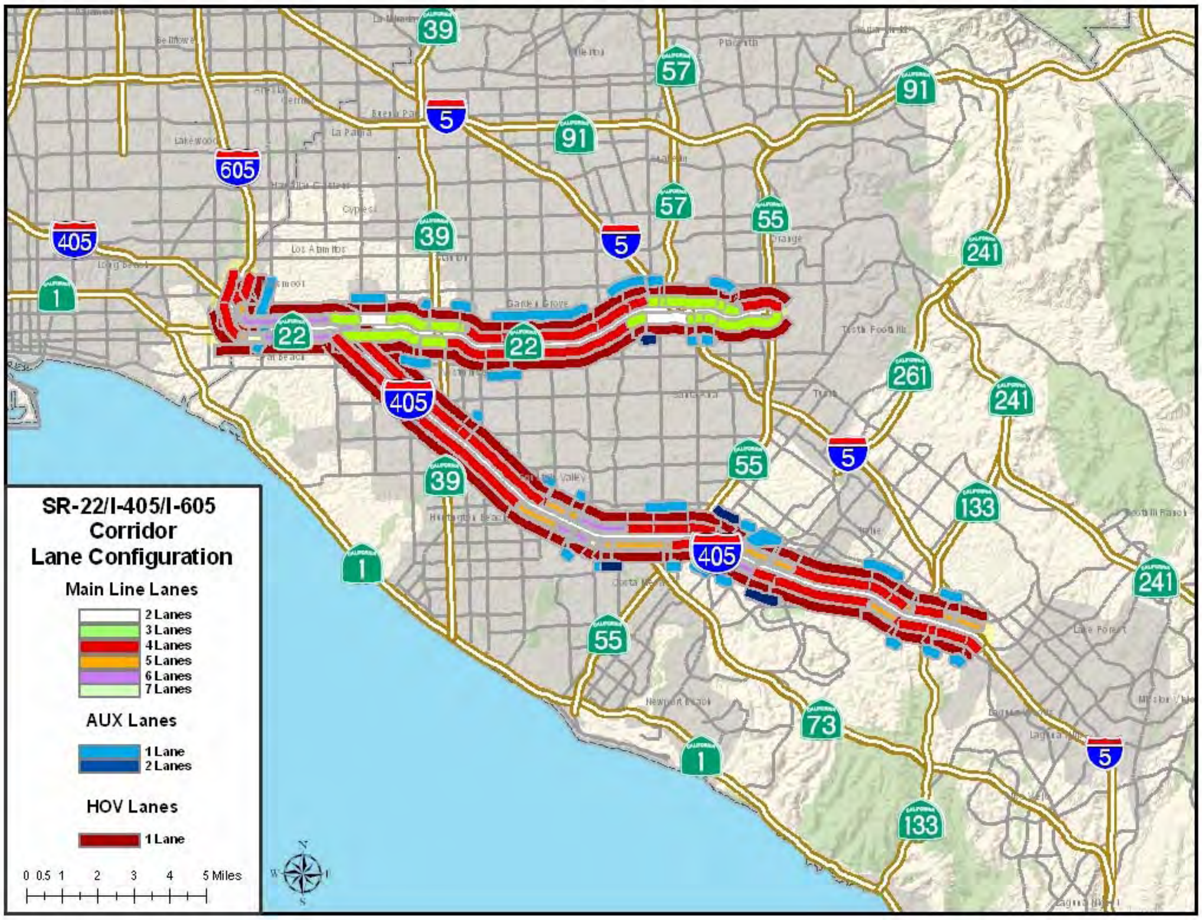
The corridor also includes a one-mile section of I-605 (Post Mile R0.000 to Post Mile R0.879). AADT is only 44,000, but traffic increases dramatically to 186,000 just beyond the corridor study area at Katella Avenue.

In the spring of 2007, the SR-22 widening project was completed, resulting in an eight-lane freeway with an HOV lane in both directions. Like SR-22, I-405 also has an HOV

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

lane in both directions, but it is wider with the majority of the corridor consisting of eight to ten lanes.

Exhibit 2-3: Lane Configurations on SR-22/I-605/I-405 Corridors

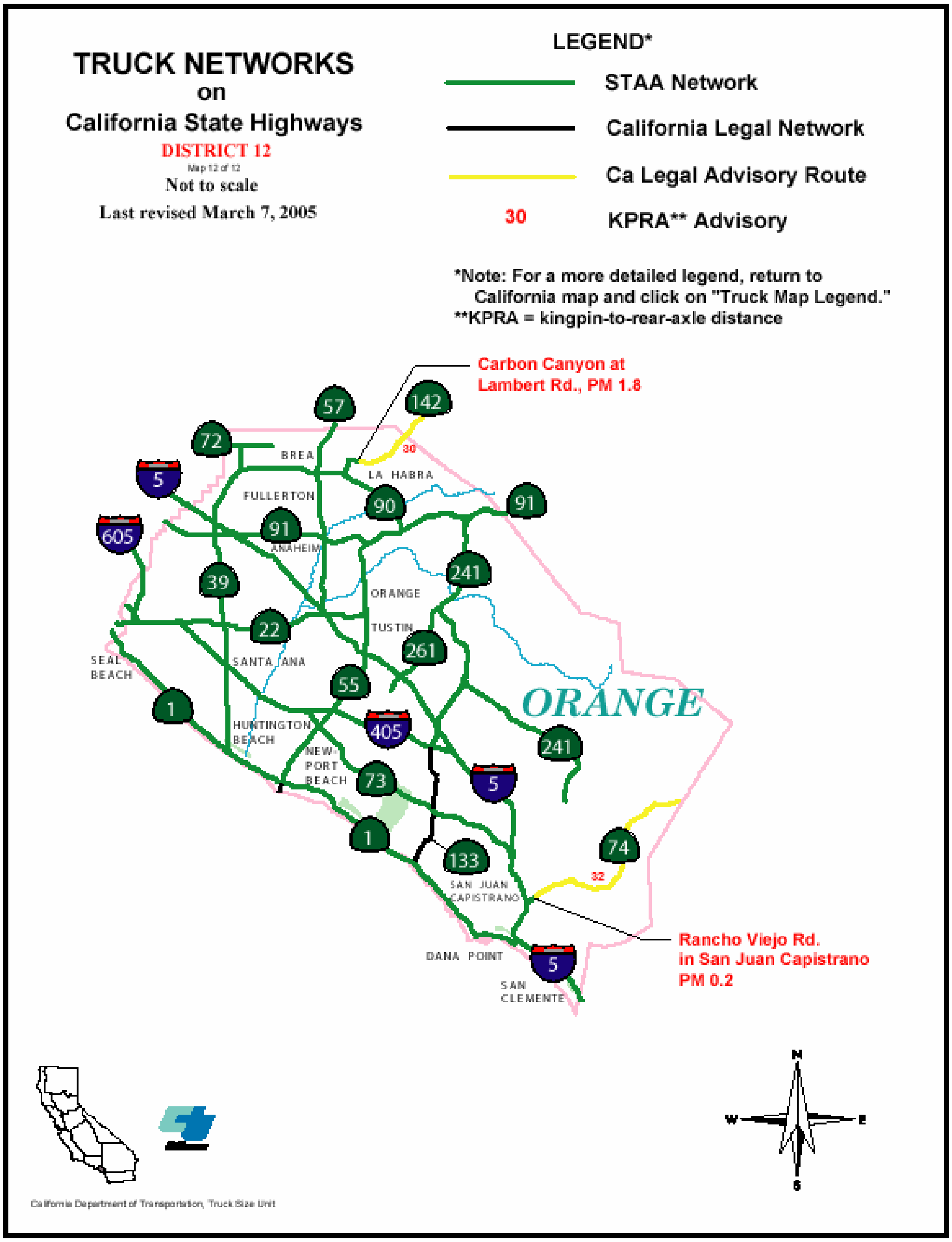


As illustrated in Exhibit 2-4, all three state highways included in the corridor are Surface Transportation Assistance Act (STAA) routes, so large trucks are permitted to operate on them. According to the latest validated truck volumes from the 2005 Caltrans Annual Average Daily Truck Traffic data, trucks comprise the following percentages of total daily traffic along the corridor:

- Between 2.6 and 8.7 percent on SR-22 with the highest percentage at the I-405 Interchange near the Port of Long Beach.
- Between 3.0 and 5.6 percent on I-405 with the highest percentages near the University of California at Irvine and Seal Beach.
- Approximately 4.6 percent on I-605 near the SR-22/I-405/I-605 interchange.

The current Traffic System Network (TSN) records and latest available aerial photos and photologs indicate that the SR-22 Corridor is a six-lane freeway. However, these records are out of date. A recently completed widening project includes an HOV lane in each direction plus additional mixed-flow lanes and auxiliary lanes.

Exhibit 2-4: Orange County Truck Network on California State Highways



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Recent Roadway Improvements

Several roadway improvements have recently been completed along the state routes that comprise the SR-22/I-605/I-405 Corridors. The SR-22 Corridor underwent a project that improved several interchanges and widened the freeway to include an HOV lane in both directions. SR-22 project construction started in September 2004 and completed during the spring of 2007. Along I-405, the Orange County Transportation Authority (OCTA) completed a $135.8 million project in July 2005 to improve the I-405/SR-55 Interchange in Costa Mesa. The interchange was reconfigured with braided connectors to eliminate weaving. HOV connectors were also added at this location. In addition, the neighboring interchange with SR-73 was reconfigured to eliminate a chokepoint. Work on this interchange was completed in July 2004.

Major Investment Study

In 2006, the Orange County Transportation Authority (OCTA) completed the San Diego Freeway (I-405) Major Investment Study (MIS), which examined the transportation needs of western Orange County and is part of OCTA's strategic effort to improve mobility on its corridors in the next 20 years. The MIS analyzed the existing conditions of the corridor in 2005, identified deficiencies along the corridor, and evaluated and recommended improvements for 2030. The MIS resulted in the adoption of a Locally Preferred Alternative, which proposes adding one general purpose lane in each direction between Brookhurst Street and I-605, and adding an auxiliary lane at selected locations. Following the completion of the MIS, a Project Study Report/Project Development Support (PSR/PDS) was completed in 2008 by Caltrans and OCTA.

Corridor Transit Services

Three major public transportation operators provide service near the freeways in the SR-22 Corridor:

- Southern California Regional Rail Authority (SCCRA) - Metrolink
- Amtrak Pacific Surfliner train service
- Orange County Transportation Authority (OCTA).

SCCRA is a joint powers authority that operates regional rail service throughout Southern California. Metrolink commuter rail service stops at 11 stations in Orange County. A total of 44 round trips are provided every weekday on three lines:

- Orange County Line provides service from Los Angeles Union Station to Oceanside.

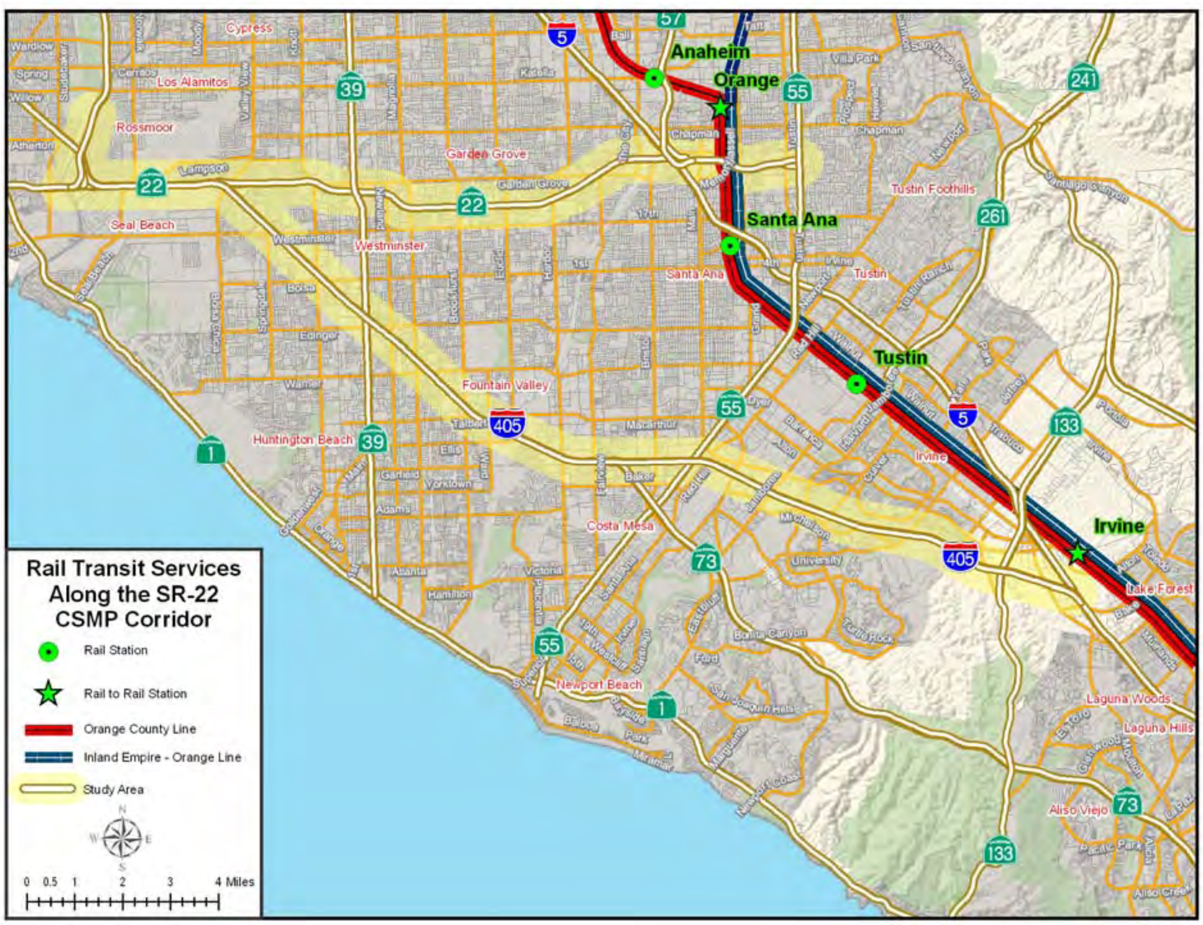
- Inland Empire-Orange County Line provides service from San Bernardino to Oceanside.
- 91 Line provides service Riverside to Los Angeles Union Station, via Fullerton and Buena Park.

While none of these lines operate directly parallel to SR-22 or the full length of I-405, the Orange County and Inland Empire-Orange County lines run along Edinger Avenue within a mile of I-405 in Tustin and Irvine. Over 9,000 people (including riders on the Amtrak Pacific Surfliner) ride the 19 trains operated daily on the Orange County Line. Nearly 4,700 people ride 16 trains on the Inland Empire-Orange County Line.

Amtrak offers Pacific Surfliner rail service along the same route as the Orange County Line. Service is provided 12 times daily in each direction. Metrolink riders can use Pacific Surfliner service as part of the Rail 2 Rail cooperative program.

Exhibit 2-4 shows the primary rail services offered by SCRRA and Amtrak near the study corridor.

Exhibit 2-4: Rail Transit Services near the SR-22 Corridor



Orange County Transportation Authority (OCTA)

OCTA is the primary transit provider in Orange County. It offers 81 fixed routes and paratransit bus service throughout the county. While none of these services operate on SR-22, two routes provide local bus service parallel to SR-22:

- Route 56 runs approximately every 30 minutes from Garden Grove to Orange via Garden Grove Boulevard.

- Route 60 provides service at about 10-minute frequency from Long Beach to Tustin via 7th Street, Westminster Avenue, and 17th Street.

Route 213A provides express weekday service between Fullerton and Irvine via SR-91, SR-55, and I-405 once in the morning and once in the afternoon. This line operates on I-405 between Jamboree Road and SR-55, where it uses the HOV connector.

Route 211 (Seal Beach to Irvine Express) operates along nearly the entire I-405 portion of the corridor. Three buses operate in the morning and four in the afternoon. In the northern end of the corridor, Route 701 provides express service from Huntington Beach to Los Angeles with three buses in the morning and three in the afternoon. In the southern end, two express routes operate along I-405 near the I-5 Interchange:

- Route 212 provides express service (two morning buses and two afternoon buses) from Irvine to San Juan Capistrano via I-405 and surface routes.

- Route 216 provides express service (one morning and one afternoon bus) from San Juan Capistrano to Costa Mesa via I-405.

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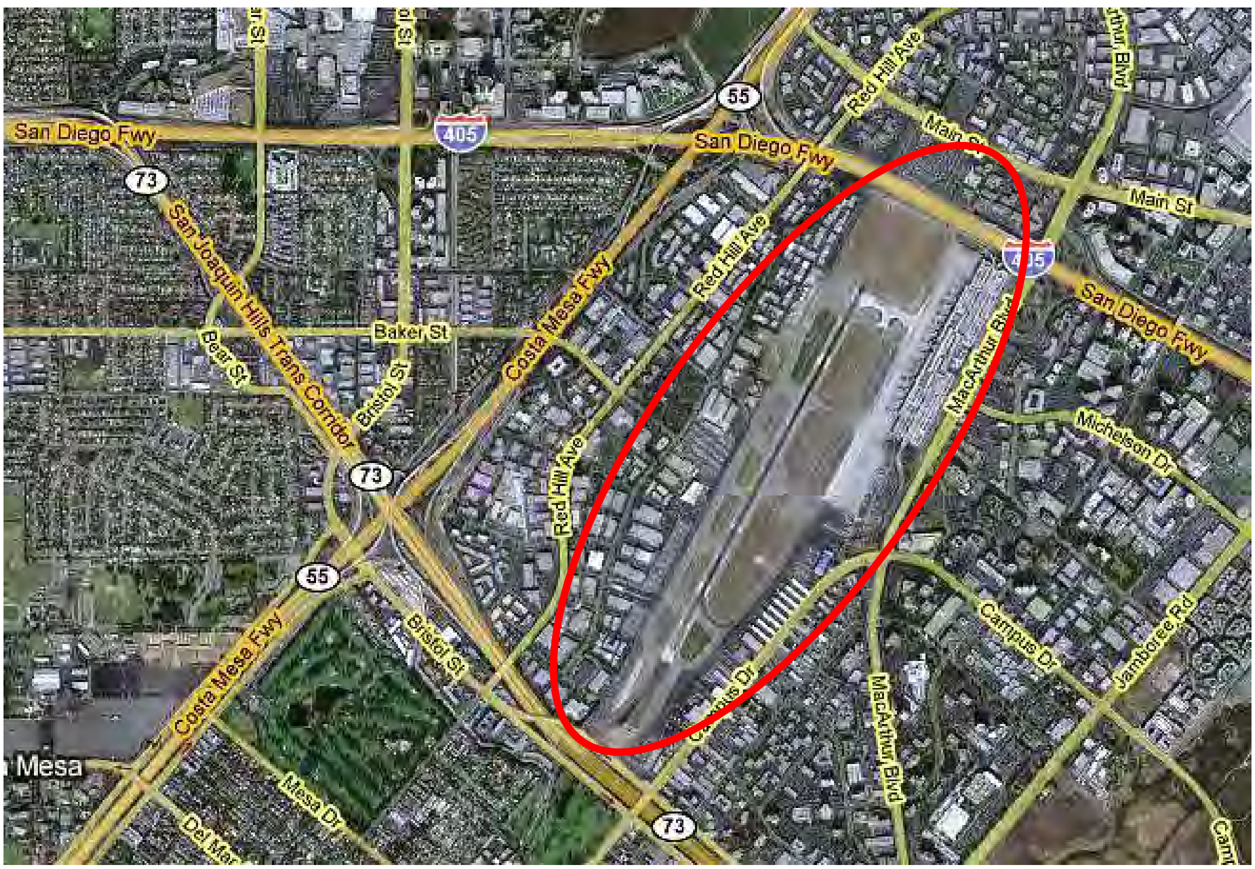
Intermodal Facilities

John Wayne Airport (SNA) is situated in the southern portion of the corridor at the intersection of three freeways (i.e., I-405, SR-55, and SR-73), as shown in Exhibit 2-5. SNA hosts air carrier, general aviation, air taxi, military, and air cargo services. Fourteen commercial and commuter air carriers serve SNA. During September 2007, SNA recorded 782,896 total passengers, including 388,735 enplanements and 394,161 deplanements. In the same month, the airport served 1,967 air cargo tons, of which 1838 tons were carried by all-cargo carriers. Both FedEx and UPS serve SNA.[4]

As of 2006, SNA recorded the 42nd most enplanements in the United States and is ranked seventh in California just ahead of Ontario International Airport (ONT).[5]

Exhibit 2-5: John Wayne Airport (SNA)



[4] Wedge, Jenny. "John Wayne Airport Posts September Statistics (Revised)." *John Wayne Airport News and Facts*. October 11, 2007. John Wayne Airport. 15 May 2008 <http://www.ocair.com/newsandfacts/newsreleases/2007/NR-2007-10-11.html>.
[5] "Passenger Boarding and All-Cargo Data." Federal Aviation Administration. May 2008. Air Carrier Activity Information System (ACAIS). <http://www.faa.gov/airports_airtraffic/airports/planning_capacity/passenger_allcargo_stats/passenger/>.

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Special Event Facilities/Trip Generators

Several major special event facilities are located along SR-22 and I-405 that might contribute several trips to corridor traffic. Exhibit 2-6 shows the location of the most significant traffic generators.

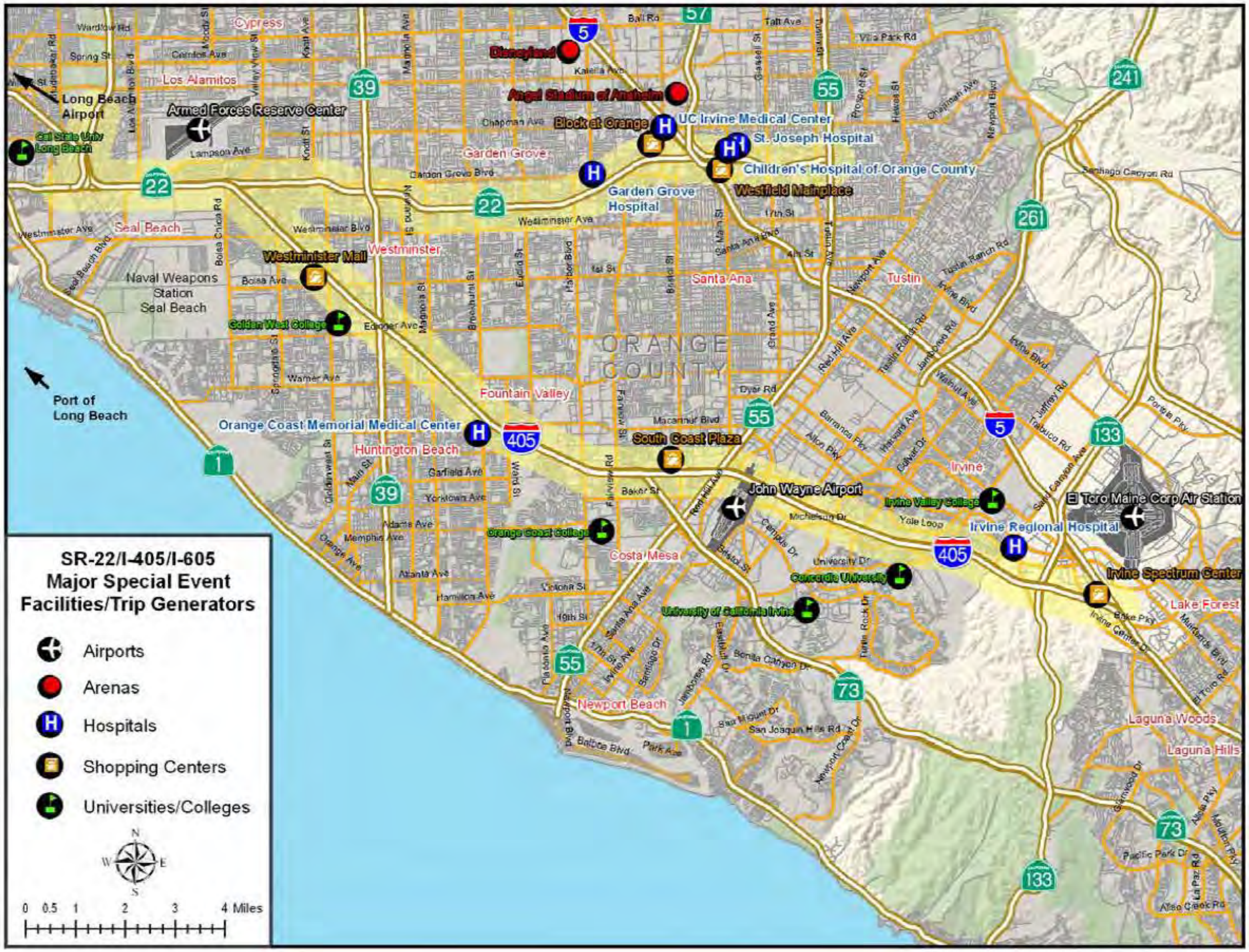
The Angel Stadium of Anaheim and the Honda Center are located less than three miles north of the SR-22/I-5 Interchange. Angel Stadium is home to the Major League Baseball team, the Los Angeles Angels of Anaheim, and the Honda Center is home to the National Hockey League's Anaheim Ducks. The Honda Center hosts other events including World Wide Wrestling events, the annual John R. Wooden Classic, the 2008 NCAA Men's Basketball Tournament West Regional, and a number of concerts and performances. Angel Stadium has a seating capacity of approximately 45,050 while Honda Center has a seating capacity of approximately 17,200. Although these two facilities primarily impact SR-91 and SR-57, they also affect SR-22 and I-405.

The Disneyland Resort and Theme Park is another major trip generator along SR-22. It is located approximately three and a half miles north of SR-22 on Harbor Blvd. and is second busiest amusement park in the world with an average daily attendance of nearly 40,000 patrons. The Disneyland Resort directly employs over 20,000 people, making it Orange County's largest employer and one of the largest sing-site private employers in the state.

There are seven major universities/colleges near the SR-22 and I-405 that can also generate significant trips:

- Cal State University Long Beach (CSULB) is located approximately 3 miles west of the SR-22/I-405 junction. It is the second largest campus of the California State University system with an enrollment of over 35,000 students each year.
- Santa Ana College, a public community college with over 25,000 students enrolled, is located at the corner of Bristol and 17th Street in Santa Ana, approximately 1.5 miles south of SR-22.
- Golden West College is located further south on I-405 in the City of Huntington Beach. It is a medium sized two-year college that serves 13,000 students.
- The University of California, Irvine (UCI) is located approximately four miles south of I-405 and north of SR-73. This four-year public university offers Bachelors, Masters, and Doctorates Degree programs, and has an estimated enrollment of 24,500 students.
- Less than three miles east from UCI, is Concordia University, a private Lutheran liberal arts institution located two miles south of I-405 off of University Dr. It has an estimated enrollment of 2,300 students.

Exhibit 2-6: Major Special Event Facilities or Trip Generators



- Irvine Valley College is less than 2 miles north of I-405 off of Jeffrey Road. It is a public community college with over 13,000 students enrolled. In addition to these educational facilities, Orange County is comprised of 28 school districts. Near the SR-22 and I-405 freeways, there are ten school districts that could affect the corridors in the mornings and afternoons.
- Orange Coast College, a public community college with over 28,000 students enrolled, is located on Fairview Road in Costa Mesa, approximately 2 miles south of I-405.

The eight major medical facilities that lie in close proximity to SR-22 and I-405 which can generate significant trips include:

- The Garden Grove Hospital and Medical Center is a 167-bed acute care medical facility and is the largest employer in the City of Garden Grove. It is located less than a mile north of SR-22 on Garden Grove Blvd.
- The UC Irvine Medical Center, the only university hospital in the County, is located north of SR-22 and immediately west of I-5 in the City of Orange. The facility has more than 400 specialty and primary care physicians and offers a full range of acute and general care services.
- St. Joseph Hospital is located north of SR-22 and east of I-5 on Main Street. It is the largest and one of the highest volume hospitals in the County with a 1,000-member medical staff.
- The Children's Hospital of Orange County (CHOC) is adjacent to St. Joseph Hospital and is the first hospital in Orange County to open an emergency room for children.
- The Orange Coast Memorial Medical Center is located less than a mile west of I-405 on Talbert Avenue in the City of Fountain Valley.
- The Irvine Regional Hospital and Medical Center is a full service hospital with 176 private rooms, equipped to handle various inpatient and outpatient procedures. It is located half a mile northeast of I-405 on Sand Canyon Avenue.
- The Fountain Valley Regional Hospital and Medical Center is a 400-bed, full-service, acute care facility located on Euclid Street in Fountain Valley, approximately 2 miles north of I-405. It provides a comprehensive range of health services including 24-hour emergency care, cardiology services, maternity care, advanced neonatal and pediatric intensive care, and a number of specialties. The hospital has a medical staff of approximately 1,100 and an employee base of 1,500 people.
- A new Kaiser Permanente Hospital in Irvine opened its door on May 14, 2008. This 434,000 square-foot medical facility is the county's largest HMO hospital and is located on Alton Parkway, north of I-405.

The five major shopping malls near SR-22 and I-405 that may generate significant trips include:

- Along SR-22 and west of I-5 in the City of Orange, is the outdoor shopping mall, The Block at Orange. The Block is popular for its skateboarding facility and thriving nightlife.
- Further east along SR-22 and east of I-5 is the Westfield Main Place, a mall in the City of Santa Ana that features over 200 specialty shops.
- In the City of Westminster, along I-405 and Bolsa Avenue, is the Westminster Mall, which houses over 180 specialty shops.
- Further south along I-405 and west of SR-55 interchange in the City of Costa Mesa is South Coast Plaza, Orange County's largest shopping mall. South Coast Plaza is an upscale shopping center with over 280 stores and approximately 24 million visitors annually.
- Lastly, along the I-5/I-405 Interchange is the Irvine Spectrum Center. The Irvine Spectrum is an outdoor mall with a 21-multiplex cinema and IMAX with two major department stores and over 130 specialty stores.

The El Toro Marine Corp Air Station also has potential to be a large trip generator. Located near the I-5/I-405 junction, the facility was decommissioned in 1999 with portions conveyed to the cities and public institutions, as well as being sold to private developers for a combination of residential, commercial, educational, and public recreational and open-space uses.

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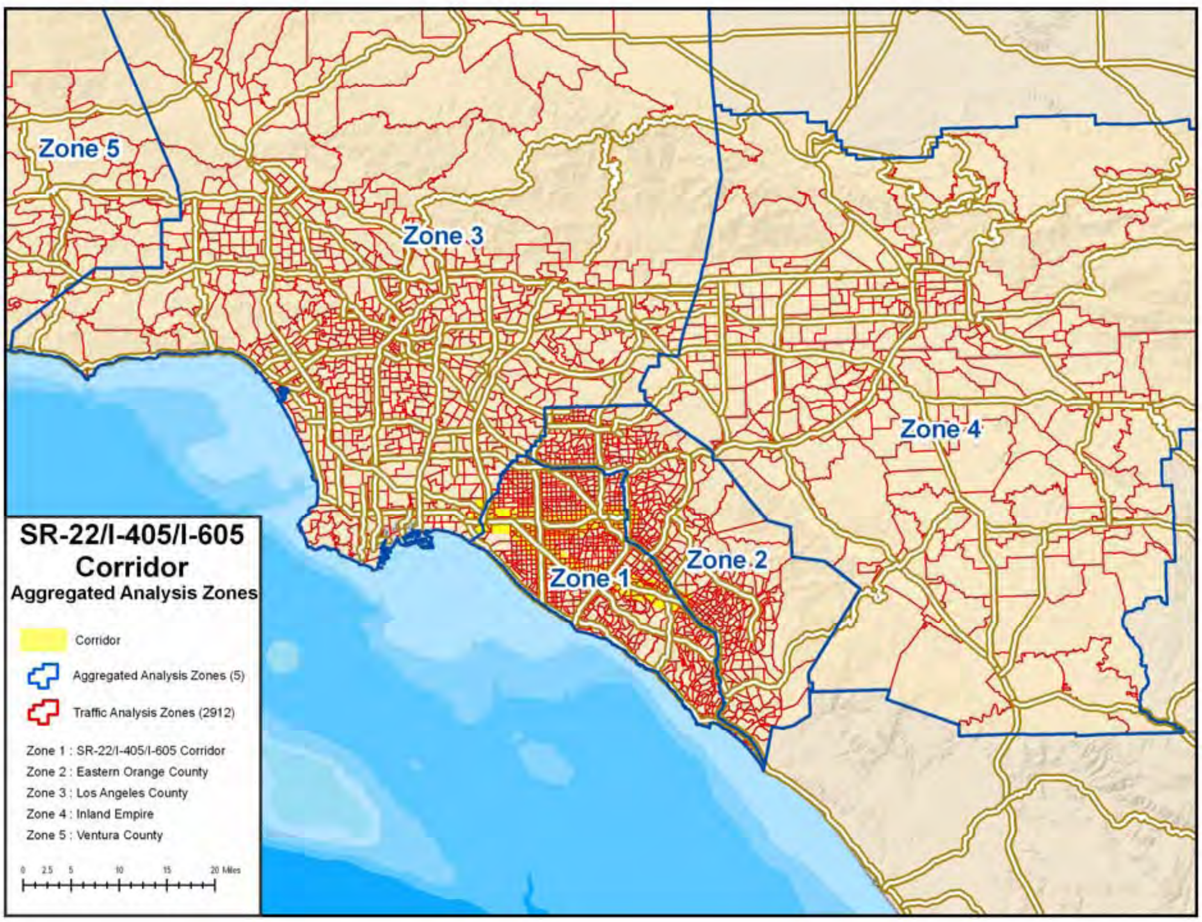
Demand Profiles

An analysis of origins and destinations was conducted to determine the travel pattern of trips made on the SR-22 CSMP study corridor. Based on OCTA's travel demand model, this "select link analysis" isolated the three freeways that comprise the SR-22 CSMP study corridor (SR-22, I-405, I-605) and identified the origins and destinations of trips made on these corridors. The origins and destinations were identified by Traffic Analysis Zones (TAZ), which were grouped into seven aggregate analysis zones shown in Exhibit 2-7.

Exhibit 2-7: Aggregate Analysis Zones for Demand Profile Analysis



Based on this aggregation, demand on the corridor was summarized by aggregated origin-destination zones as shown on Exhibits 2-8 and 2-9 for the AM and PM peak periods. The analysis showed that a significant percentage of trips using the SR-22 Corridor involve inter-county trips.

During the AM peak period, only about 44 percent of all trips originate and terminate in Orange County (Zones 1 or 2). The remaining trips originate in Orange County and terminate in another county (26 percent), originate outside Orange County and terminate in Orange County (25 percent), or originate and terminate outside Orange County (6 percent).

Exhibit 2-8: SR-22 AM Peak Origin Destination by Aggregated Analysis Zone

		TO ZONE					
	AM Trips	SR-22/ I-405/ I-605	Eastern Orange County	LA County	Inland Empire	Ventura County	Outside Zones
FROM ZONE	SR-22/ I-405/ I-605	18,234	5,641	11,150	3,092	83	22
	Eastern OC	7,755	2,191	4,266	1,176	28	10
	LA County	10,719	3,140	2,417	770	7	40
	Inland Empire	3,729	1,129	940	309 *1	3	12
	Ventura County	168	48	11	8	0	2
	Outside Zones	104	29	149	39	7	1

Trips starting and ending in Orange County ~ 44%
Trips starting in Orange County and ending outside of Orange County ~ 26%
Trips starting outside of Orange County and ending in Orange County ~ 25%
Trips starting and ending outside of Orange County ~ 6%

*1 Note that travel demand models sometimes assign a small number of trips to unusual routing. The 309 trips shown in the table originating from and terminating in the Inland Empire represent such an anomaly.

The picture is similar for the PM peak period, which experiences around 28 percent more demand than the AM. Around 44 percent of trips originate and terminate in Orange County. The remaining trips originate in Orange County and terminate in another county (25 percent), originate outside Orange County and terminate in Orange County (25 percent), or originate and terminate outside Orange County (7 percent).

Exhibit 2-9: SR-22 PM Peak Origin Destination by Aggregated Analysis Zone

		TO ZONE					
	PM Trips	SR-22/ I-405/ I-605	Eastern Orange County	LA County	Inland Empire	Ventura County	Outside Zones
FROM ZONE	SR-22/ I-405/ I-605	25,449	9,883	15,568	4,794	185	63
	Eastern OC	8,473	2,933	4,993	1,539	61	30
	LA County	14,994	5,234	4,076	1,311	46	135
	Inland Empire	4,319	1,510	1,145	392 *2	4	37
	Ventura County	192	54	38	10	0	4
	Outside Zones	62	15	81	24	3	0

Trips starting and ending in Orange County ~ 44%
Trips starting in Orange County and ending outside of Orange County ~ 25%
Trips starting outside of Orange County and ending in Orange County ~ 25%
Trips starting and ending outside of Orange County ~ 7%

*2 Note that travel demand models sometimes assign a small number of trips to unusual routing. The 392 trips shown in the table originating from and terminating in the Inland Empire represent such an anomaly.

The origin-destination pattern for I-405 is similar to SR-22 with less than half of all trips occurring entirely within Orange County. During the AM peak period, about 46 percent of all trips originate and terminate in Orange County (Zones 1 or 2). The remaining trips originate in Orange County and terminate in another county (22 percent), originate outside Orange County and terminate in Orange County (26 percent), or originate and terminate outside Orange County (5 percent).

Exhibit 2-10: I-405 AM Peak Origin Destination by Aggregated Analysis Zone

		TO ZONE					
	AM Trips	SR-22/ I-405/ I-605	Eastern Orange County	LA County	Inland Empire	Ventura County	Outside Zones
FROM ZONE	SR-22/ I-405/ I-605	36,335	16,076	21,301	5,695	240	381
	Eastern OC	16,934	7,295	7,271	1,963	87	172
	LA County	23,266	6,982	4,746	1,308	89	163
	Inland Empire	7,377	2,329	1,400	363	*3 7	48
	Ventura County	571	170	72	14	0	8
	Outside Zones	1,497	625	538	155	23	2

Trips starting and ending in Orange County ~ 46%
Trips starting in Orange County and ending outside of Orange County ~ 22%
Trips starting outside of Orange County and ending in Orange County ~ 26%
Trips starting and ending outside of Orange County ~ 5%

*3 Note that travel demand models sometimes assign a small number of trips to unusual routing. The 363 trips shown in the table originating from and terminating in the Inland Empire represent such an anomaly.

The pattern is again similar during the PM peak period, which experiences around 27 percent more demand than the AM peak period. Almost half of all trips (48 percent) originate and terminate in Orange County. The remaining trips originate in Orange County and terminate in another county (25 percent), originate outside Orange County and terminate in Orange County (21 percent), or originate and terminate outside Orange County (5 percent).

Exhibit 2-11: I-405 PM Peak Origin Destination by Aggregated Analysis Zone

		TO ZONE					
	PM Trips	SR-22/ I-405/ I-605	Eastern Orange County	LA County	Inland Empire	Ventura County	Outside Zones
FROM ZONE	SR-22/ I-405/ I-605	62,488	30,123	38,247	11,611	728	2,256
	Eastern OC	10,632	4,963	3,004	944	76	76
	LA County	34,298	11,029	4,641	1,500	0	696
	Inland Empire	915	401	261	62	*4 0	49
	Ventura County	192	82	76	3	0	15
	Outside Zones	1,908	585	2,867	638	199	3

Trips starting and ending in Orange County ~ 48%
Trips starting in Orange County and ending outside of Orange County ~ 25%
Trips starting outside of Orange County and ending in Orange County ~ 21%
Trips starting and ending outside of Orange County ~ 5%

*4 Note that travel demand models sometimes assign a small number of trips to unusual routing. The 62 trips shown in the table originating from and terminating in the Inland Empire represent such an anomaly.

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3. CORRIDOR-WIDE PERFORMANCE AND TRENDS

This section summarizes the analysis results of the performance measures used to evaluate the existing conditions of the SR-22 CSMP 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 of analysis and modeling for SR-22 is 2008 (post-construction) and for I-405 is 2006.

The performance measures focus on four key areas:

- **Mobility** describes how well the corridor moves people and freight
- **Reliability** captures the relative predictability of the public's travel time
- **Safety** captures the safety characteristics in the corridor such as collisions
- **Productivity** describes the productivity loss due to inefficiencies in the corridor
- **Pavement Condition** describes the structural adequacy and ride quality of the pavement.

MOBILITY

Mobility describes how well the corridor moves people and freight. The mobility performance measures are both readily measurable and straightforward for documenting current conditions and are readily forecast making them useful for future comparisons. Two primary measures are typically used to quantify mobility: delay and travel time.

Delay

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

$$(\text{Vehicles Affected per Hour}) \times (Distance) \times (Duration) \times \left[\frac{1}{(\text{Congested Speed})} - \frac{1}{\text{35mph}} \right]$$

In the formula above, the *Vehicles Affected per Hour* value depends on the methodology used. Some methods assume a fixed flow rate (e.g., 2,000 vehicles per hour per lane), while others use a measured or estimated flow rate. The distance is the length under which the congested speed prevails and the duration is the hours of congestion experience below the threshold speed.

However, all delays can be computed by replacing the “35 mph” with “60 mph” in the previous formula. Different reports and studies use one of the two versions of this formula. The HICOMP report discussed next uses the 35 mph formula and assumes 2,000 vehicles per hour per lane are experiencing the delay. HICOMP therefore reports on only severe delay, while the PeMS results shown after use the 60 mph formula and uses the actual number of vehicles reported by the detection systems and therefore represents overall delay. The results of these two sources are difficult to compare due to the methodological differences. Each is therefore discussed separately.

<u>Caltrans HICOMP</u>

The HICOMP report has been published annually by Caltrans since 1987.[6] Delay is presented as average daily vehicle-hours of delay (DVHD). The HICOMP defines delay as travel time in excess of free-flow travel time when speeds dip below 35 mph for 15 minutes or longer.

For the HICOMP report, probe vehicle runs are performed only two to four days during the entire year for the mainline facility only. (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 is discussed later in the section on PeMS data, congestion levels vary from day to day and depend on any number of factors including accidents, weather, and special events.

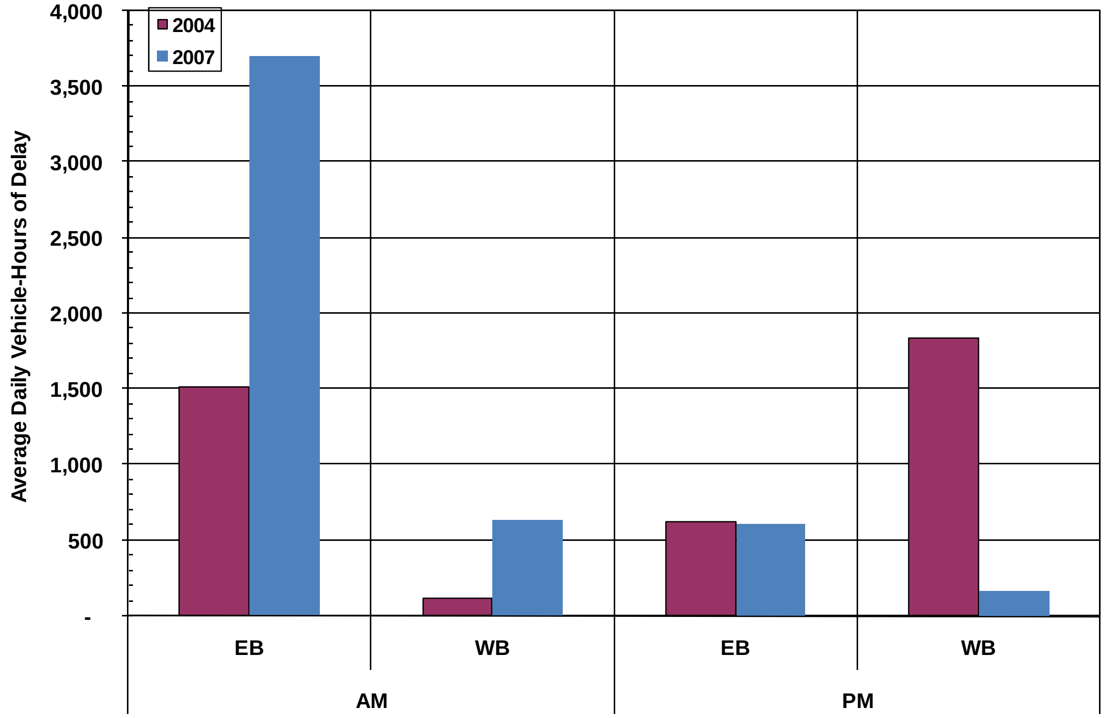
Exhibit 3-1 shows the yearly delay trend for SR-22 in 2004 and 2007 during the AM and PM peak periods for both directions. Data for 2005 and 2006 is not included in the exhibit because it was not available. From the year 2004 to 2007, congestion increased during the AM peak in both directions, and decreased during the PM peak. The eastbound direction experienced the heaviest congestion in 2004 and 2007 during the AM peak, while the westbound direction experienced the most congestion in 2004 during the PM peak.

Exhibit 3-2 illustrates the yearly delay trends for I-405 in 2006 and 2007 during the AM and PM peak periods. HICOMP information for 2005 was not available. The exhibit reveals that congestion increased in the northbound direction during both peak periods, but decreased in the southbound direction during both peak periods between 2006 and 2007.

It should be noted that changes in delay from one year to the next may not be significant given the limited number of days on which data is collected. Trends over several years can be deemed significant.

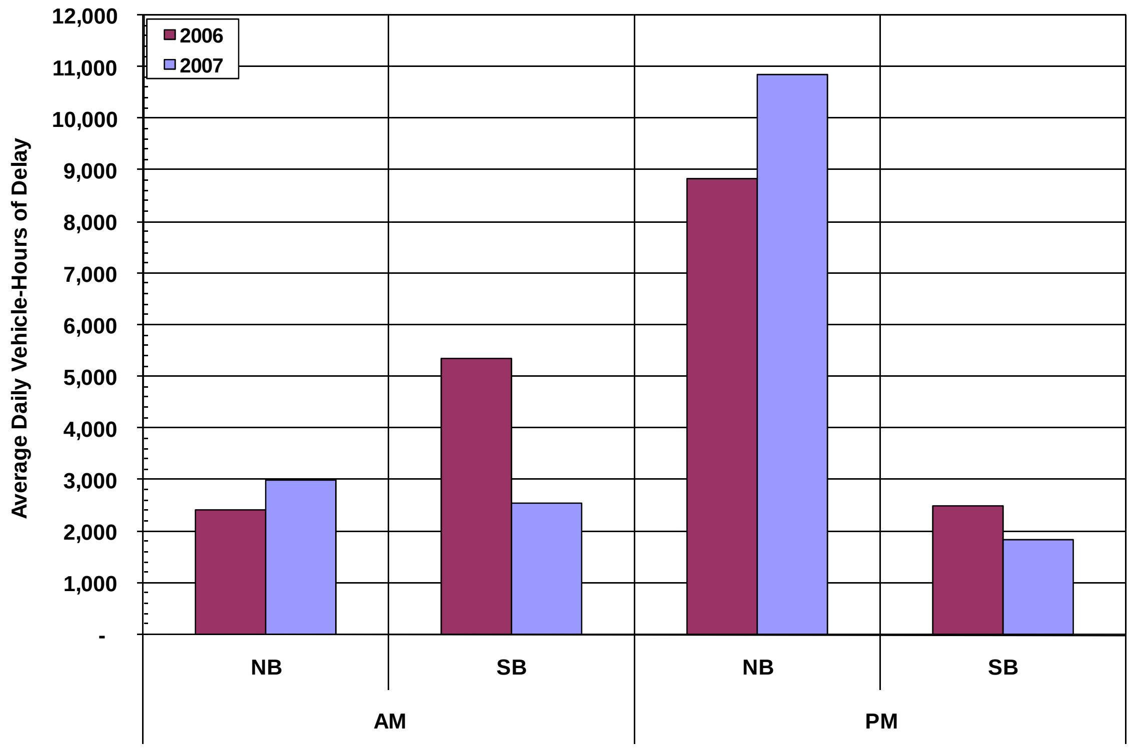
[6] Located at: http://www.dot.ca.gov/hq/traffops/sysmgtpl/HICOMP/index.htm

Exhibit 3-1: SR-22 ML Average Daily Vehicle-Hours of Delay (2004 & 2007)



Source: 2004 & 2007 HICOMP Reports

Exhibit 3-2: I-405 ML Average Daily Vehicle-Hours of Delay (2006-2007)



Source: 2006 & 2007 HICOMP Reports

Exhibit 3-3 identifies the complete list of congested segments reported by the HICOMP Report for SR-22. The most congested segment was in the eastbound direction from Newland Street to Main Street with 1,507 hours (in 2004) and 3,701 hours of delay (in 2007) during the AM peak. From 2004 to 2007, overall congestion increased on the freeway, most notably during the AM peak from 1,623 hours of delay in 2004 to 4,340 hours in 2007. This is an increase of more than 250 percent.

Exhibit 3-3: SR-22 ML HICOMP Congested Segments (2004 & 2007)

Period	Dir	Generalized Congested Area	Generalized Area Congested	
			2004	2007
AM	EB	Newland St to Main St	1,507	3,701
	WB	Goldenwest St to Valley View St	116	639
AM PEAK PERIOD SUMMARY			1,623	4,340
PM	EB	Garden Grove Bl to Springdale St	64	
		Newland St to Magnolia St	33	
		Magnolia St to Deodara Rd	59	
		Brookhurst St to Taft St	84	
		Euclid St to Garden Grove Bl	211	
		Town & Country to w/o Parker St	43	
		Parker St to Cambridge St	123	
		w/o Harbor Blvd to Parker St		609
	WB	e/o Blue Spruce Ave to Main St	826	168
		Tustin Ave to Lewis St	1,010	
PM PEAK PERIOD SUMMARY			2,453	777
TOTAL CORRIDOR CONGESTION			4,076	5,117

Note: 2005 and 2006 HICOMP not available for the SR-22.

Exhibit 3-4 identifies the list of congested segment for I-405. The most congested segment on the corridor was in the northbound direction from Harvard Avenue to Harbor Boulevard during the PM peak. Delay in this segment totaled 7,748 hours of delay in 2007. In 2006, the most congested segment occurred in a different location - Sand Canyon Avenue and Harbor Boulevard. In 2006, the most congested segment was also in the northbound direction during the PM peak. From 2006 to 2007, total corridor congestion decreased during the AM peak by approximately 30 percent and increased during the PM peak by about 12 percent.

Exhibit 3-4: I-405 ML HICOMP Congested Segments (2006 & 2007)

Period	Dir	Generalized Congested Area	Generalized Area Congested 2006	Generalized Area Congested 2007
AM	NB	Irvine Ctr Dr to Jamboree Bl	1,757	
		Harbor Bl to Jnct 605	656	
		Irvine Center Dr to s/o Macarthur Blvd		2,428
		Brookhurst St to LA County Line		569
	SB	Harbor Bl to Jeffrey Rd	257	
		Jnct 22 to Harbor Bl	5,088	
		n/o Bolsa Chica St to Brookhurst St		2,417
		Harbor Blvd to University Dr		112
AM PEAK PERIOD SUMMARY			7,758	5,526
PM	NB	Sand Canyon Av to Harbor Bl	5,765	
		Harbor Blvd to Jnct 605	3,066	
		Harvard Ave to Habor Blvd		7,748
		Harbor Blvd to LA County Line		3,092
	SB	LA County Line to Magnolia/Warner	363	
		SR-55 to Sand Canyon Av	2,113	
		LA County Line to Newland St		381
		Red Hill Ave to n/o Sand Cayon Ave		1,456
PM PEAK PERIOD SUMMARY			11,307	12,677
TOTAL CORRIDOR CONGESTION			**19,065**	**18,203**

Source: 2006 & 2007 HICOMP Reports

Exhibits 3-5 and 3-6 present the congestion information on maps for the AM and PM peak commute periods in 2007. The maps show the congestion on both freeways (SR-22 and I-405). The approximate locations of the congested segments, the duration of that congestion, and the reported recurrent daily delay are also shown. More "generalized" congested segments were created so that segment comparisons can be made from one year to the next.

Exhibit 3-5: HICOMP ML Congested Segments Map - AM Peak Period (2007)

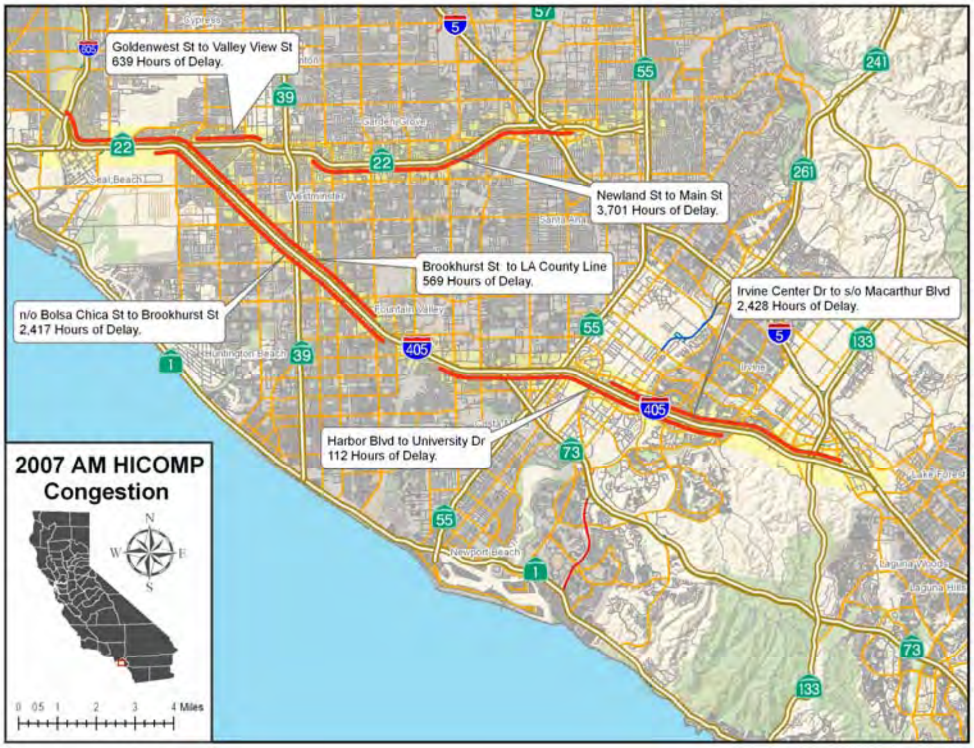
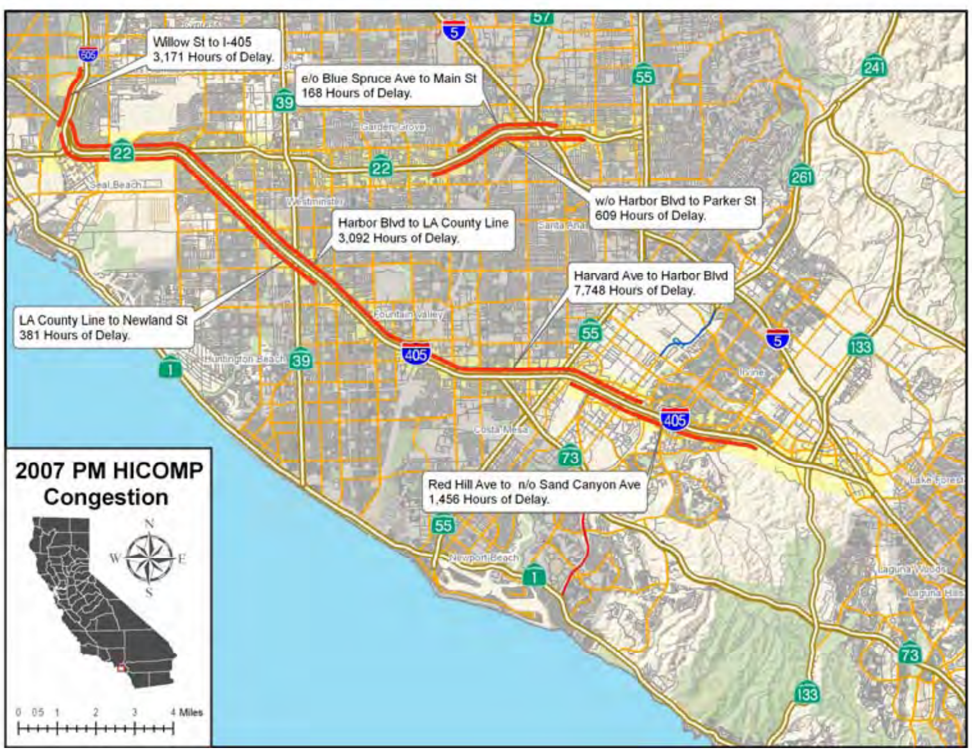


Exhibit 3-6: HICOMP ML Congested Segments Map - PM Peak Period (2007)



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Freeway Performance Measurement System (PeMS)

Using freeways detector data discussed in Section 1 and accessed via PeMS, delay is computed for every day and summarized in various ways, which is not possible when using probe vehicle data. Performance assessments were initially conducted during the three-year period of 2002-2004 (pre-construction) for the SR-22 Corridor, and 2004-2006 for the I-405 Corridor. These assessments were recently supplemented to include more recent data.

Unlike HICOMP where delay is captured only for speeds below 35 miles per hour and applied to an assumed output or capacity volume of 2,000 vehicles per hour, delays presented in this section represent the difference in travel time between actual conditions and free-flow conditions at 60 miles per hour, applied to the actual output flow volume collected from a vehicle detector station.

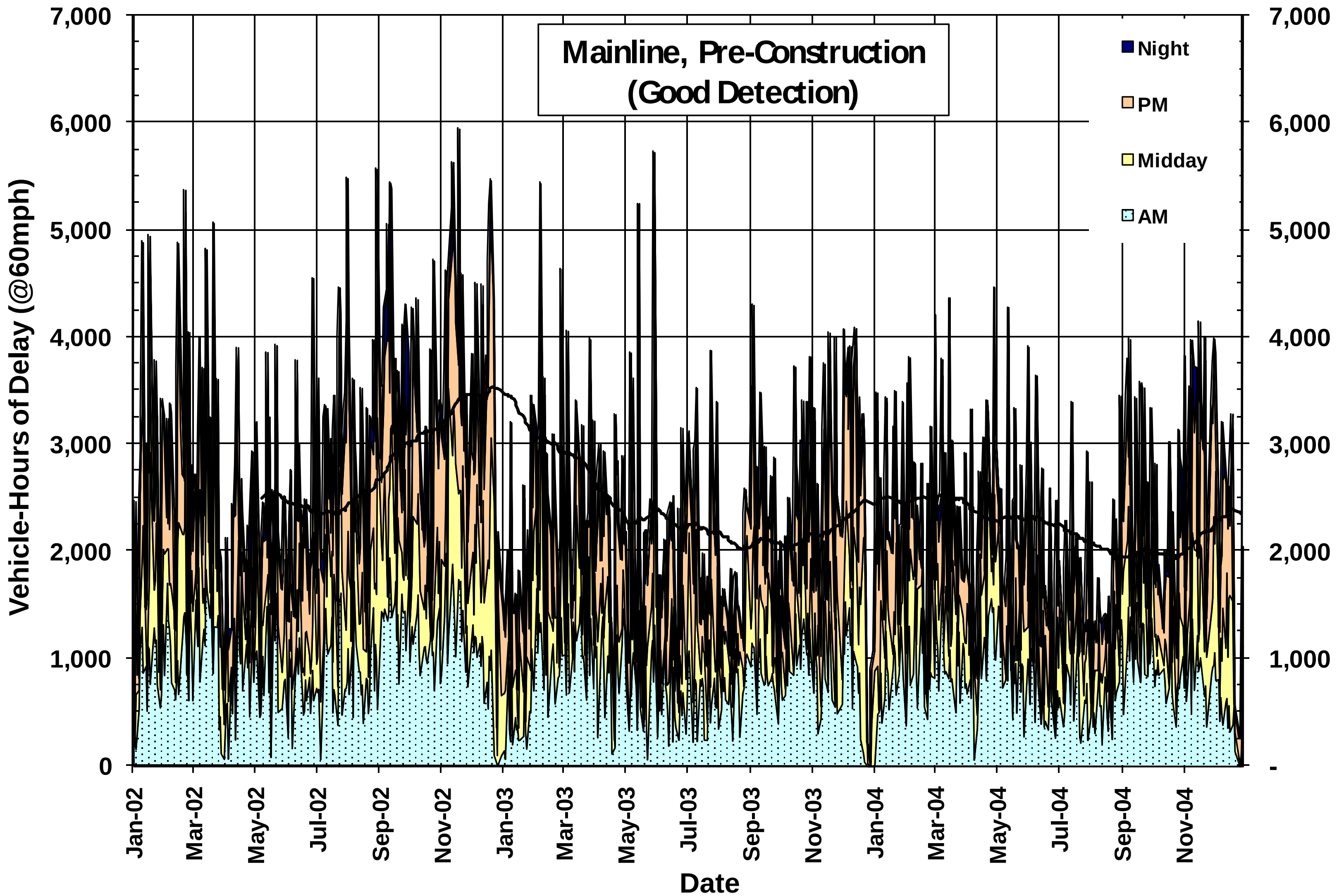
Total delay for SR-22 and I-405 were computed for four time periods: AM peak (6:00 AM to 9:00 AM), Midday (9:00 AM to 3:00 PM), PM peak (3:00 PM to 7:00 PM), and evening/early AM (7:00 PM to 6:00 AM). The total delay by time period is shown in Exhibits 3-7 to 3-12. The exhibits include a 90-day moving average that reduces the day-to-day variations, which illustrates the seasonal and annual changes in congestion over time more easily.

The following ten exhibits illustrate the delay experienced on the weekdays for the SR-22 Corridor. Exhibits 3-7 through 3-12 depict the mainline facility and Exhibits 3-13 and 3-14 depict the HOV facility. For the mainline facility, the exhibits are arranged by time period. Exhibits 3-7 and 3-10 show the pre-construction period (2002-2004); Exhibits 3-8 and 3-11 depict the post-construction period of year 2008, which had poor detection quality below 50 percent; and Exhibits 3-9 and 3-12 depict the post-construction period of February in 2009, when detection quality was considered good.

Mainline delay in the eastbound direction (Exhibit 3-7 through 3-9) was greatest during the AM peak period. Delay significantly declined between pre- and post-construction periods. The pre-construction period (Exhibit 3-7) experienced an average delay that ranged between 2,000 and 3,000 vehicle-hours, whereas the post-construction period (Exhibit 3-9) witnessed an average delay between 1,000 and 2,000 vehicle-hours.

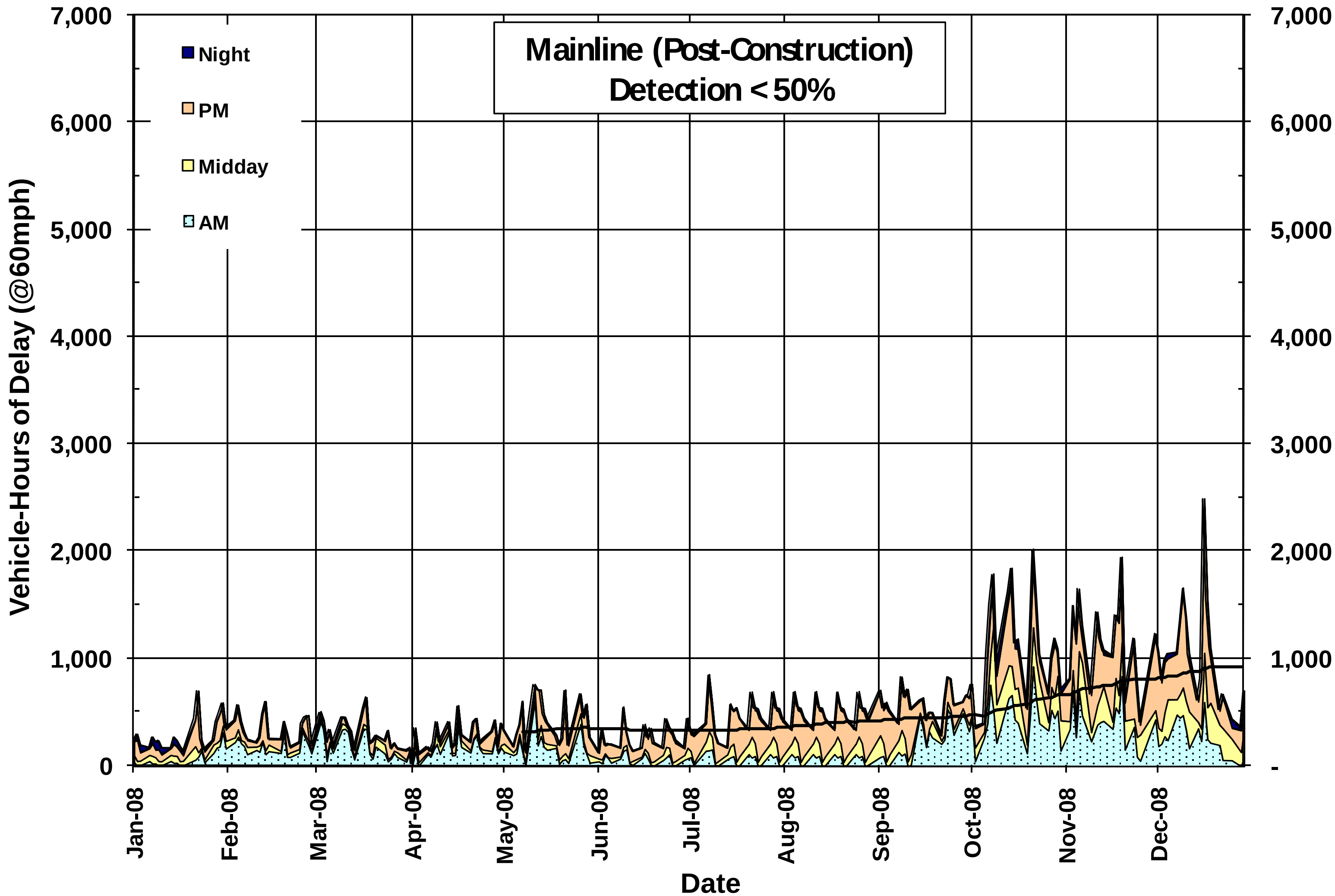
Mainline delay in the westbound direction (Exhibits 3-10 through 3-12) was overwhelmingly concentrated in the PM peak. The westbound mainline direction experienced the same levels of decline in delay as the eastbound mainline between pre-and post construction periods. Total delay in the westbound mainline was lower than the eastbound mainline. In February 2009, delay in the eastbound mainline exceeded the westbound mainline by 25 percent.

Exhibit 3-7: Eastbound SR-22 ML Average Daily Delay by Time Period (2002-2004)



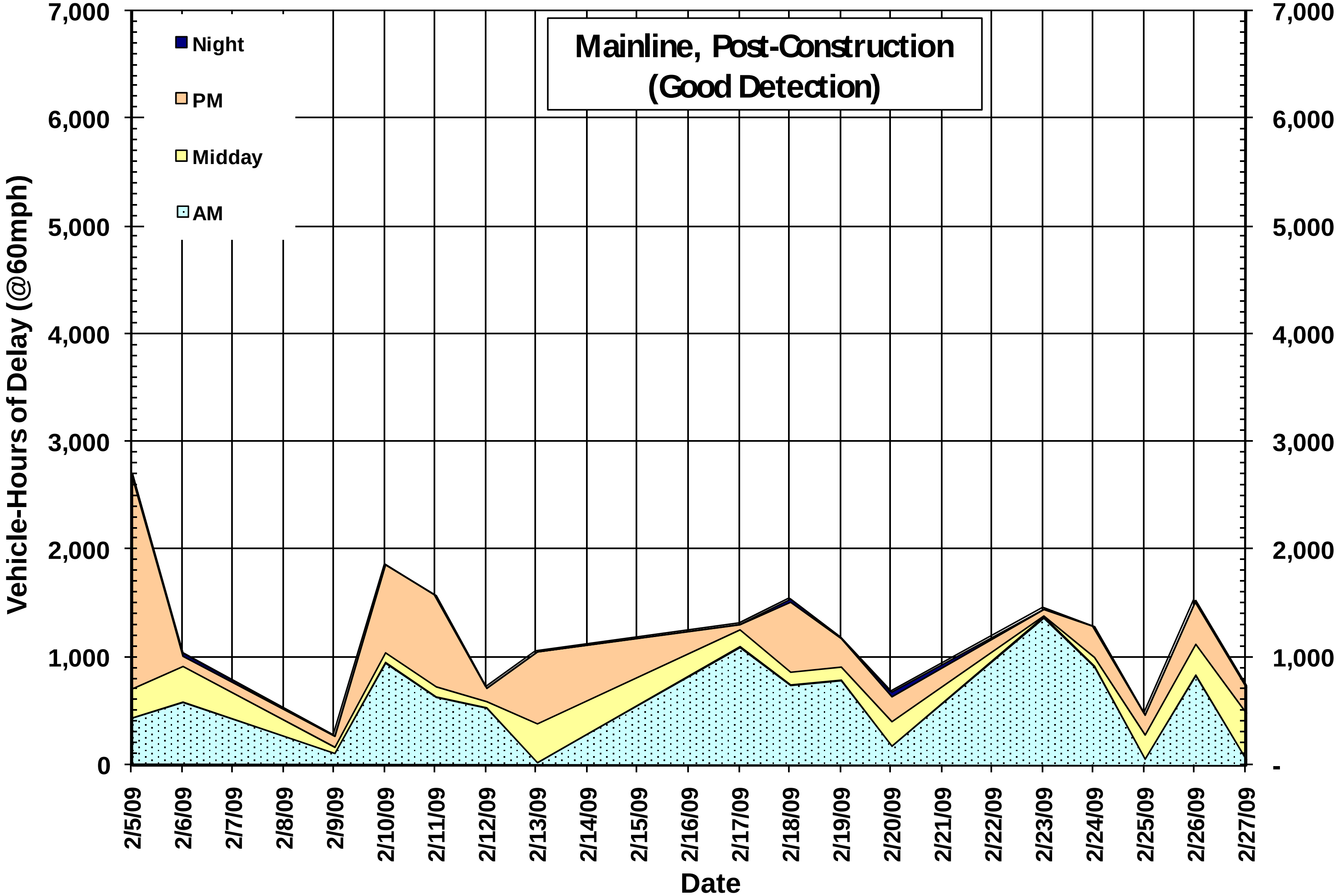
Source: SMG Analysis of PeMS Data

Exhibit 3-8: Eastbound SR-22 ML Average Daily Delay by Time Period (2008)



Source: SMG Analysis of PeMS Data
Note: Due to poor detection on SR-22 in 2008, delay may be underreported for 2008.

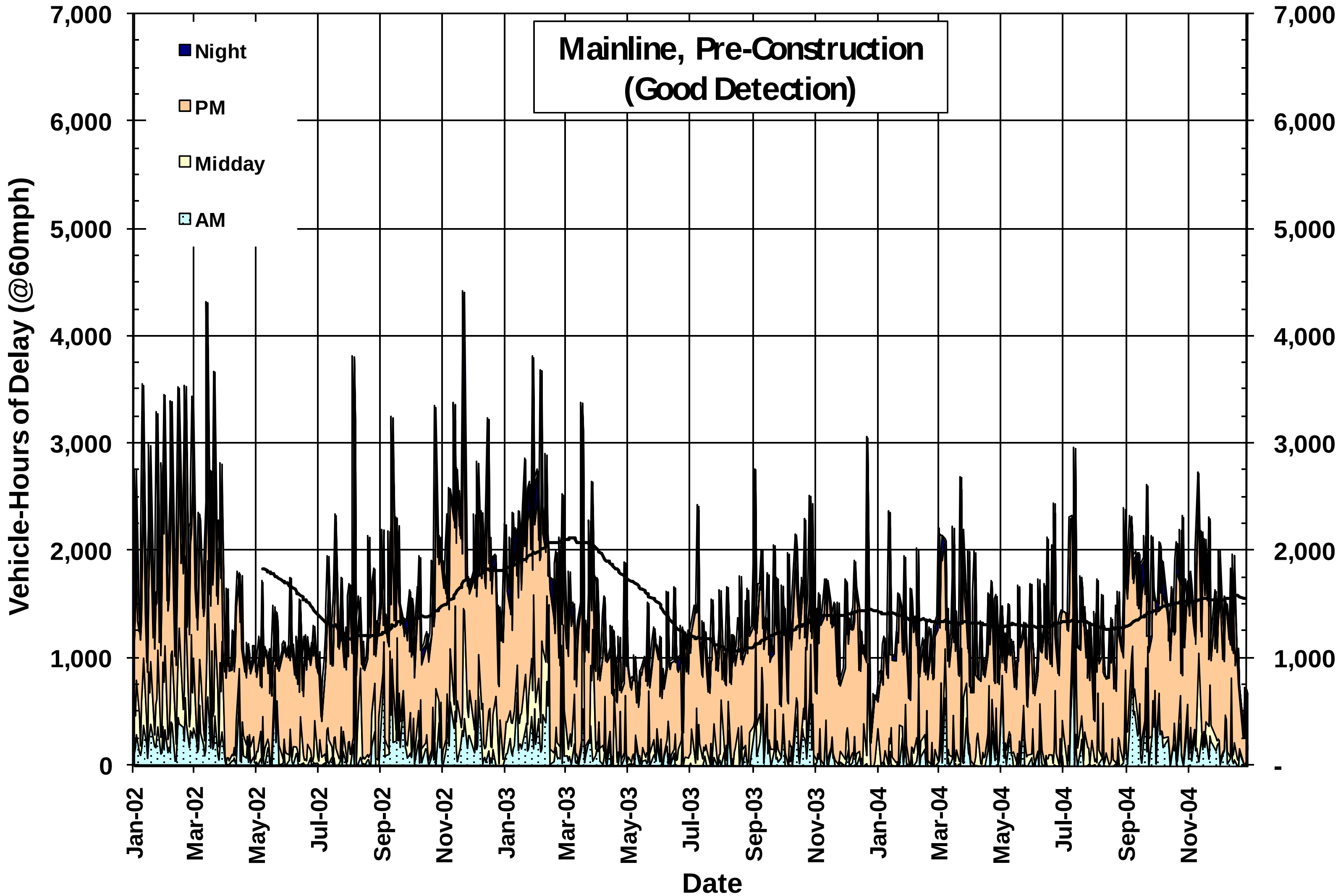
Exhibit 3-9: Eastbound SR-22 ML Average Daily Delay by Time Period (Feb 2009)



Source: SMG Analysis of PeMS Data

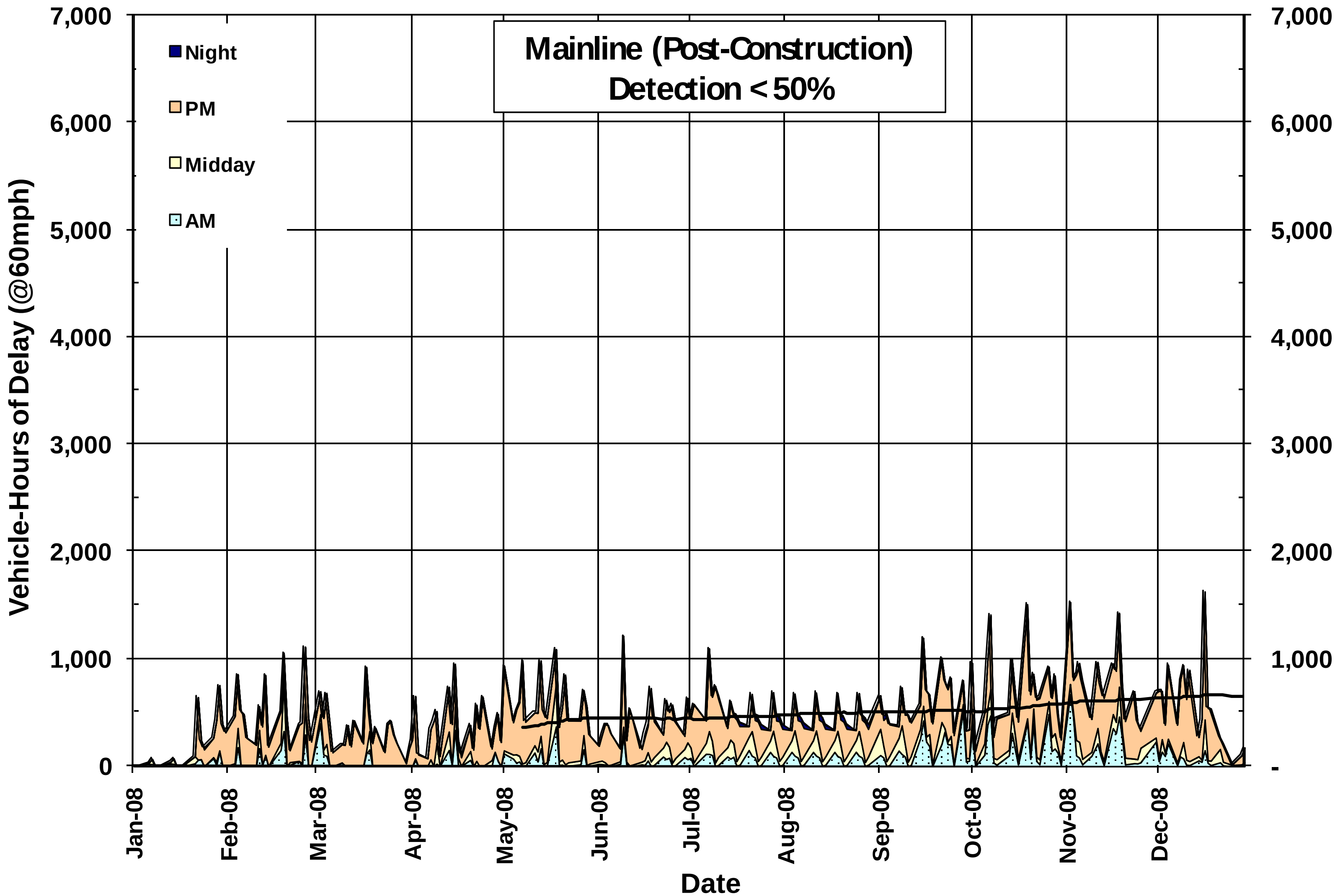
Note: Good detection on the SR-22 mainline started on February 5, 2009.

Exhibit 3-10: Westbound SR-22 ML Average Daily Delay by Time Period (2002-2004)



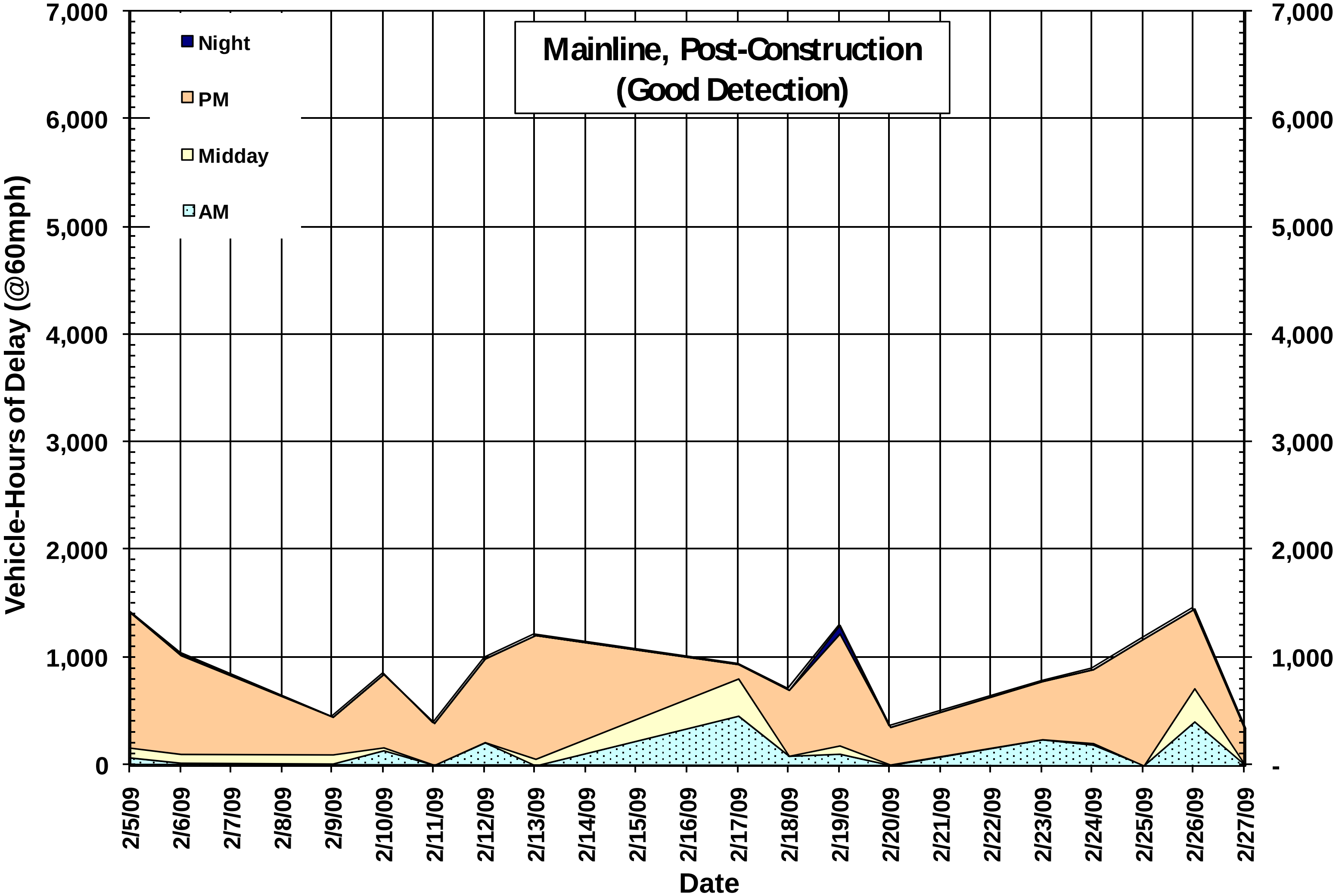
Source: SMG Analysis of PeMS Data

Exhibit 3-11: Westbound SR-22 ML Average Daily Delay by Time Period (2008)



Source: SMG Analysis of PeMS Data
Note: Due to poor detection on SR-22 in 2008, delay may be underreported for 2008.

Exhibit 3-12: Westbound SR-22 ML Average Daily Delay by Time Period (Feb 2009)

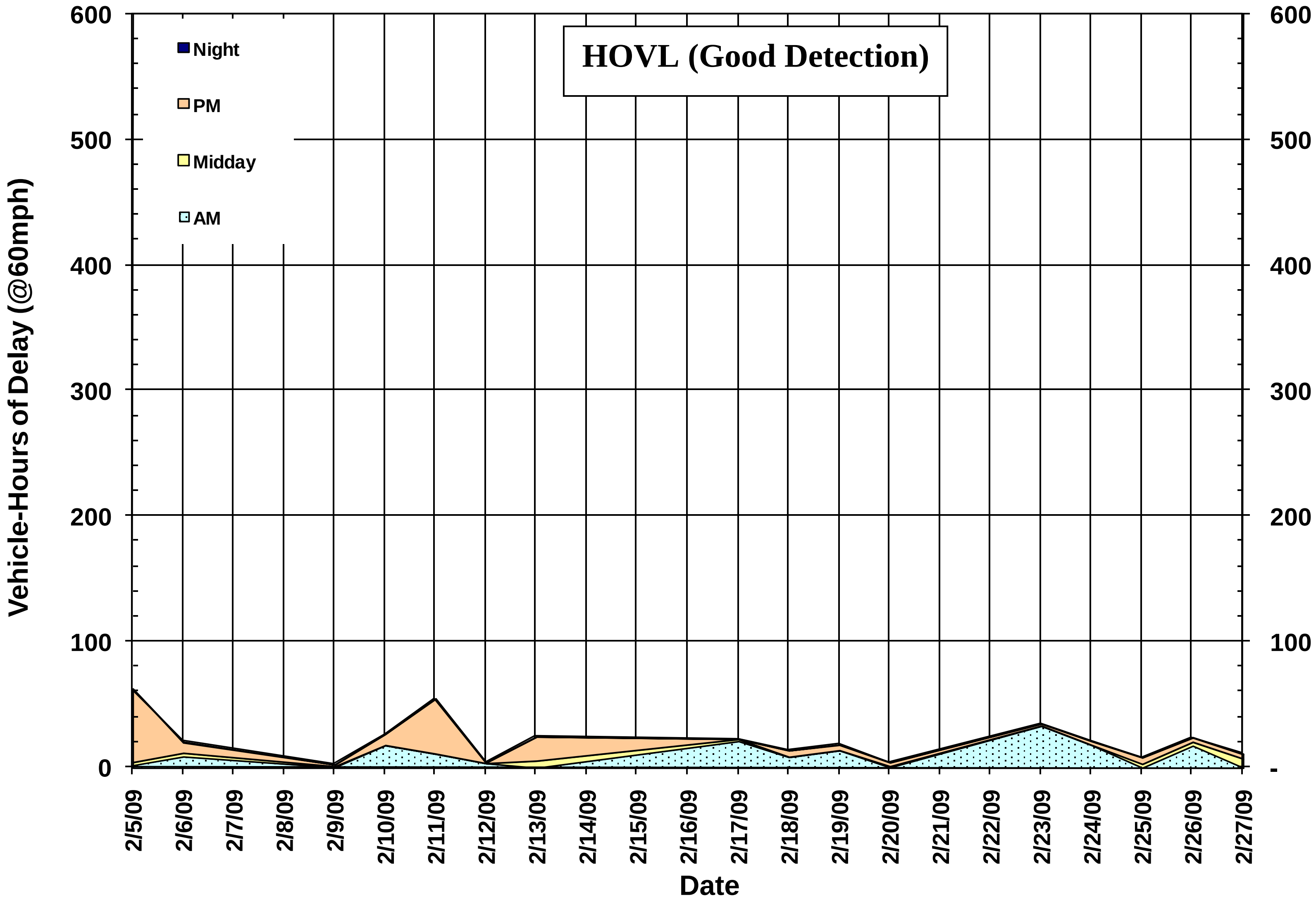


Source: SMG Analysis of PeMS Data
Note: Good detection on the SR-22 mainline started on February 5, 2009.

Delay on the SR-22 HOV facility is presented in Exhibits 3-13 and 3-14. The HOV facility was completed in spring of 2007 and detection data on the HOV facility was not available until February 5, 2009.

Delay on the SR-22 HOV-lanes followed the same pattern as the mainline facility. In February 2009, delay in the eastbound direction was concentrated in the AM peak (Exhibit 3-13) and delay in the westbound direction was concentrated in the PM peak (Exhibit 3-14). However, unlike the mainline facility which consistently experienced more delay in the eastbound direction, the HOV facility experienced more delay in the westbound direction in February 2009 by about 35 percent. Note that detection on the SR-22 HOV facility was not available until February 5, 2009.

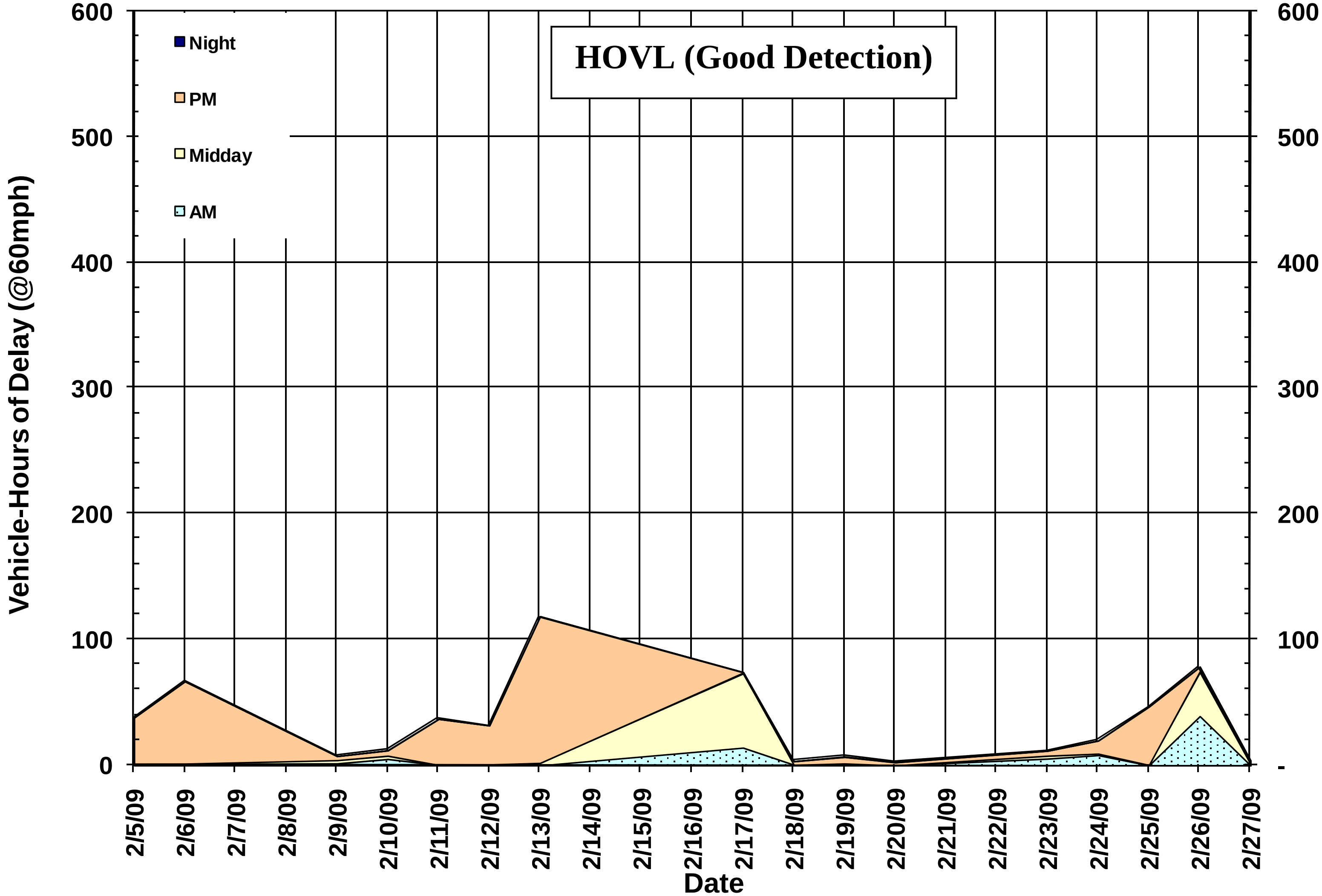
Exhibit 3-13: Eastbound SR-22 HOVL Average Daily Delay by Time Period (Feb 2009)



Source: SMG Analysis of PeMS Data

Note: Detection data for the SR-22 HOV facility was available starting on February 5, 2009.

Exhibit 3-14: Westbound SR-22 HOVL Average Daily Delay by Time Period (Feb 2009)



Source: SMG Analysis of PeMS Data

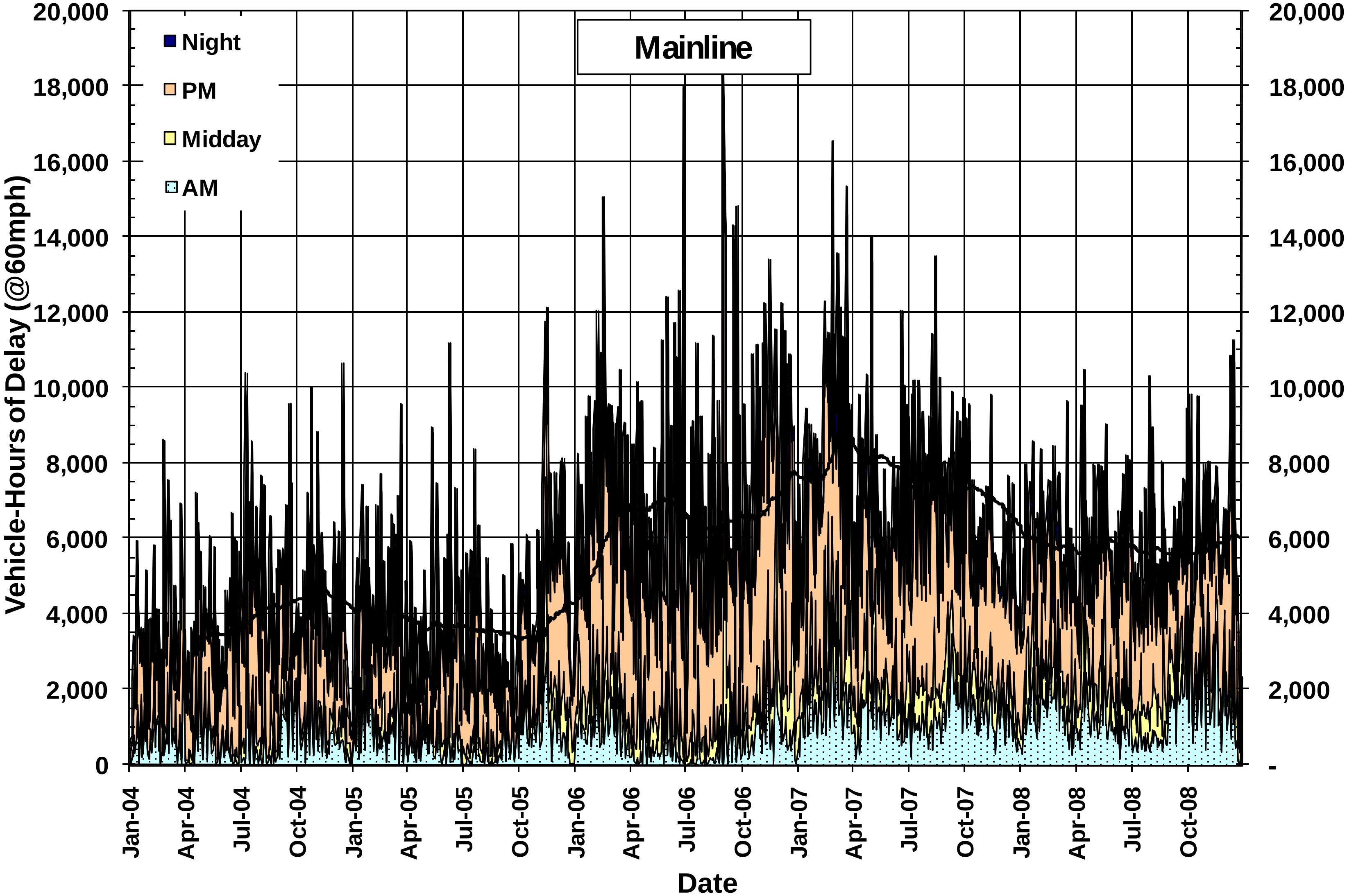
Note: Detection data for the SR-22 HOV facility was available starting on February 5, 2009.

Delay on the I-405 Corridor is shown in Exhibits 3-15 through 3-18. Unlike the delay exhibits shown for SR-22, these exhibits cover the entire five-year period from 2004 through 2008 continuously without any breaks since major construction did not take place on I-405 during this time.

For the mainline facility, Exhibit 3-15 shows that delay in the northbound direction increased significantly from 2006 to mid-2007 and decreased from mid-2007 to 2008. The southbound mainline facility shows the same trend with increased delay from 2006 to mid-2007 and decreased delay from mid-2007 to 2008. Delay in the northbound direction (Exhibit 3-15) was concentrated in the PM peak while delay in the southbound direction (Exhibit 3-16) was concentrated in the AM peak, suggesting a directional pattern of congestion.

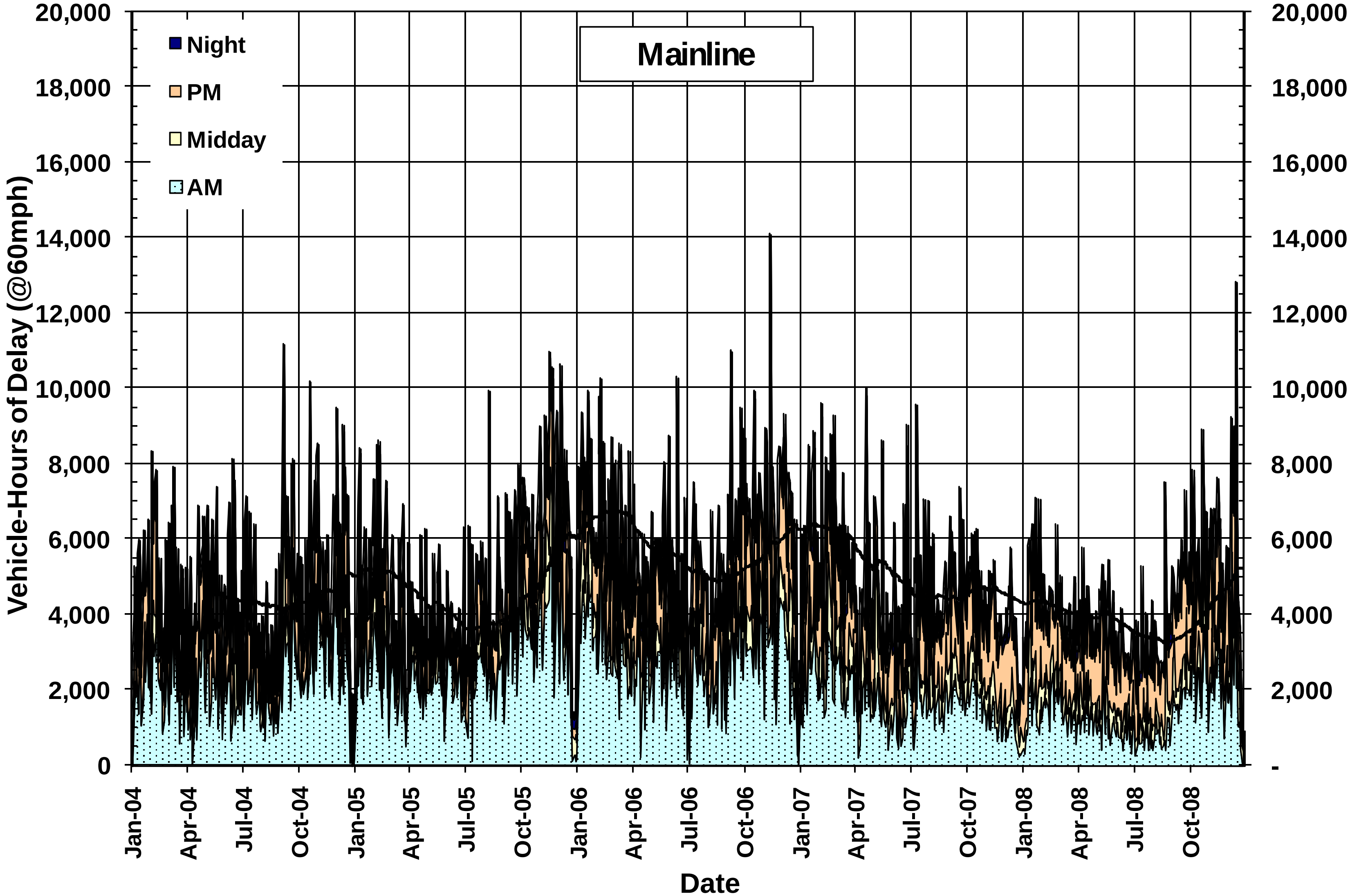
Delay on the I-405 HOV facility is depicted in Exhibits 3-17 and 3-18 for the same years (2004-2008). Exhibit 3-17 shows that the northbound direction experienced significantly greater delay than the southbound direction, specifically in 2007 when the average vehicle hours of delay reached 2,000, compared to only 1,000 in the southbound direction for the same time period. Again, delay in the northbound direction is concentrated in the PM peak period while delay in the southbound direction is concentrated in the AM peak period. In the northbound direction of the HOV facility, the last few months of 2006 experienced the most congestion, peaking over 3,500 vehicle-hours. In the southbound direction (Exhibit 3-18), the highest delay occurred in March 2006 when it experienced about 1,000 vehicle-hours. In both directions of the HOV facility, delay slowly increased in 2008.

Exhibit 3-15: Northbound I-405 ML Average Daily Delay by Time Period (2004-2008)



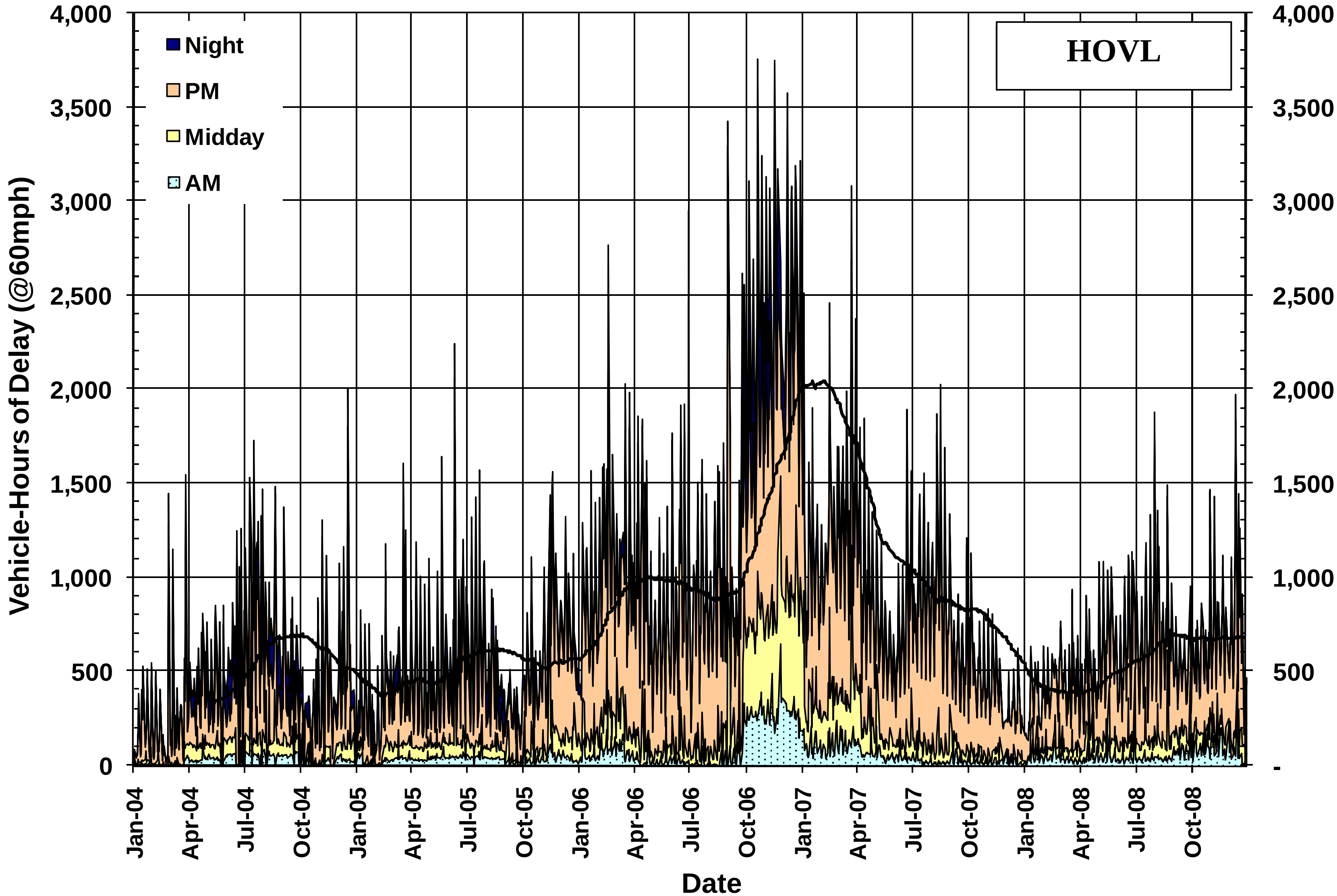
Source: SMG Analysis of PeMS Data

Exhibit 3-16: Southbound I-405 ML Average Daily Delay by Time Period (2004-2008)



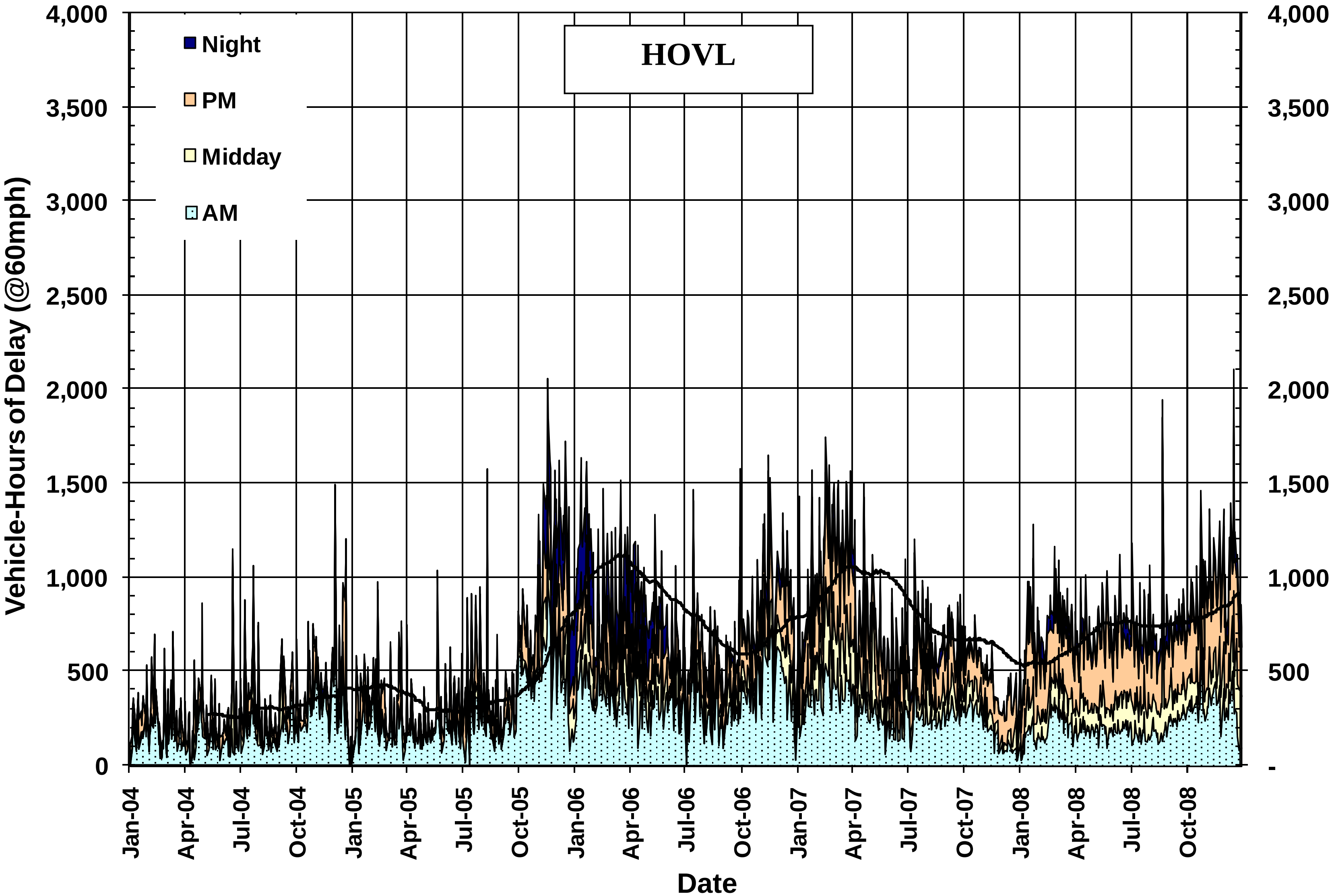
Source: SMG Analysis of PeMS Data

Exhibit 3-17: Northbound I-405 HOVL Average Daily Delay by Time Period (2004-2008)



Source: SMG Analysis of PeMS Data

Exhibit 3-18: Southbound I-405 HOVL Average Daily Delay by Time Period (2004-2008)

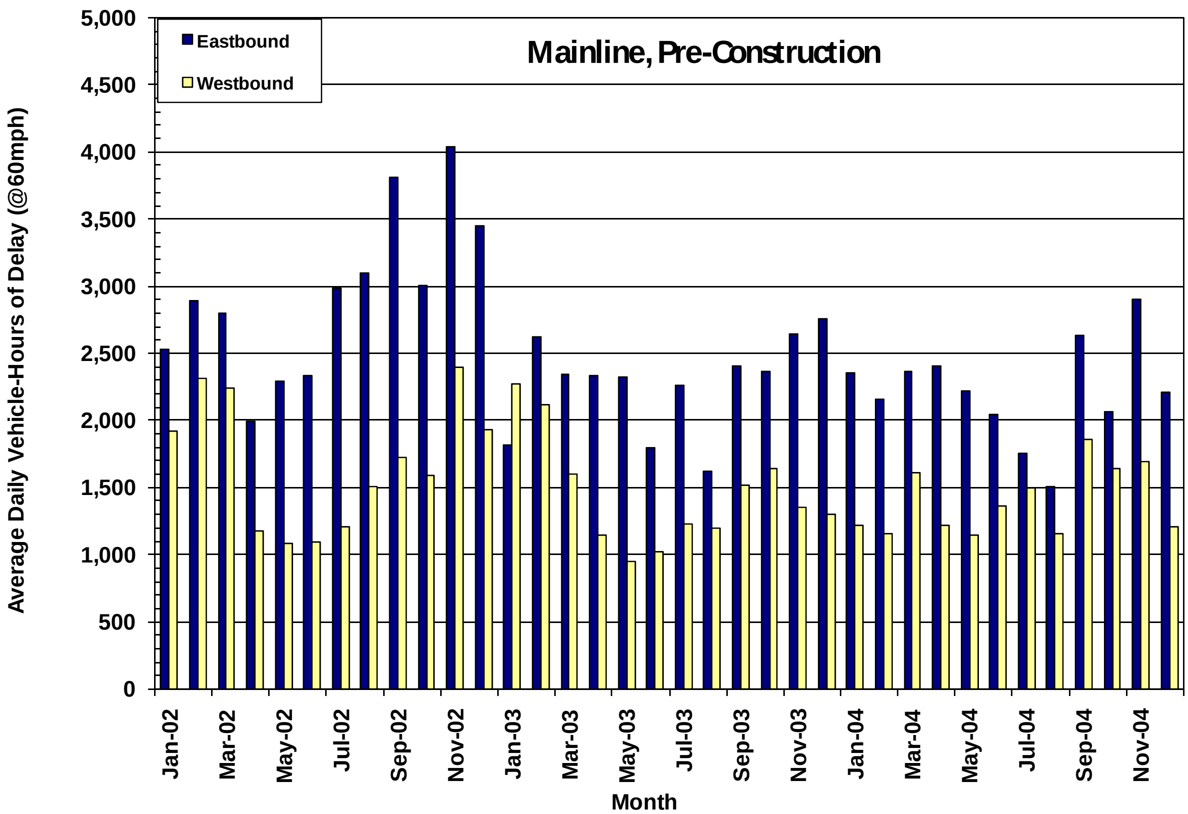


Source: SMG Analysis of PeMS Data

Another way to look at delay trends is by monthly average. The average daily weekday delay by month and by direction is shown for the SR-22 Corridor in Exhibits 3-19 through 3-21. For the mainline facility, the years 2005 and 2006 are omitted from the exhibits since traffic patterns change dramatically as a result of construction activity and the use of alternate routes. Although the project was completed in spring 2007, 2007 is also excluded from the exhibit since traffic patterns vary immediately after construction with motorists continuing to use alternate routes or motorists getting accustomed to the new facility. Exhibits 3-19 and 3-20 illustrate that the average weekday delay decreased significantly in 2009 compared to the previous years of study, suggesting that the widening project improved mobility on SR-22. In February 2009, the eastbound direction experienced approximately 1,250 vehicle-hours of delay and the westbound approximately 900 vehicle-hours. During the pre-construction years (Exhibit 3-19), the eastbound and westbound directions exceeded the February 2009 delay numbers by at least 30 percent.

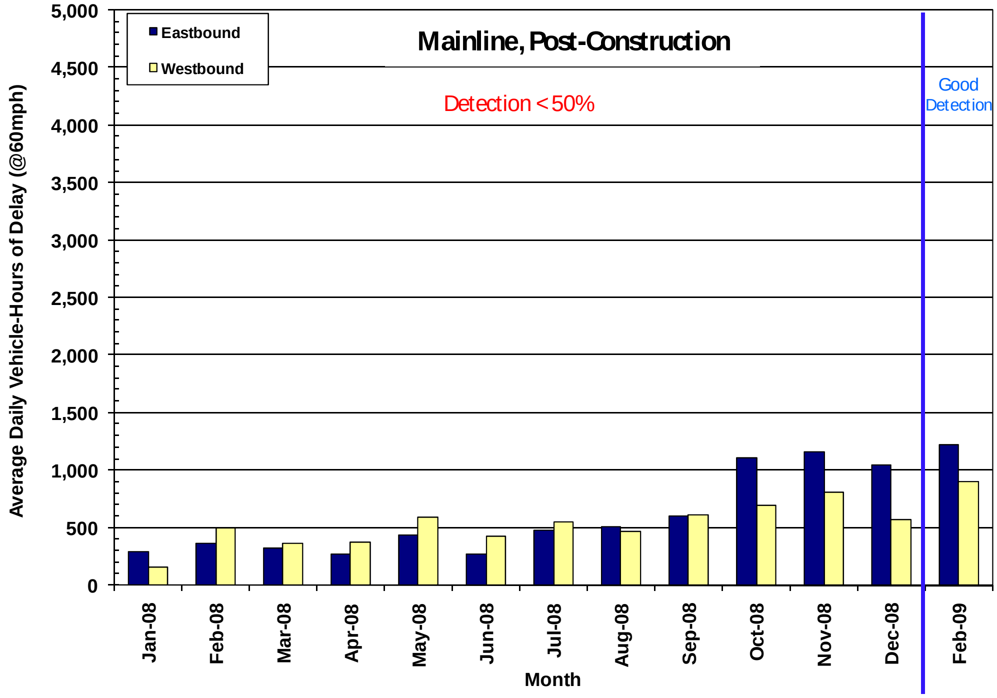
Unlike the mainline facility, which shows greater delay in the eastbound direction, the HOV facility shows greater delay in the westbound direction (Exhibit 3-21) in February 2009.

Exhibit 3-19: SR-22 ML Average Weekday Delay by Month (2002-2004)



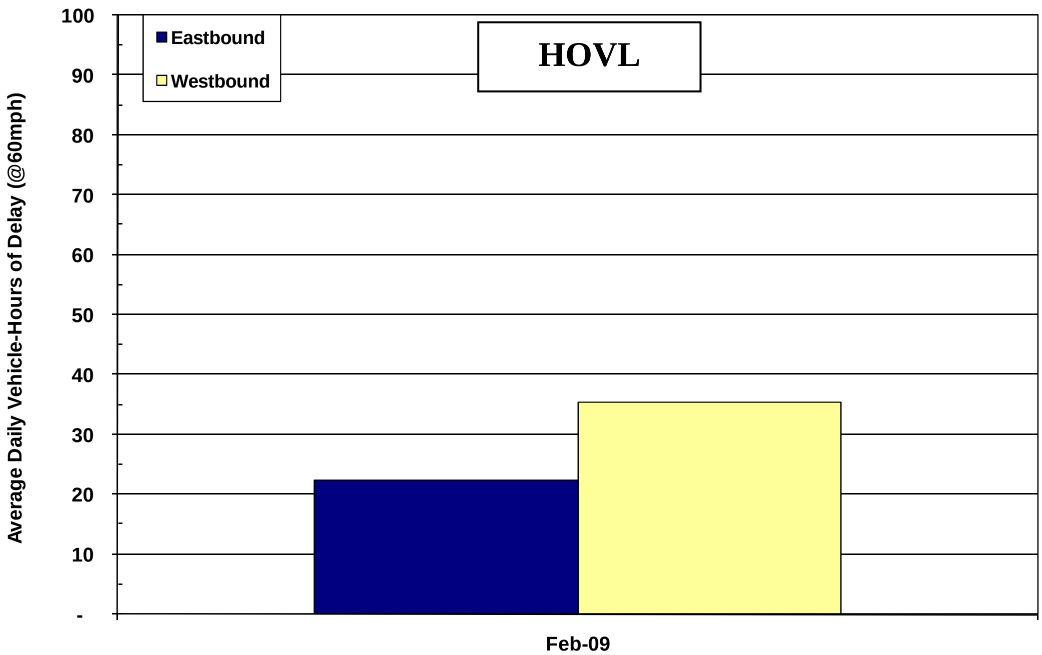
Source: SMG Analysis of PeMS Data

Exhibit 3-20: SR-22 ML Average Weekday Delay by Month (2008, Feb 2009)



Source: SMG Analysis of PeMS Data
Note: Due to poor detection on SR-22 in 2008, delay may be underreported for 2008.

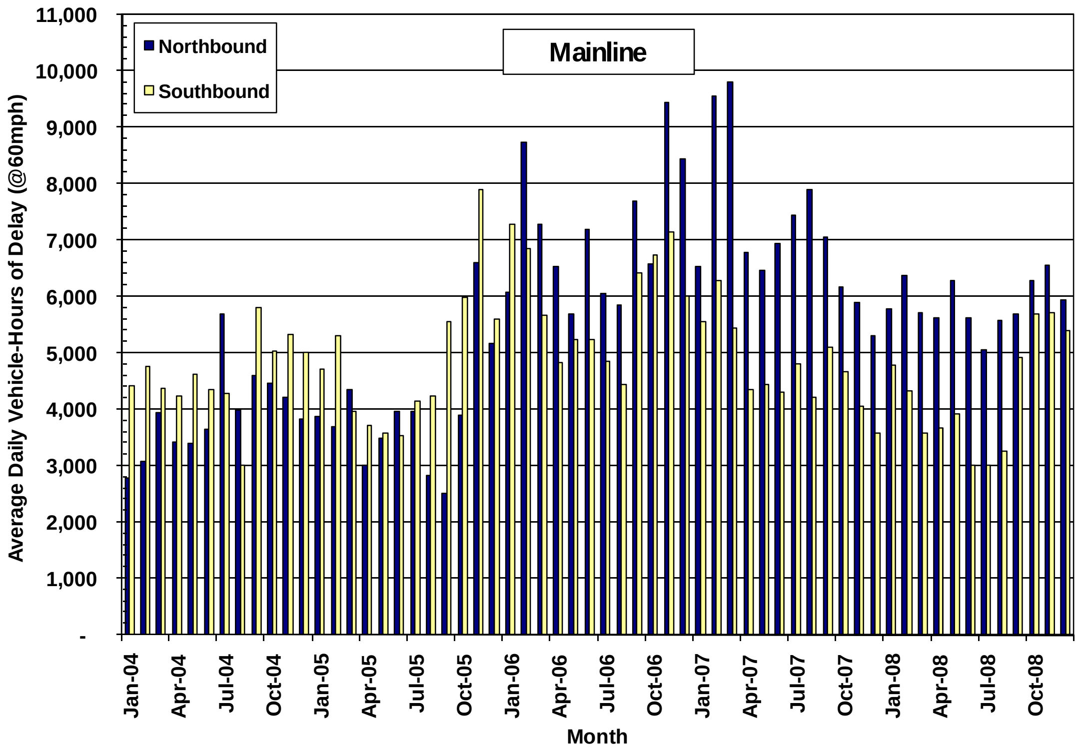
Exhibit 3-21: SR-22 HOVL Average Weekday Delay by Month (Feb 2009)



Source: SMG Analysis of PeMS Data
Note: Detection on the SR-22 HOV facility was not available until February 5, 2009.

For the I-405 Corridor, Exhibit 3-22 shows that delay increased from 2005 to mid-2007 and decreased from mid-2007 to 2008 on the mainline facility. Interestingly, in 2004 and 2005, delay was greater in the southbound direction than the northbound. However, this trend was reversed in the following years (2006-2008), when delay in the northbound direction exceeded the southbound by almost thirty percent in 2008.

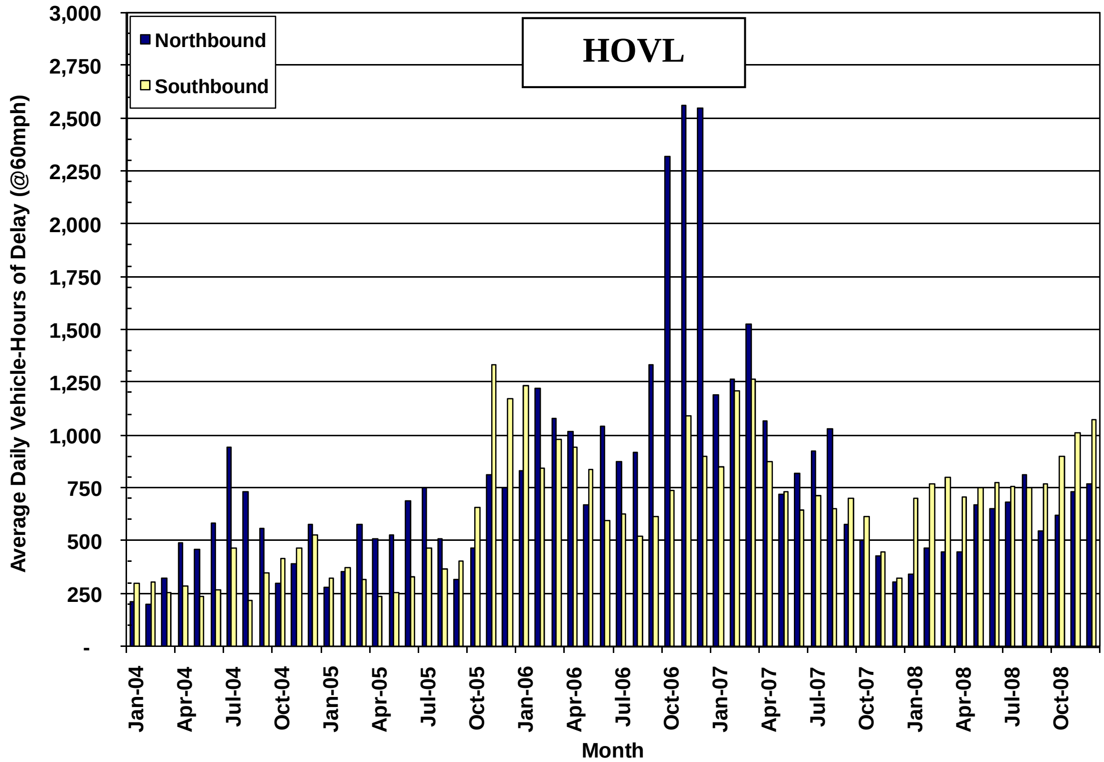
Exhibit 3-22: I-405 ML Average Weekday Delay by Month (2004-2008)



Source: SMG Analysis of PeMS Data

Exhibit 3-23 illustrates the average daily vehicle-hours of delay experienced on the I-405 HOV facility. Before 2008, the northbound direction typically experienced more delay, as indicated by the blue-colored bars. However, in 2008, the trend reversed and the southbound direction (yellow-colored bars) experienced more delay than the northbound. The HOV facility followed a similar trend as the mainline facility, with delay peaking in late 2006, declining until 2008, and gradually increasing throughout 2008.

Exhibit 3-23: I-405 HOVL Average Weekday Delay by Month (2004-2008)



Source: SMG Analysis of PeMS Data

Delay presented to this point represents 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 Exhibit 3-24:

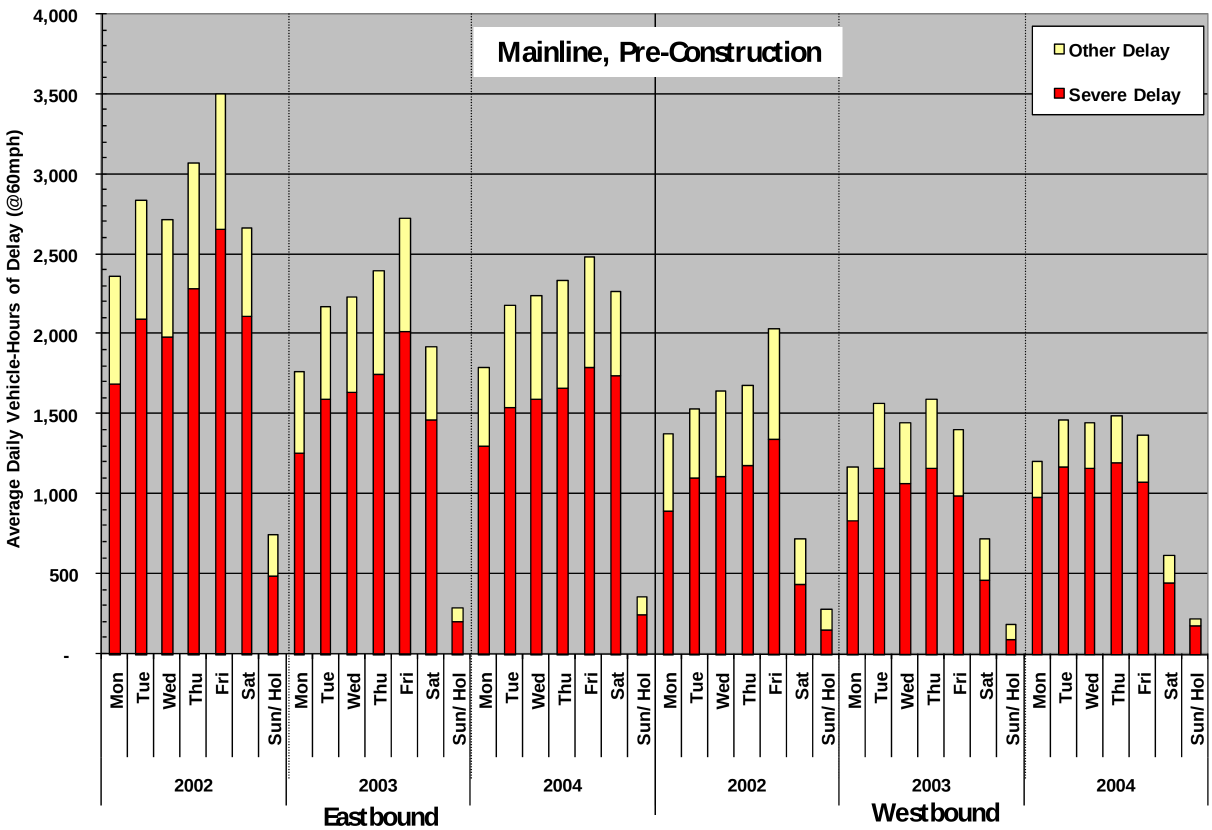
- Severe delay – delay that occurs when speeds are below 35 miles per hour; and
- Other delay – delay that occurs when speeds are between 35 miles per hour and 60 miles per hour.

Severe delay in Exhibits 3-24 through 3-26 represents breakdown conditions, which is the focus of most congestion mitigation strategies. "Other" delay represents conditions approaching the breakdown congestion, leaving the breakdown conditions, or areas that do not cause widespread breakdowns, but cause at least temporary slowdowns. 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.

Exhibits 3-24 and 3-25 show that severe delay comprised about 75 percent of all weekday delay on the mainline facility. It also shows that severe delay was greater in the eastbound direction than the westbound direction during both pre and post-construction periods. In the eastbound direction of the mainline during the pre-construction period, the level of congestion grew during the workweek and peaked on

Fridays, whereas no consistent pattern emerged during the post-construction period. Exhibit 3-27 clearly shows the drop in delay experienced post-construction compared to pre-construction. Delays were minimal on weekends in both directions of the mainline.

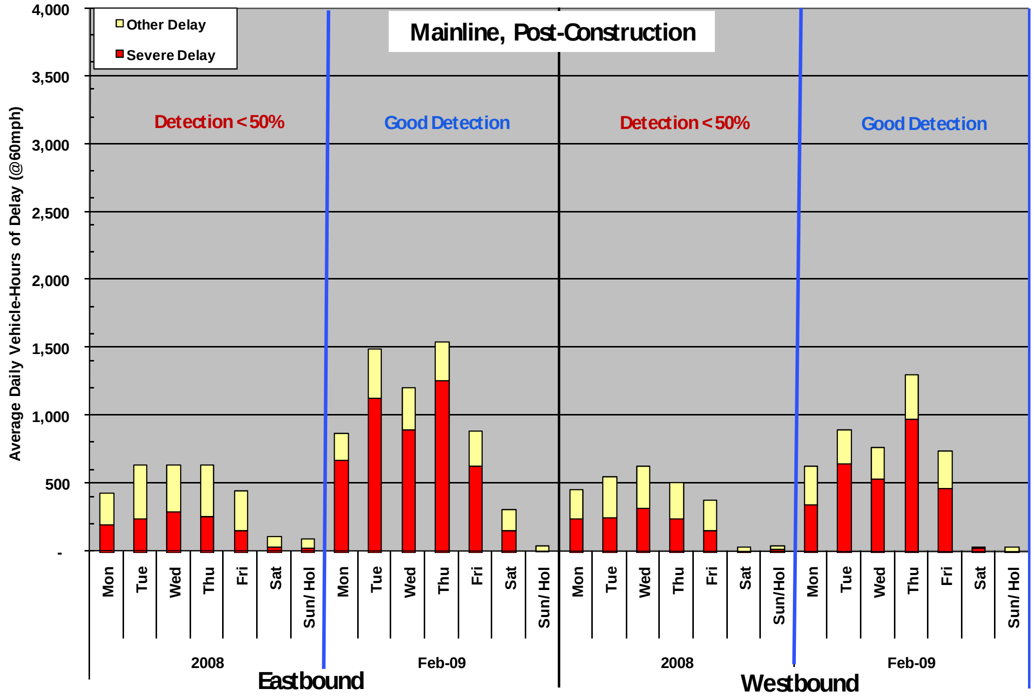
Exhibit 3-24: SR-22 ML Average Delay by Day of Week by Severity (2002-2004)



Source: SMG Analysis of PeMS Data

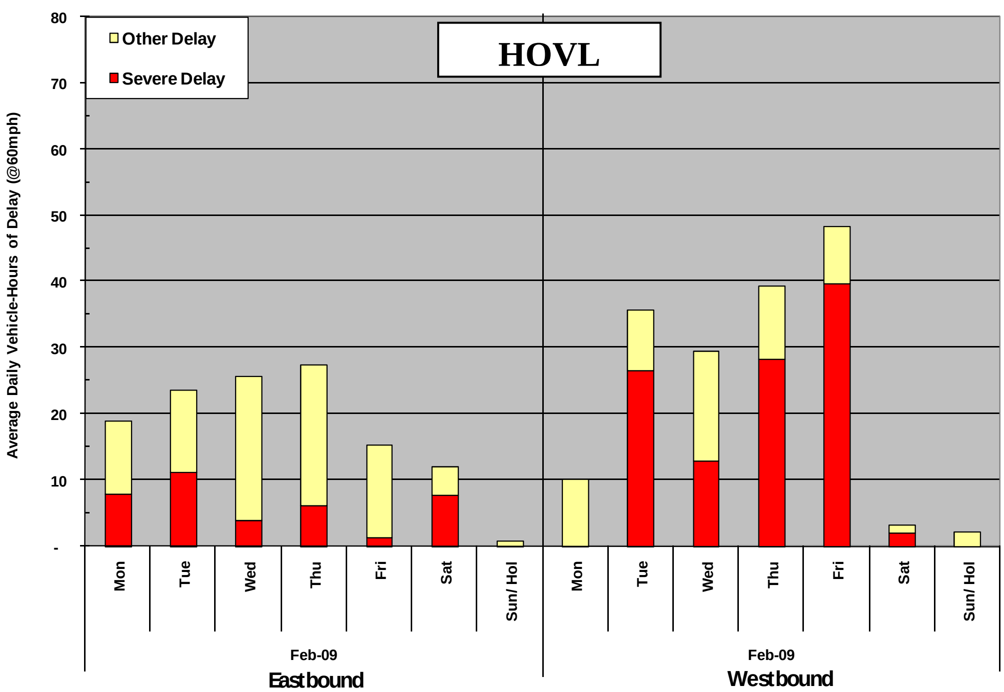
On the HOV facility of the SR-22 Corridor (Exhibit 3-26), total delay is greater in the westbound direction by about 25 percent. Severe delay is also greater in the westbound direction, with the highest delay having occurred on Fridays with 40 hours of severe delay out of the 48 hours of total delay.

Exhibit 3-25: SR-22 ML Delay by Day of Week by Severity (2008, Feb 2009)



Source: SMG Analysis of PeMS Data
Note: Due to poor detection on SR-22 in 2008, delay may be underreported for 2008.

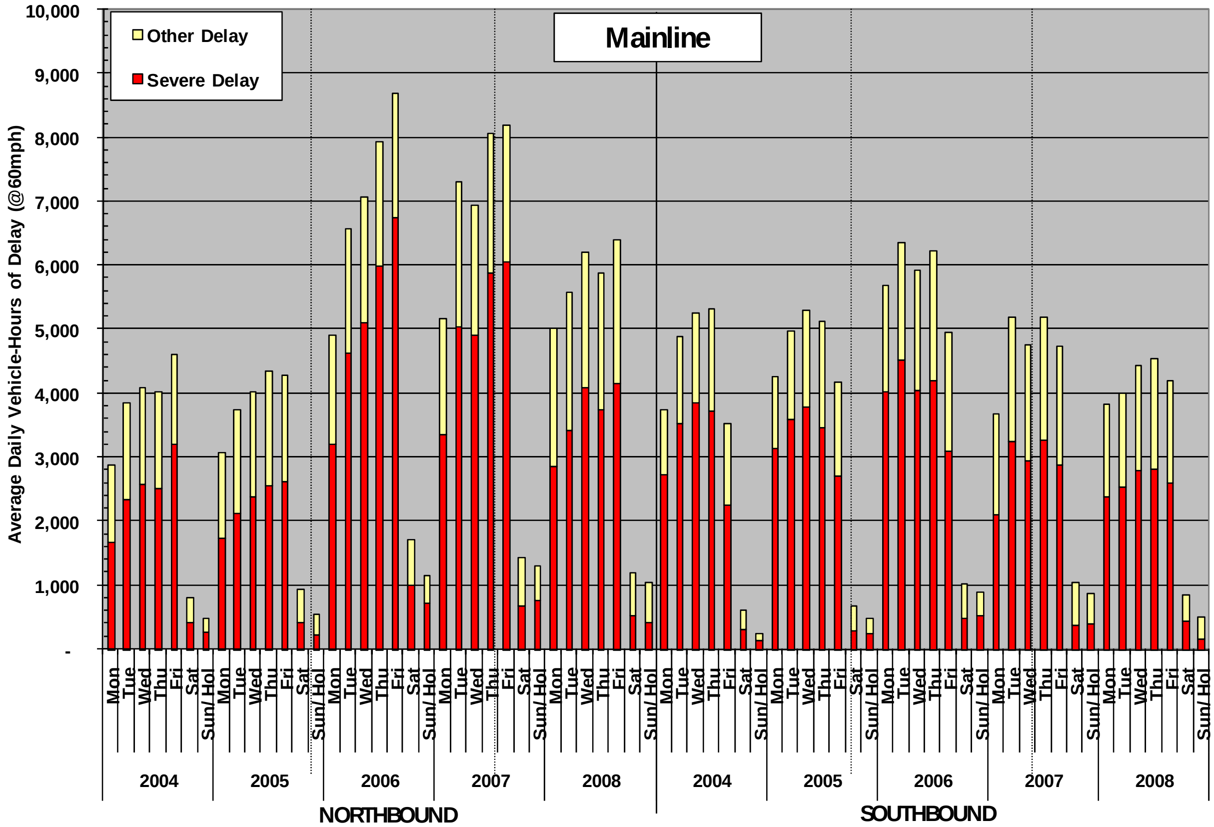
Exhibit 3-26: SR-22 HOVL Average Delay by Day of Week by Severity (Feb 2009)



Source: SMG Analysis of PeMS Data
Note: Detection on the SR-22 HOV facility was not available until February 5, 2009.

For the I-405 Corridor, severe delay was typically greater in the northbound direction than the southbound of the mainline facility. As depicted in Exhibit 3-27, severe delay increased during the weekdays in the northbound direction and peaked on Fridays. The southbound direction did not experience this trend.

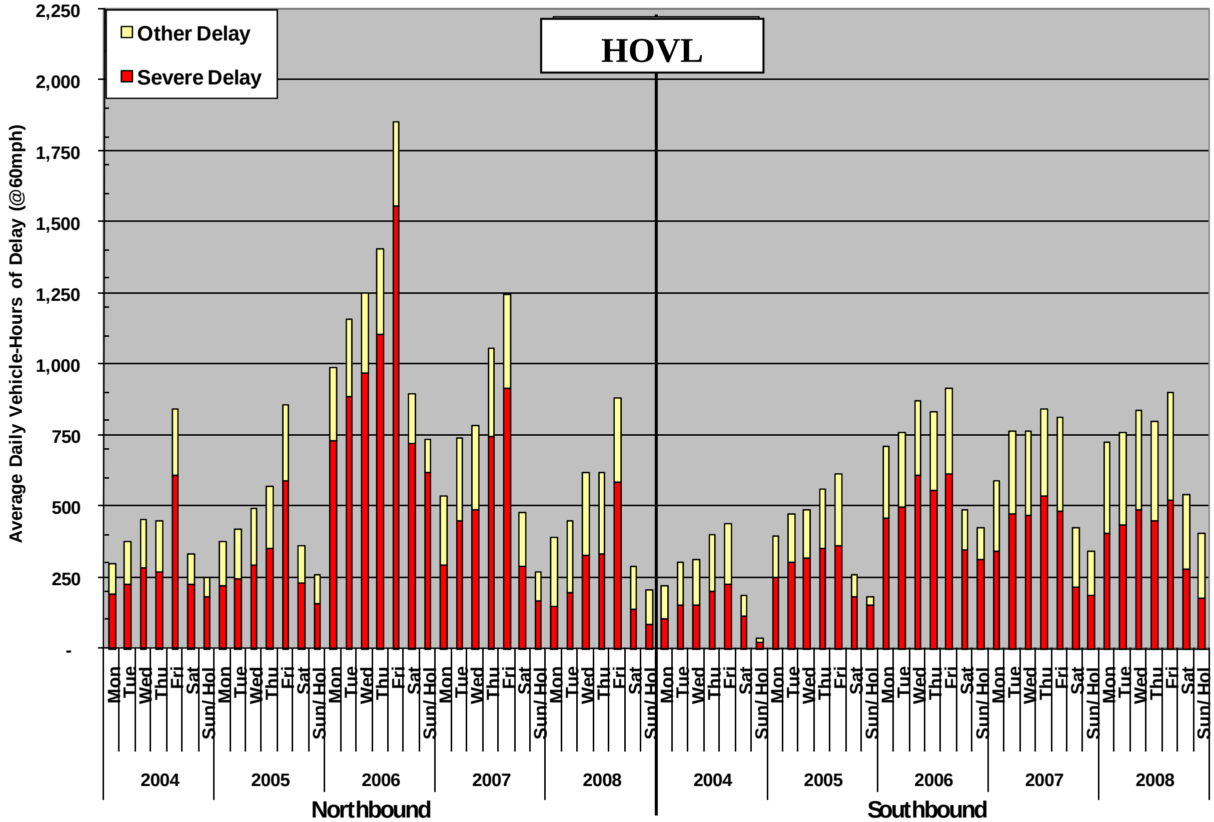
Exhibit 3-27: I-405 ML Average Delay by Day of Week by Severity (2004-2008)



Source: SMG Analysis of PeMS Data

On the HOV facility, both directions of travel experienced an increase in severe delay as the work week progressed, peaking on Fridays. Again, 2006 was the most congested year with Fridays reaching up to 1,800 vehicle-hours of delay.

Exhibit 3-28: I-405 HOVL Average Delay by Day of Week by Severity (2004-2008)



Source: SMG Analysis of PeMS Data

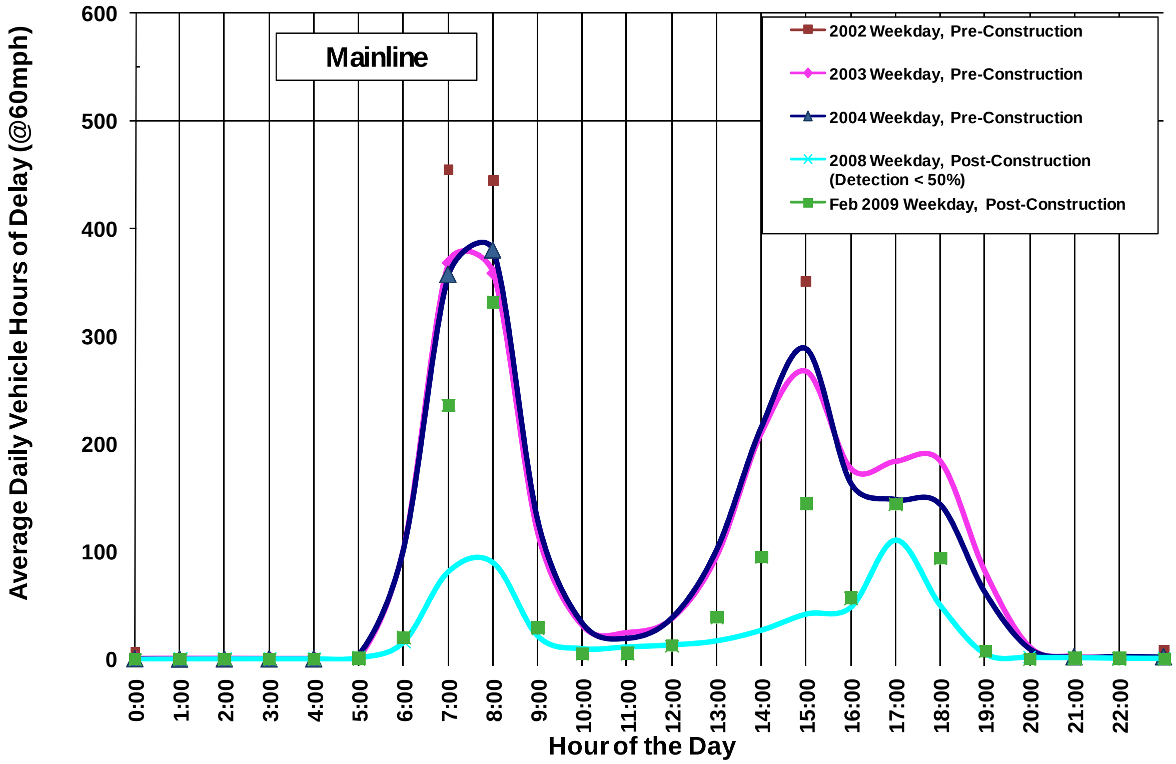
Another way to understand the characteristics of congestion and related delays is to examine average weekday delays by hour. For the mainline facility of SR-22, Exhibit 3-29 illustrates the average weekday delay by hour for the eastbound direction, while Exhibit 3-30 shows the westbound direction. Delay on the HOV facility is depicted in Exhibits 3-31 and 3-32. Each point represents the total delay for the hour. For example, the 7:00 AM point is the sum of delay from 7:00 AM to 8:00 AM. The exhibits show the peaking characteristics of congestion and how the peak period changes over time.

A number of observations can be made about the time-of day patterns shown in Exhibits 3-29 and 3-30 for the mainline facility and Exhibits 3-31 and 3-32 for the HOV facility:

- During the 7:00 AM peak hour in the eastbound direction of the mainline facility (Exhibit 3-29), daily delay decreased significantly from approximately 470 vehicle-hours in 2002 to approximately 230 in February 2009. Similarly, at the 3:00 PM peak hour, daily delay decreased from approximately 350 vehicle-hours in 2002 to 150 vehicle-hours in February 2009. Exhibit 3-29 suggests that delay improved in the eastbound direction of the mainline more than 50 percent from 2002 to February 2009.

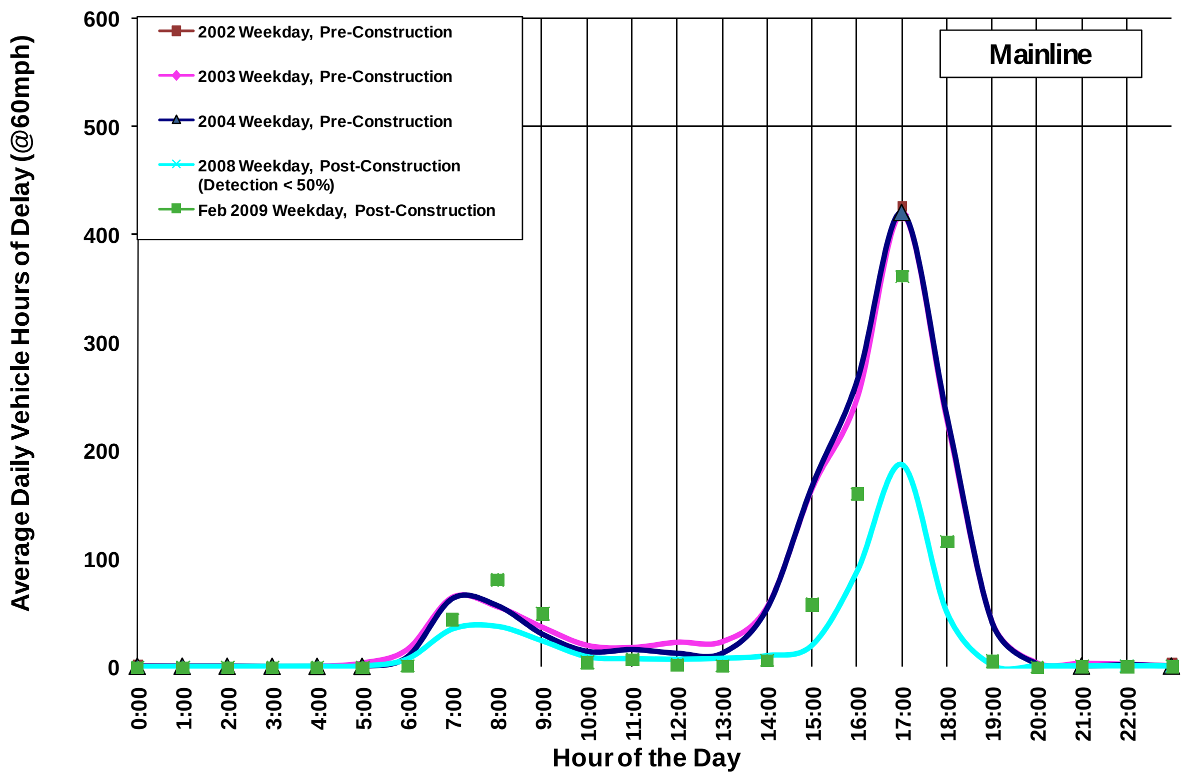
- The westbound direction of the mainline (Exhibit 3-30) also witnessed an improvement in delay from 2002 to February 2009. At the 5:00 PM peak hour, daily delay decreased from approximately 420 vehicle-hours in 2002 to 375 vehicle-hours in February 2009. Although not as significant of an improvement in delay as in the eastbound direction of the mainline, the westbound direction experienced a 10 percent decrease in delay at the 5:00 PM peak hour.

Exhibit 3-29: Eastbound SR-22 ML Average Weekday Hourly Delay (2002-2004, 2008, Feb 2009)



Source: SMG Analysis of PeMS Data
Note: Due to poor detection on SR-22 in 2008, delay may be underreported for 2008.

Exhibit 3-30: Westbound SR-22 ML Average Weekday Hourly Delay (2002-2004, 2008, Feb 2009)

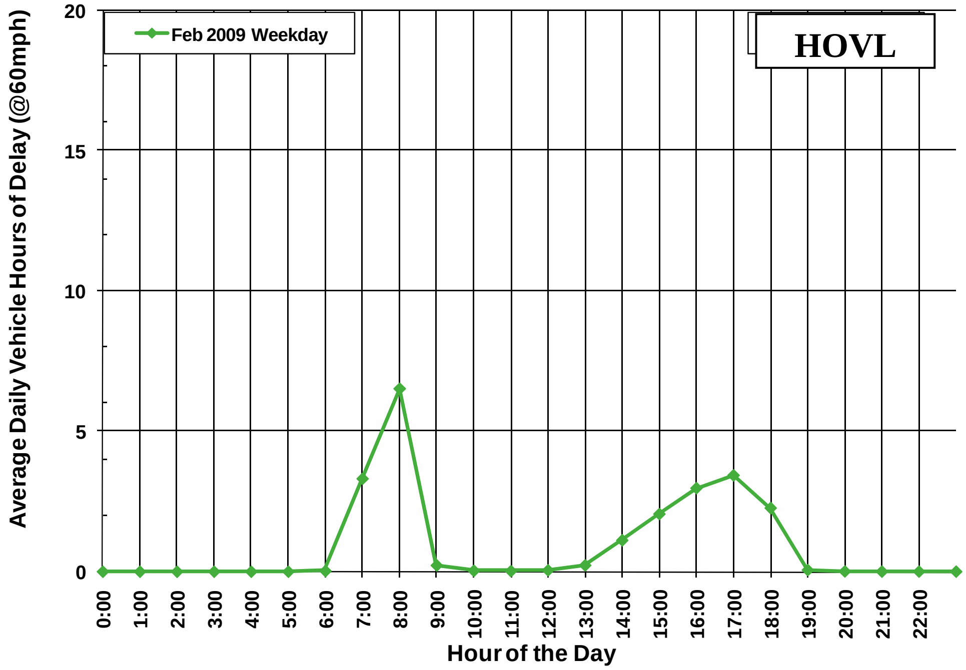


Source: SMG Analysis of PeMS Data
Note: Due to poor detection on SR-22 in 2008, delay may be underreported for 2008.

- During the 8:00 AM peak hour in the eastbound direction of the HOV facility (Exhibit 3-31), the average vehicle hour of delay was 7 hours in February 2009. Delay was even less than that at about 3 hours during the 5:00 PM peak hour.

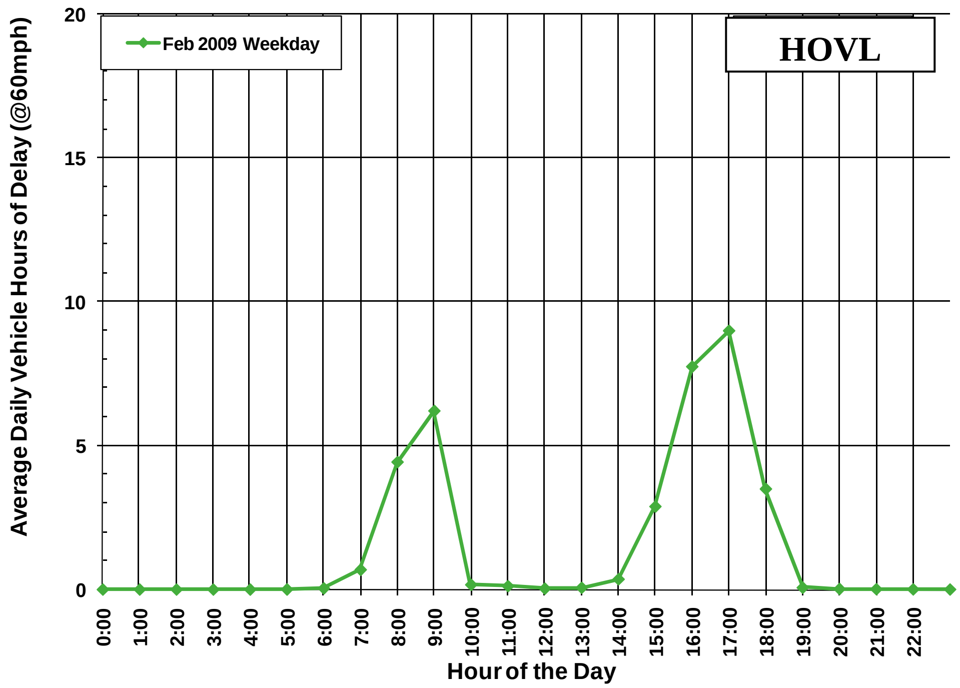
- During the 9:00 AM and 5:00 PM peak hour in the westbound direction of the HOV facility (Exhibit 3-32), the average vehicle hour of delay was respectively 6 hours and 9 hours in February 2009.

Exhibit 3-31: Eastbound SR-22 HOVL Average Weekday Hourly Delay (Feb 2009)



Source: SMG Analysis of PeMS Data
Note: Detection on the SR-22 HOV facility was not available until February 5, 2009.

Exhibit 3-32: Westbound SR-22 HOVL Average Weekday Hourly Delay (Feb 2009)



Source: SMG Analysis of PeMS Data
Note: Detection on the SR-22 HOV facility was not available until February 5, 2009.

Exhibits 3-33 through 3-36 show the average daily vehicle hours of delay for the I-405 Corridor for each year during the 2004-2008 period. The following observations can be made about time-of-day patterns on I-405:

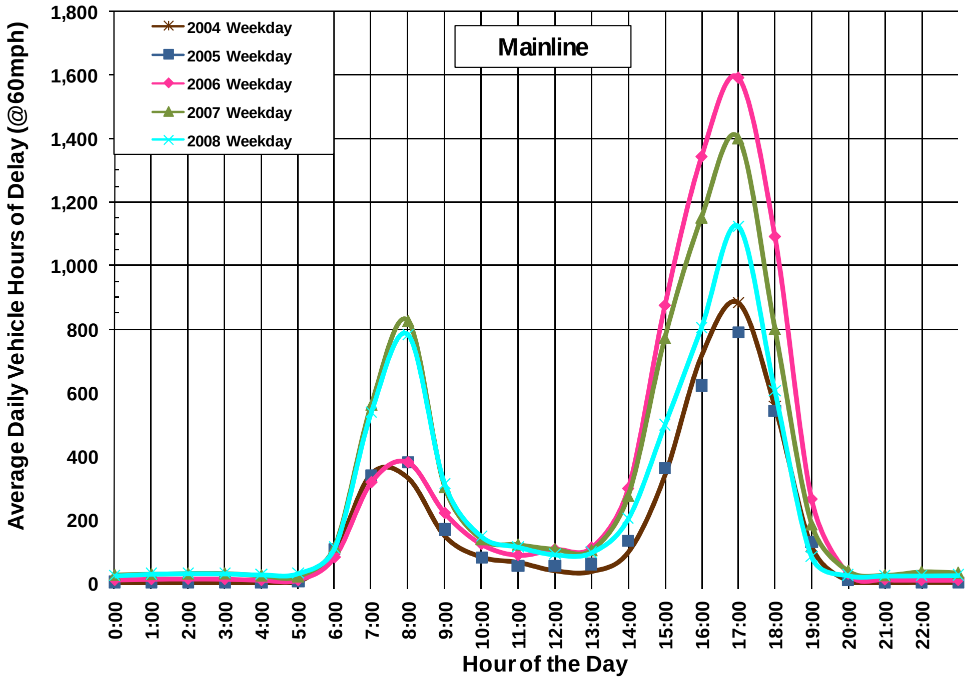
- Delay in the northbound direction of the mainline facility (Exhibit 3-33) decreased overall between 2007 and 2008. During the 8:00 AM peak hour, delay in 2008 (slightly under 800 vehicle-hours) was greater than delay in 2004, 2005, and 2006, but less than delay in 2007. During the 5:00 PM peak hour, delay in 2008 (at around 1,100 vehicle-hours) was greater than the delay in 2004 and 2005, but less than the delay in 2006 and 2007.

- Delay in the southbound direction of the mainline facility (Exhibit 3-34) was the lowest in 2008 during the 8:00 AM peak hour at around 800 vehicle-hours, and highest in 2008 during the 5:00 PM peak hour also at about 800 vehicle-hours.

- Delay in the northbound direction of the HOV facility (Exhibit 3-35) followed the same pattern as the mainline. During the 5:00 PM peak hour, delay in 2008 was greater than the delay in 2004 and 2005 (at roughly 140 vehicle-hours), but less than the delay in 2006 and 2007.

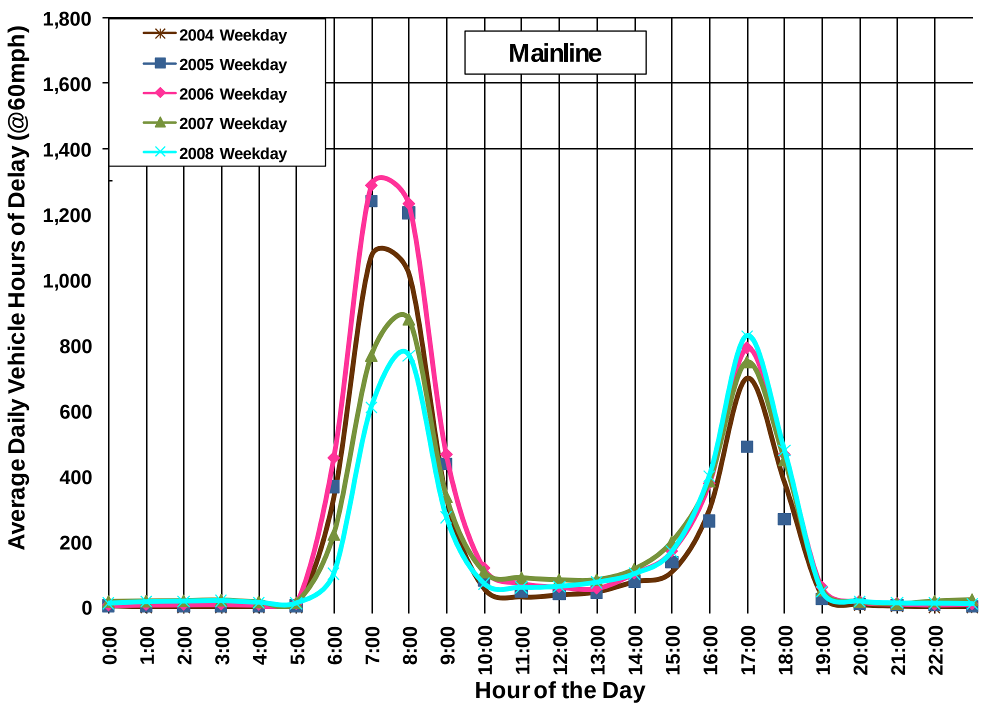
- Delay in the southbound direction of the HOV facility also followed the same pattern as the mainline. During the 7:00 AM peak hour, delay in 2008 (100 hours) was the lowest compared to the previous years, but highest during the 5:00 PM peak hour at around 130 hours.

Exhibit 3-33: Northbound I-405 ML Average Weekday Hourly Delay (2004-2008)



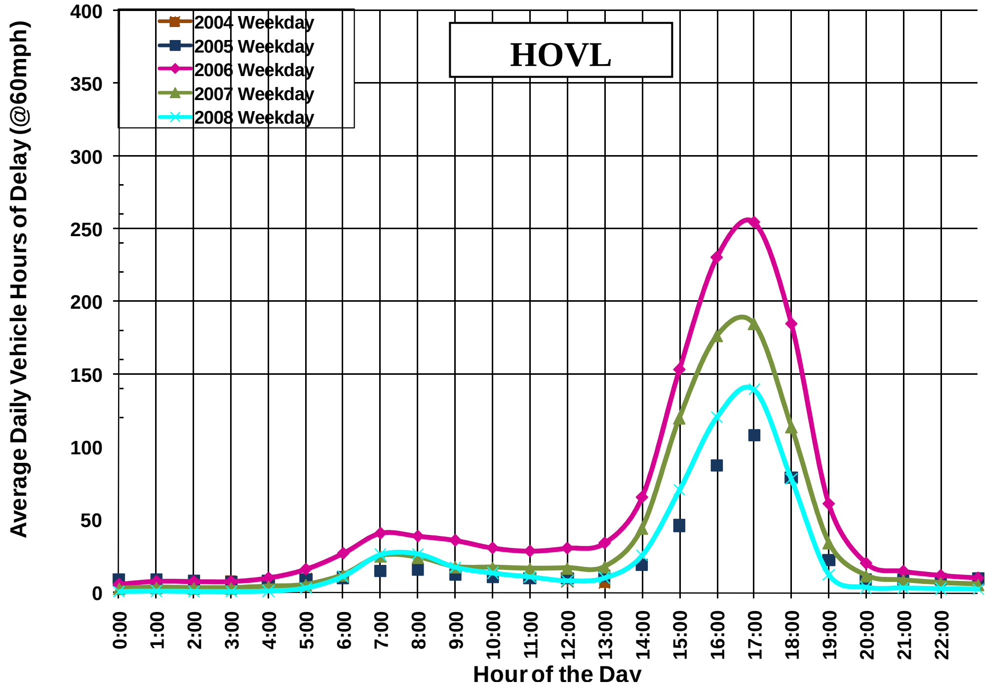
Source: SMG Analysis of PeMS Data

Exhibit 3-34: Southbound I-405 ML Average Weekday Hourly Delay (2004-2008)



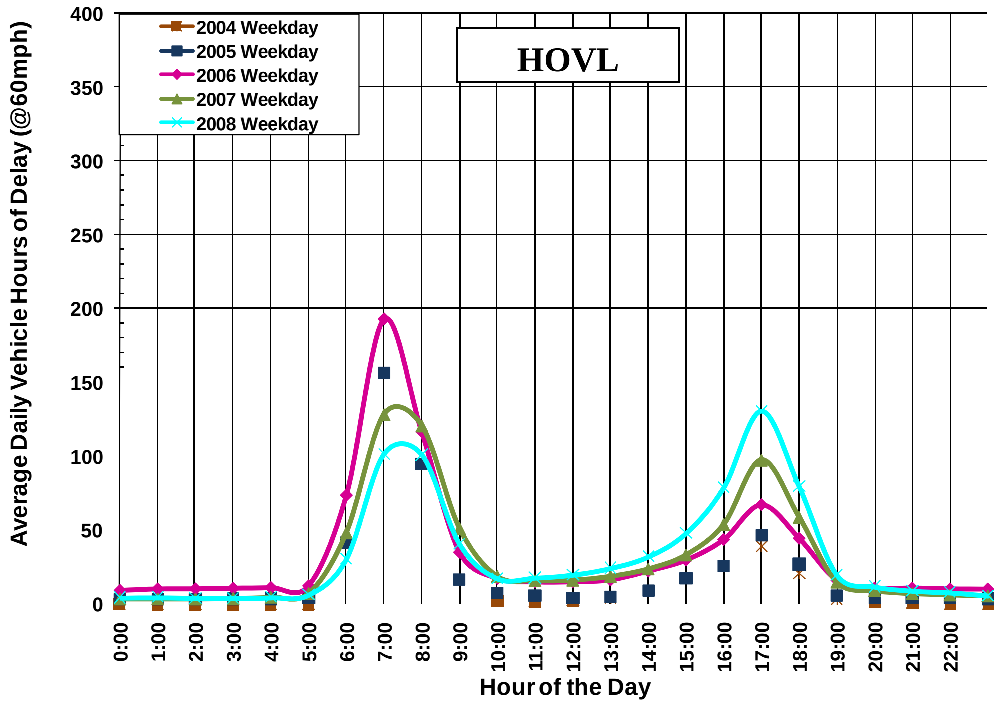
Source: SMG Analysis of PeMS Data

Exhibit 3-35: Northbound I-405 HOVL Average Weekday Hourly Delay (2004-2008)



Source: SMG Analysis of PeMS Data

Exhibit 3-36: Southbound I-405 HOVL Average Weekday Hourly Delay (2004-2008)



Source: SMG Analysis of PeMS Data

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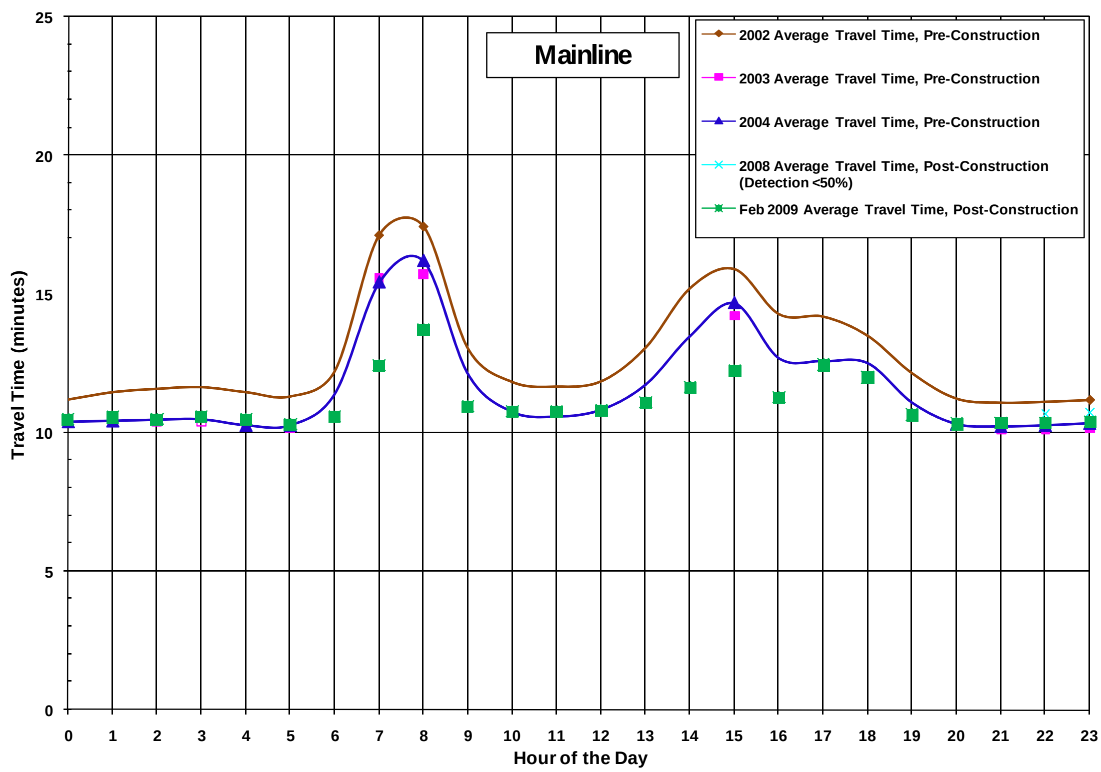
Travel Time

Travel time is reported as the amount of time for a vehicle to travel the distance between two points on a corridor. For the travel time analysis, PeMS data was analyzed for the entire 13-mile segment of SR-22 and the entire 24-mile segment of I-405. Travel time on parallel arterials is not included for this analysis.

Exhibits 3-37 and 3-38 illustrate the travel times assessed for the mainline facility of SR-22. As indicated in Exhibit 3-37, the eastbound direction of the mainline had typical travel times of 15 to 17 minutes in the AM peak period during the pre-construction period of 2002-2004. However, post construction in February 2009, travel times decreased (as shown by the green line) to roughly 14 minutes. The westbound direction of the mainline facility also experienced an improvement in travel times as depicted in Exhibit 3-38. In 2002-2004, the westbound direction experienced typical travel times of approximately 17 minutes during the PM peak hour and about 11 to 12 minutes during the off-peak hours. In February 2009, travel times during the PM peak period decreased to under 15 minutes.

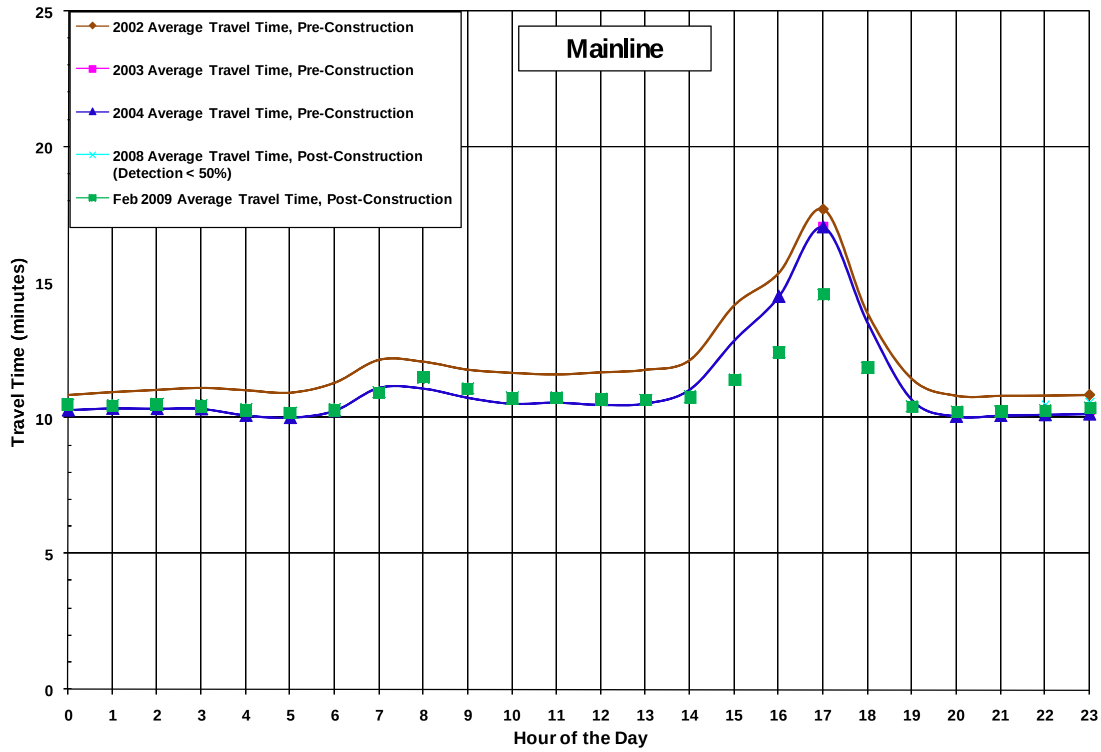
Exhibit 3-37: Eastbound SR-22 ML Travel Time by Time of Day (2002-2004, 2008, Feb 2009)



Source: SMG Analysis of PeMS Data

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

Exhibit 3-38: Westbound SR-22 ML Travel Time by Time of Day (2002-2004, 2008, Feb 2009)

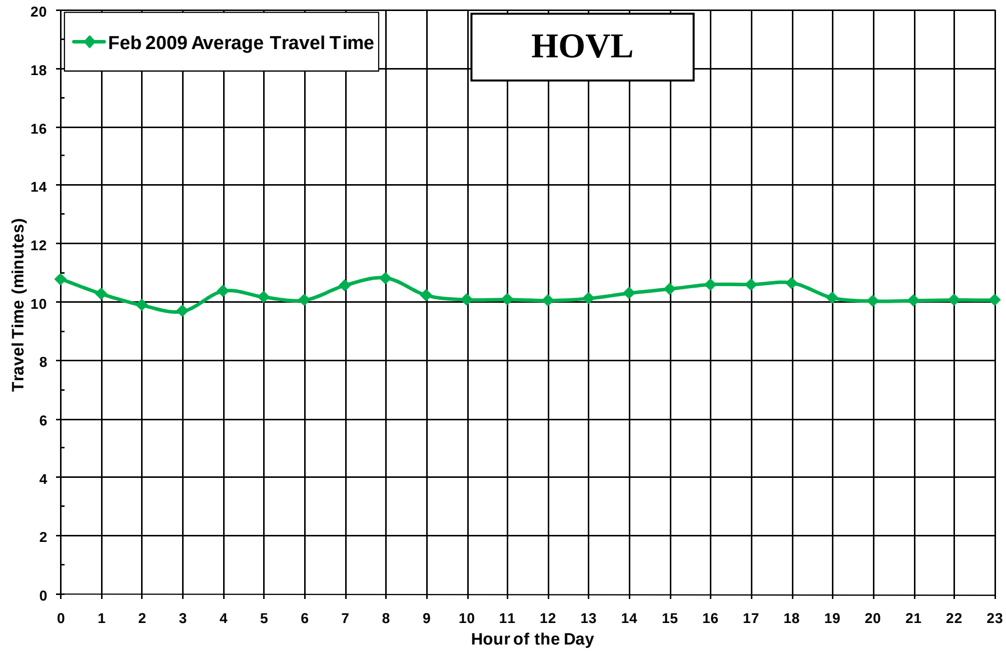


Source: SMG Analysis of PeMS Data

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

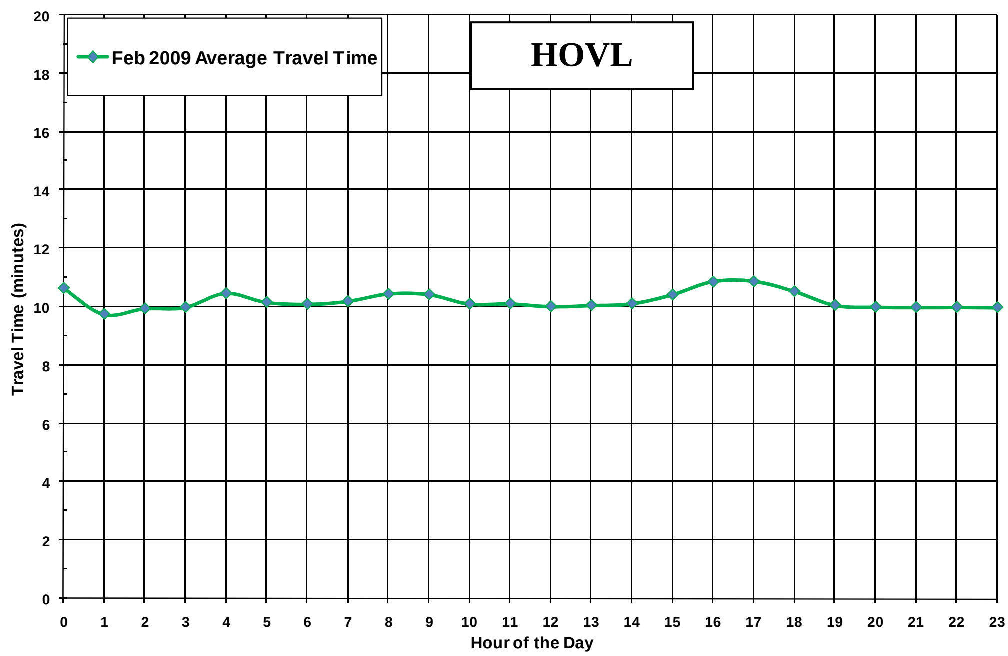
Travel times for the SR-22 HOV facility are illustrated in Exhibits 3-39 and 3-40. For both directions of the HOV facility, travel times during the peak periods in February 2009 were extremely close to travel times during the off-peak periods, at around 10 minutes. Travel times during the peak period were only one minute greater (at 11 minutes) than during the off-peak periods. Again, 2008 results are not discussed in the analysis given the poor detection.

Exhibit 3-39: Eastbound SR-22 HOVL Travel Time by Time of Day (Feb 2009)



Source: SMG Analysis of PeMS Data
Note: Detection on the SR-22 HOV facility was not available until February 5, 2009.

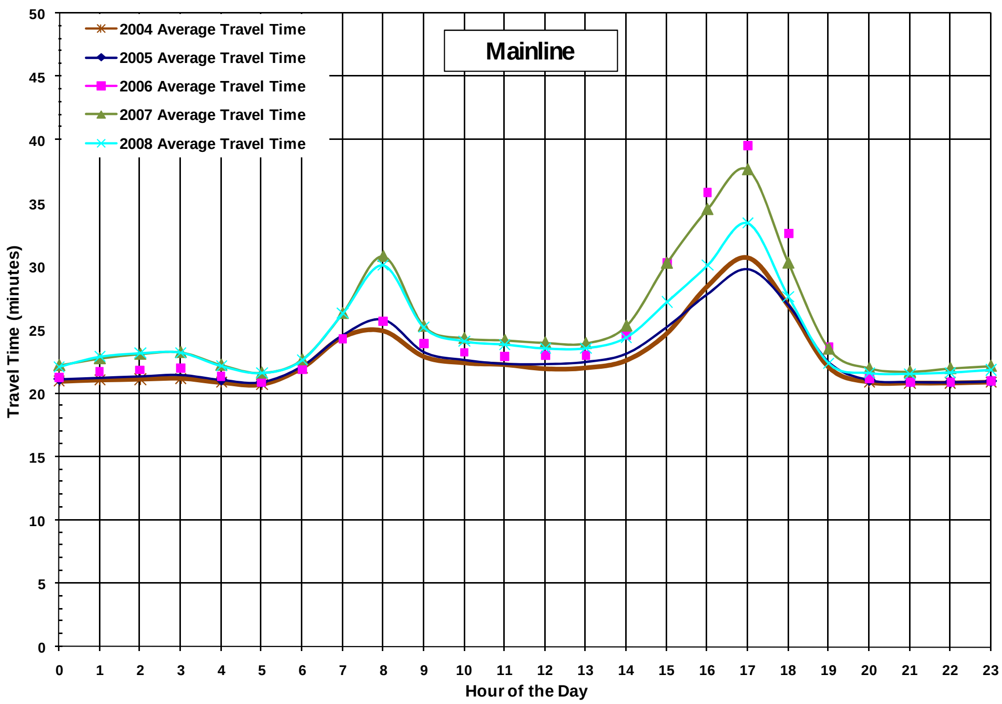
Exhibit 3-40 Westbound SR-22 HOVL Travel Time by Time of Day (Feb 2009)



Source: SMG Analysis of PeMS Data
Note: Detection on the SR-22 HOV facility was not available until February 5, 2009.

Exhibits 3-41 through 3-44 reveal the travel times for the I-405 Corridor for each year between 2004 and 2008. In the northbound direction of the mainline, travel times were highest during the PM peak period. The northbound direction experienced an overall travel time increase during the AM peak period, but a decline during the PM peak period. In 2008 during at 8:00 AM (Exhibit 3-41), it took a vehicle 30 minutes to drive the corridor, which is five minutes longer than the 25 minutes it took to drive the corridor in 2004-2006. However, in 2008 during the PM peak, it took a vehicle about 33 minutes to drive the corridor, which is seven minutes faster than it took to drive it in 2006.

Exhibit 3-41: Northbound I-405 ML Travel Time by Time of Day (2004-2008)



Source: SMG Analysis of PeMS Data

Exhibit 3-42 illustrates travel time for the southbound direction of the I-405 mainline facility. In the southbound direction of the mainline, travel times were highest during the AM peak period. During the AM peak hour, the southbound direction experienced an overall decline in delay, reaching its lowest level in 2008 at about 31 minutes. However, during the PM peak hour, the southbound direction experienced the greatest delay in 2008 at slightly under 30 minutes.

Exhibit 3-42: Southbound I-405 ML Travel Time by Time of Day (2004-2008)

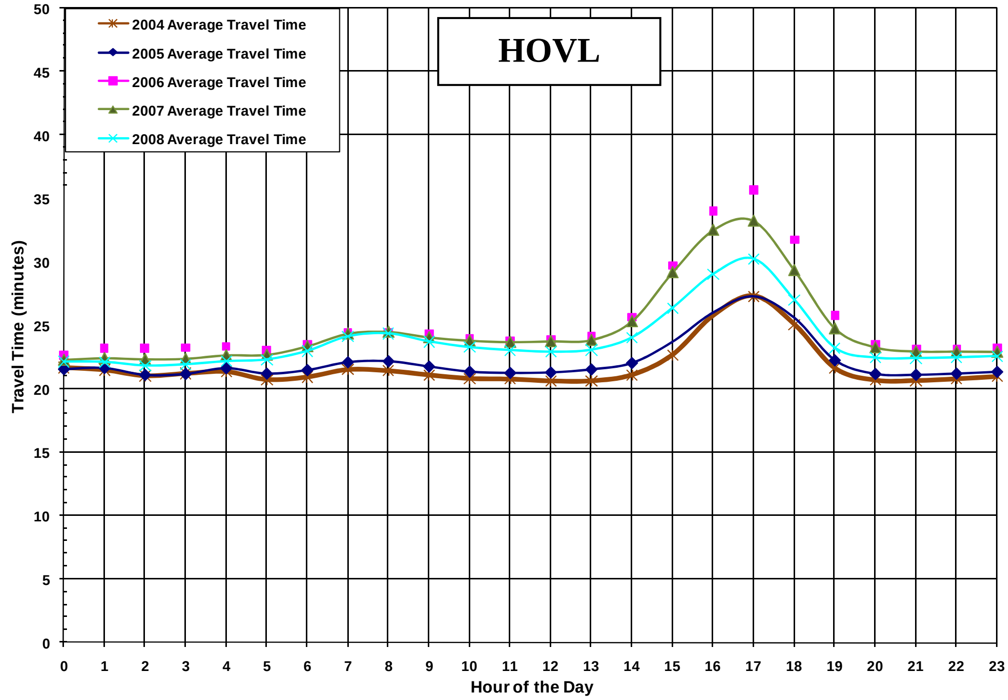
Mainline

Source: SMG Analysis of PeMS Data

Travel times for both directions of the the I-405 HOV facility are lower than the mainline facility. In the northbound direction of the HOV facility, travel times ranged from 27 to 35 minutes at the 5:00 PM peak hour, which is less than the travel time range of 30-40 minutes on the mainline facility. The travel time in 2008 for the northbound direction of the HOV facility (Exhibit 3-43) at 5:00 PM was 30 minutes, which an improvement over 2006 and 2007 travel times, but still higher than 2004 and 2005 travel times.

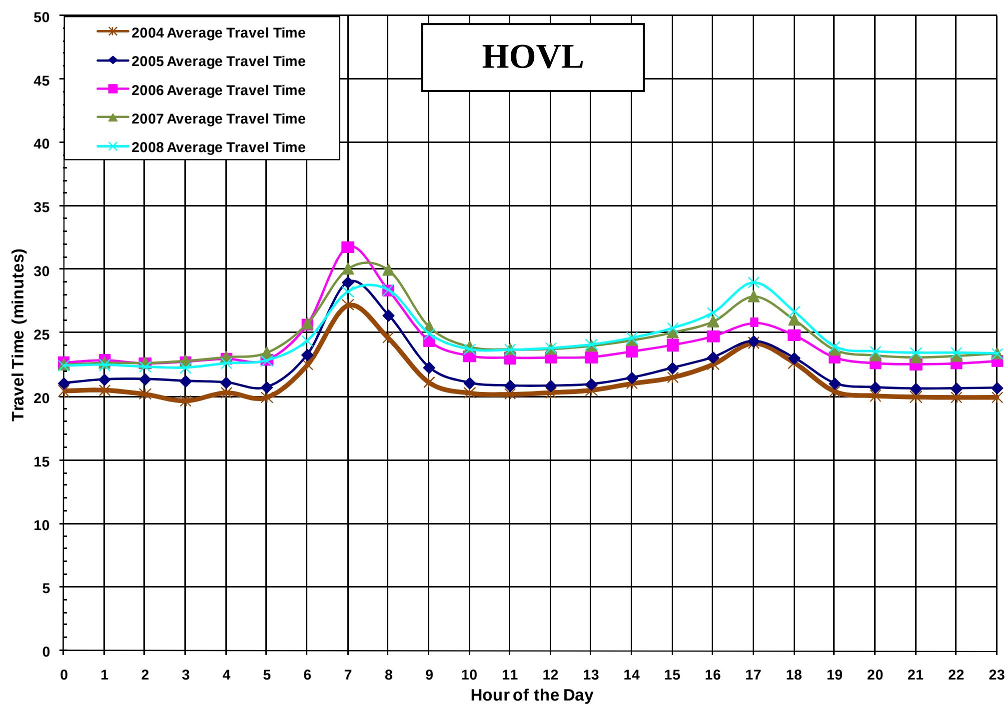
The travel time for the southbound direction of the HOV facility (Exhibit 3-45) was also an improvement over the mainline facility. Southbound travel times ranged between 27-33 minutes on the HOV lane, which is less than the mainline travel time range of 28-36 minutes. During the AM peak period, the southbound HOV travel time in 2008 was about 28 minutes, which is an improvement over every other year except for 2004. However, during the PM peak period, the southbound HOV travel time in 2008 was the highest compared to the previous years at about 29 minutes.

Exhibit 3-43: Northbound I-405 HOVL Travel Time by Time of Day (2004-2008)



Source: SMG Analysis of PeMS Data

Exhibit 3-44: Southbound I-405 HOVL Travel Time by Time of Day (2004-2008)



Source: SMG Analysis of PeMS Data

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RELIABILITY

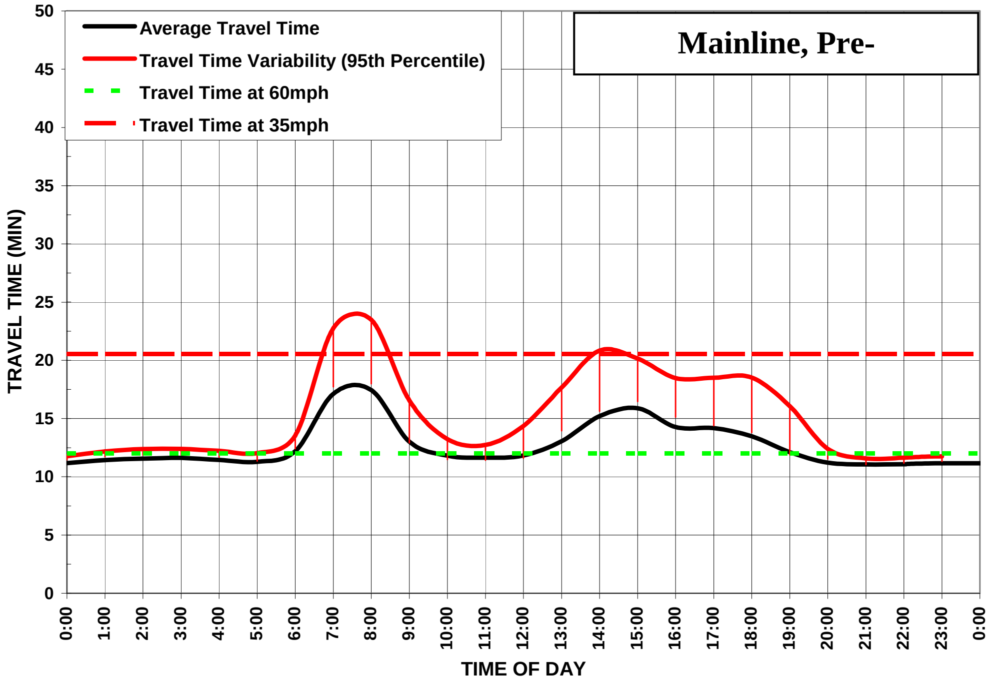
Reliability captures the relative predictability of the public's travel time. Unlike mobility, which measures the rate of travel, the reliability measure focuses on how travel time varies from day to day. To measure reliability, the study team estimated travel time variability using PeMS data. The 95^{th} percentile was chosen as a reasonable representation of the maximum peak travel time that could be experienced along the corridor. Severe incidents, such as fatal accidents, could cause travel times longer than the 95^{th} percentile, but this statistic is a balance between extreme outliers and the "typical" travel day.

Exhibits 3-45 through 3-56 on the following pages illustrate the variability of travel time for the SR-22 Corridor on weekdays for the years 2002-2004 (pre-construction) and 2008 and February 2009 (post-construction). Exhibits 3-45 through 3-54 present travel time variability for the mainline in the eastbound direction followed by the westbound. Similarly, Exhibits 3-55 and 3-56 show travel time variability for the HOV facility beginning with the eastbound and followed by the westbound direction.

For the mainline facility of SR-22, the AM peak hour was the most unreliable in addition to being the slowest hour in the eastbound direction. In 2002 (shown in Exhibit 3-45), motorists driving the entire length of the corridor had to add 7 minutes to an average travel time of 17 minutes (for a total travel time of 24 minutes) to ensure that they arrived on time 95 percent of the time. This is 12 minutes longer than the 12-minute travel time at 60 mph. In 2003 (Exhibit 3-46), the time needed to arrive on time 95 percent of the time decreased to 21 minutes; remained the same in 2004 (Exhibit 3-47); and declined significantly in February 2009 to 15 minutes (Exhibit 3-49). The westbound direction of the mainline facility experienced a similar decline in travel time variability. In 2002 (Exhibit 3-50), the time needed to arrive on time 95 percent of the time was 25 minutes, which declined in 2003 and 2004 to 21 minutes (Exhibits 3-51 and 3-52), and further declined in February 2009 to 16 minutes (Exhibit 3-54).

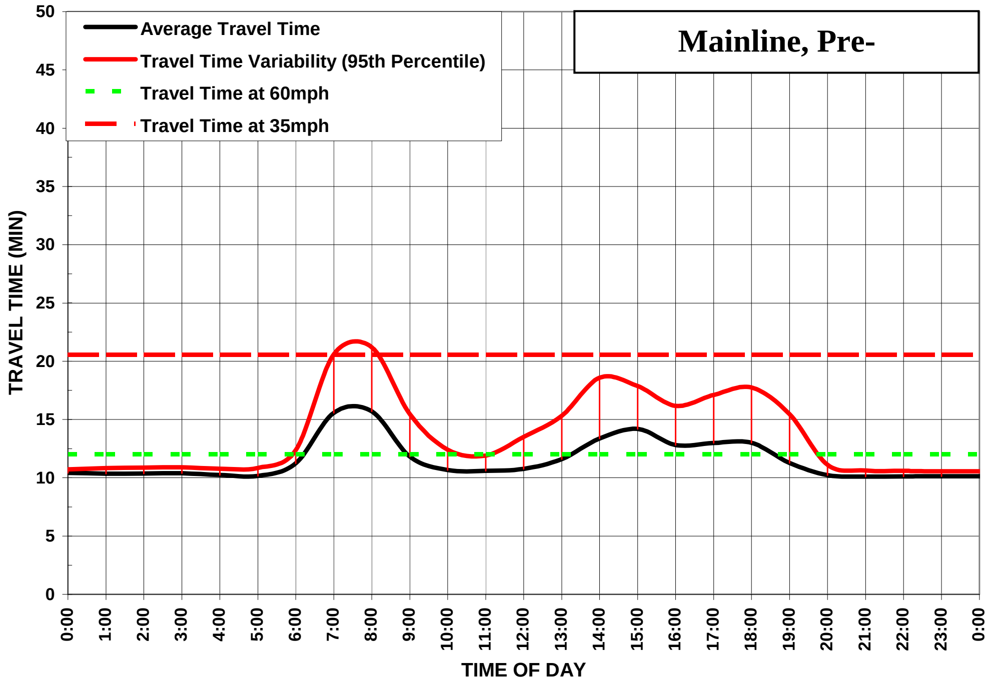
The SR-22 HOV facility experienced lower levels of travel time variability. In the eastbound direction in 2009 (Exhibit 3-55), the driving time needed to arrive on time 95 percent of the time was below 12 minutes, the same as the travel time at 60 miles per hour (mph), even during the AM peak period. In the westbound direction (Exhibit 3-6560), the time needed to arrive on time during the 4:00 PM peak hour was about 13 minutes, which is 2 minutes greater than the 11-minute average travel time, and 1 minute greater than the travel time at 60 mph. Given the poor detection on the corridor in 2008, the results are not discussed.

Exhibit 3-45: Eastbound SR-22 ML Travel Time Variation (2002)



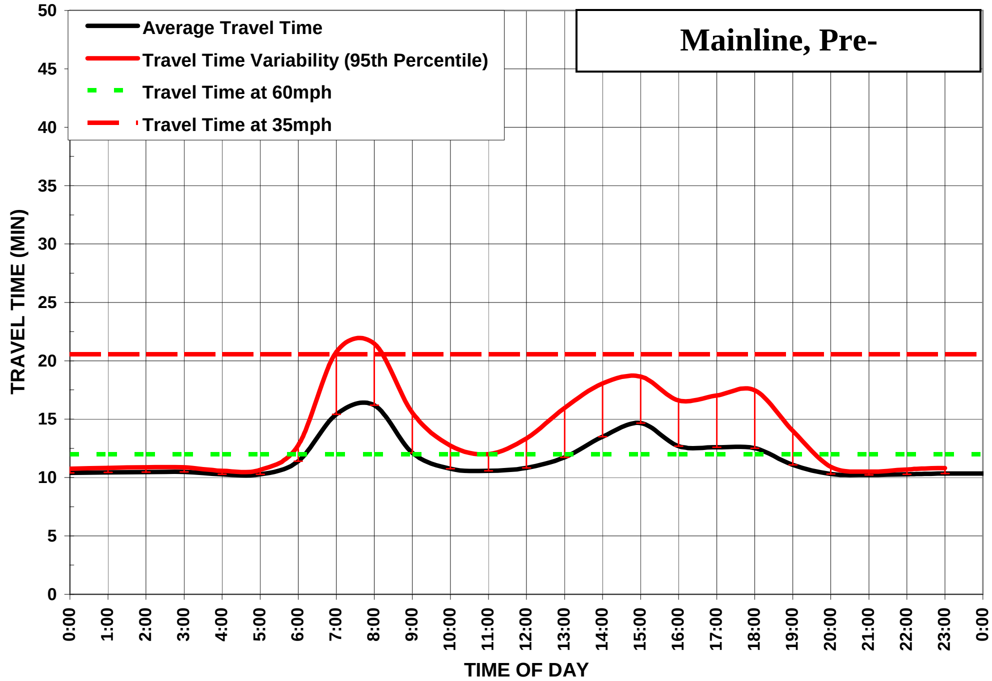
Source: SMG Analysis of PeMS Data

Exhibit 3-46: Eastbound SR-22 ML Travel Time Variation (2003)



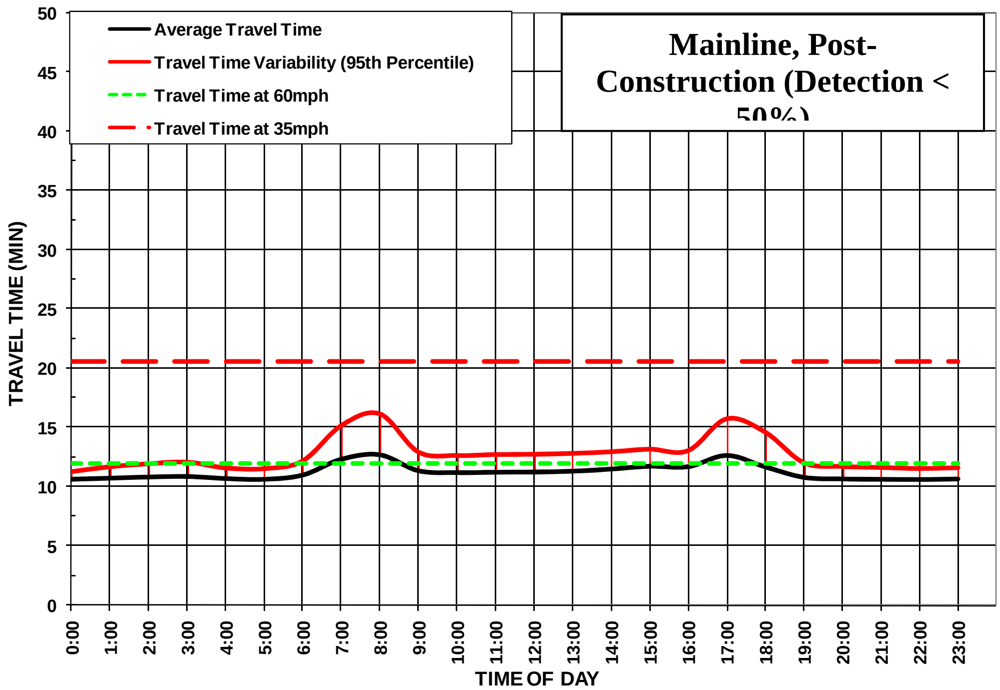
Source: SMG Analysis of PeMS Data

Exhibit 3-47: Eastbound SR-22 ML Travel Time Variation (2004)



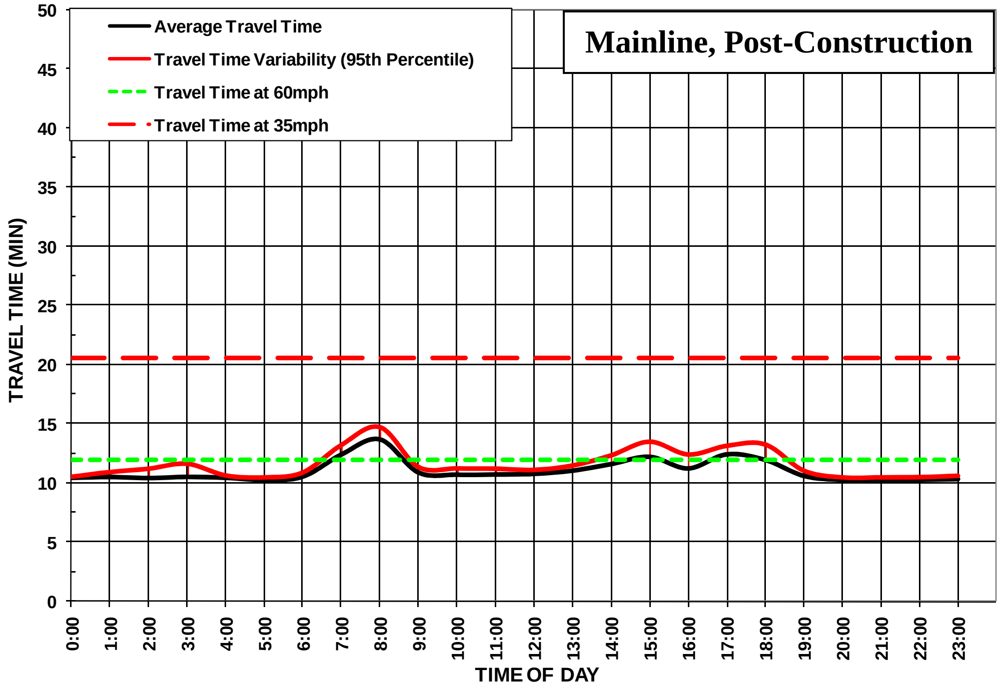
Source: SMG Analysis of PeMS Data

Exhibit 3-48: Eastbound SR-22 ML Travel Time Variation (2008)



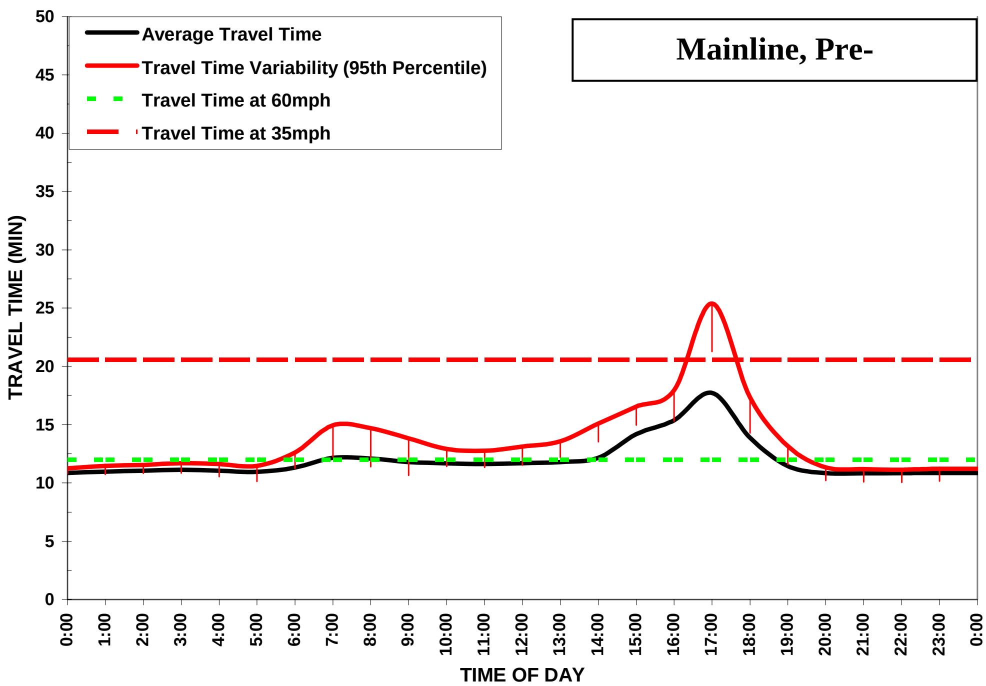
Source: SMG Analysis of PeMS Data
Note: Due to poor detection on SR-22 in 2008, travel time variation may be underreported for 2008.

Exhibit 3-49: Eastbound SR-22 ML Travel Time Variation (Feb 2009)



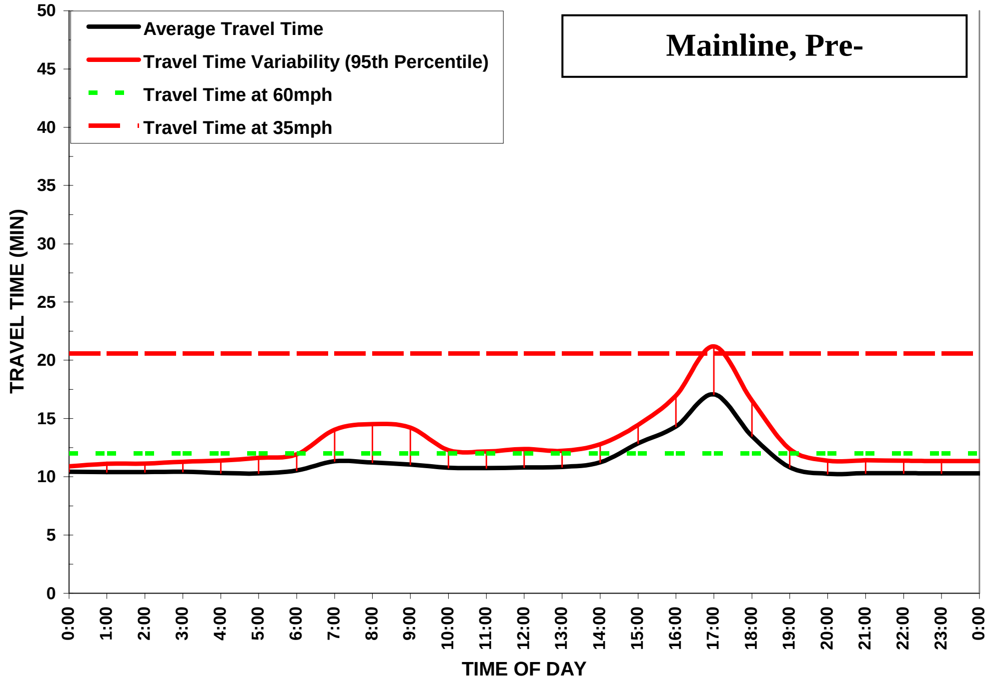
Source: SMG Analysis of PeMS Data

Exhibit 3-50: Westbound SR-22 ML Travel Time Variation (2002)



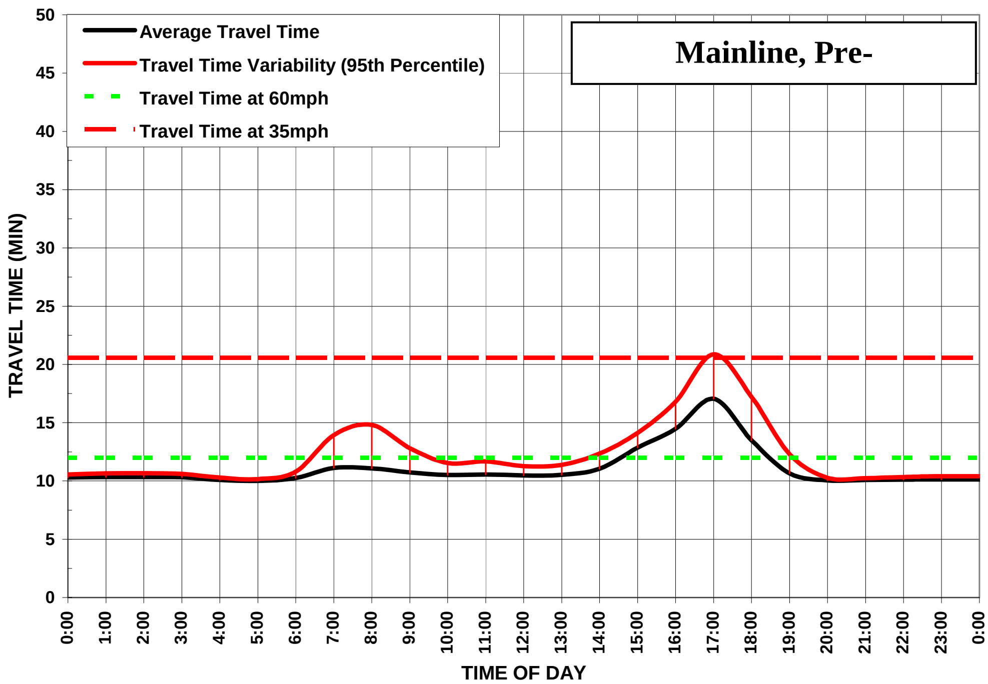
Source: SMG Analysis of PeMS Data

Exhibit 3-51: Westbound SR-22 ML Travel Time Variation (2003)



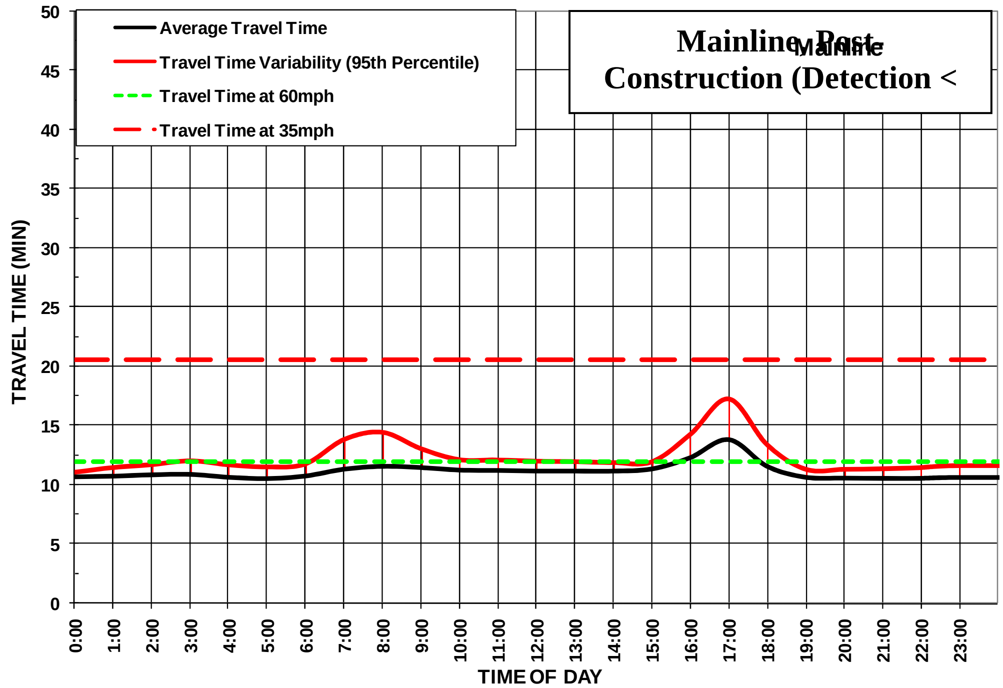
Source: SMG Analysis of PeMS Data

Exhibit 3-52: Westbound SR-22 ML Travel Time Variation (2004)



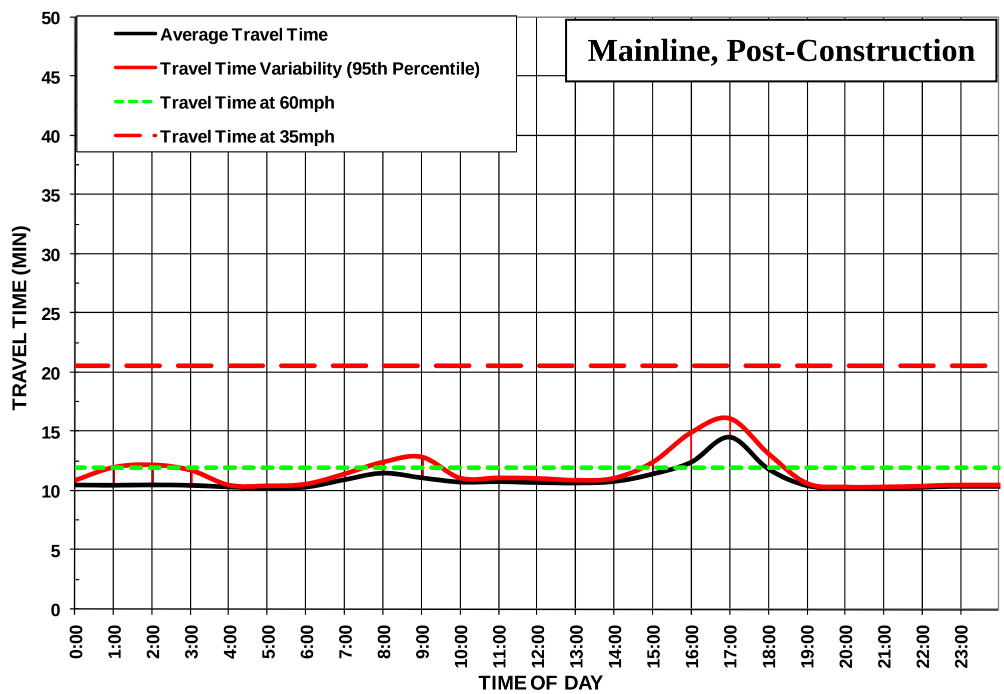
Source: SMG Analysis of PeMS Data

Exhibit 3-53: Westbound SR-22 ML Travel Time Variation (2008)



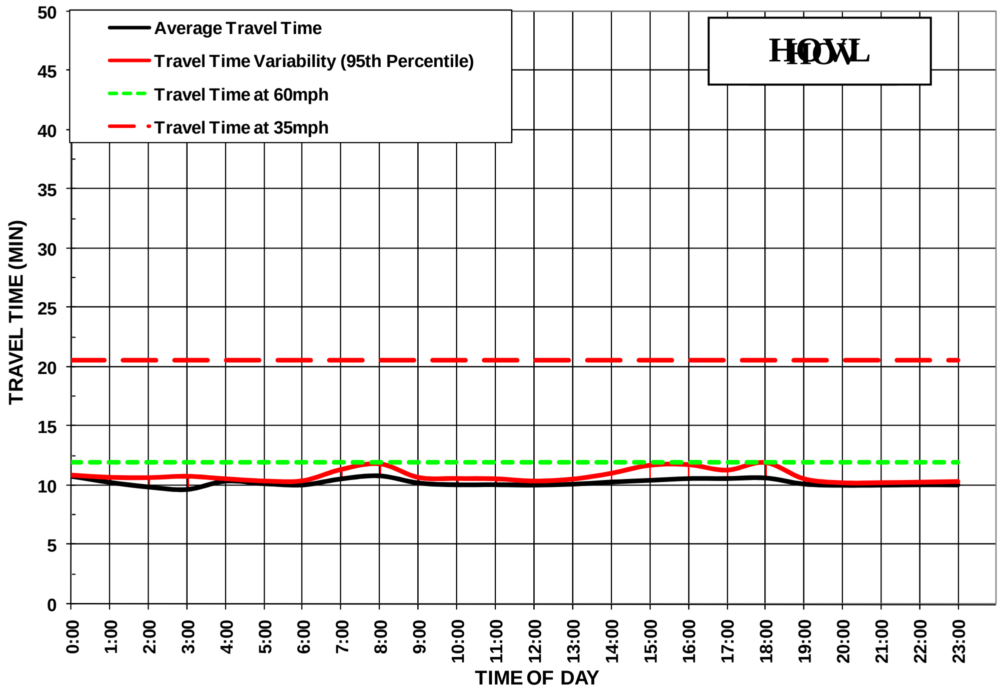
Source: SMG Analysis of PeMS Data
Note: Due to poor detection on SR-22 in 2008, travel time variation may be underreported for 2008.

Exhibit 3-54: Westbound SR-22 ML Travel Time Variation (Feb 2009)



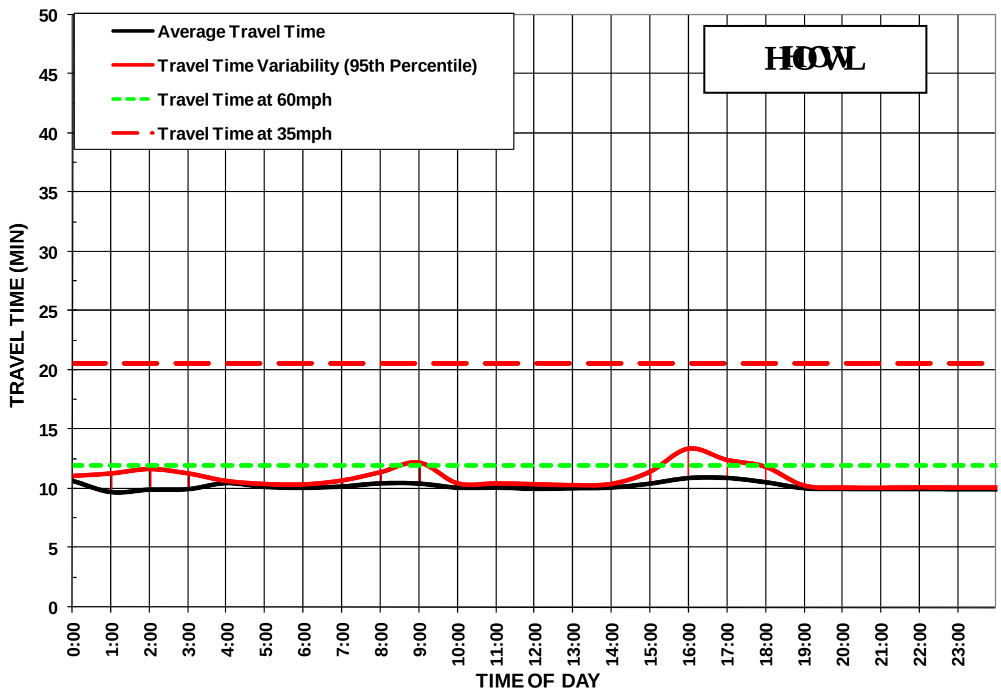
Source: SMG Analysis of PeMS Data

Exhibit 3-55: Eastbound SR-22 HOVL Travel Time Variation (Feb 2009)



Source: SMG Analysis of PeMS Data
Note: Detection on the SR-22 HOV facility was not available until February 5, 2009.

Exhibit 3-56: Westbound SR-22 HOVL Travel Time Variation (Feb 2009)



Source: SMG Analysis of PeMS Data
Note: Detection on the SR-22 HOV facility was not available until February 5, 2009.

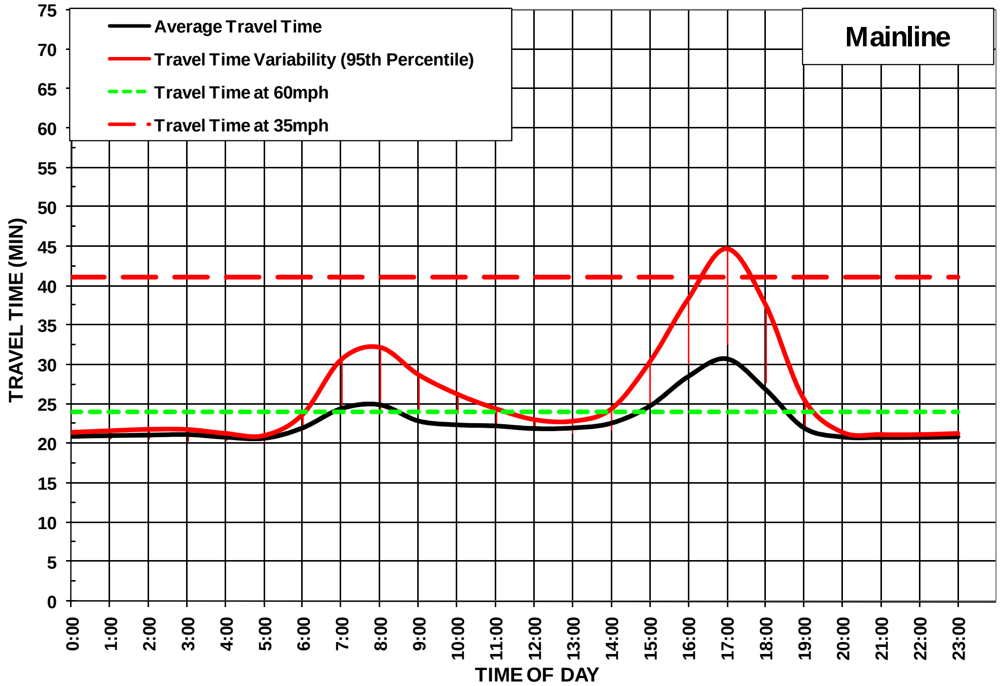
Exhibits 3-57 to 3-76 on the proceeding pages illustrate the variability of travel time for the I-405 Corridor on weekdays for the years 2004-2008. Exhibits 3-57 to 3-66 present travel time variability for the mainline in the northbound direction followed by the southbound. Similarly, Exhibits 3-67 through 3-76 show travel time variability for the HOV facility beginning with the northbound and followed by the southbound direction.

For the mainline facility of I-405, the 5:00 PM peak hour was the most unreliable in addition to being the slowest hour in the northbound direction. In 2004 (shown in Exhibit 3-57), motorists driving the entire length of the corridor had to add 15 minutes to an average travel time of 30 minutes (for a total travel time of 45 minutes) to ensure that they arrived on time 95 percent of the time. This is 20 minutes longer than the 25-minute travel time at 60 mph. In 2005 (Exhibit 3-58), the time needed to arrive on time 95 percent of the time decreased to 41 minutes; but increased dramatically to 55 minutes in 2006 (Exhibit 3-59); declined to 50 minutes in 2007 (Exhibit 3-60); and further declined to 40 minutes in 2008 (Exhibit 3-61). The southbound direction of the mainline facility experienced a gradual decline in travel time variability between 2004 and 2008. In 2004 (Exhibit 3-62) at the 7:00 AM peak hour, the time needed to arrive on time 95 percent of the time was 46 minutes; which increased to 50 minutes in 2005 (Exhibit 3-63); but declined to 48 minutes in 2006 (Exhibit 3-64); and declined further to 41 minutes in 2007 and 2008 (Exhibits 3-65 and 3-66).

Travel times for the I-405 HOV facility are illustrated in Exhibits 3-67 through 3-76. During the 5:00 PM peak hour in the northbound direction of the HOV facility, 2006 experienced the highest travel time at about 49 minutes (Exhibit 3-69), which declined in the following two years to 41 minutes in 2007 (Exhibit 3-70) and 37 minutes in 2008 (Exhibit 3-71). The same trend occurred in the southbound direction. In 2006 during the 7:00 AM peak hour, the southbound HOV lane experienced the highest travel time at slightly under 40 minutes (Exhibit 3-74), which declined to 38 minutes in 2007 (Exhibit 3-75) and further declined to 35 minutes in 2008 (Exhibit 3-76).

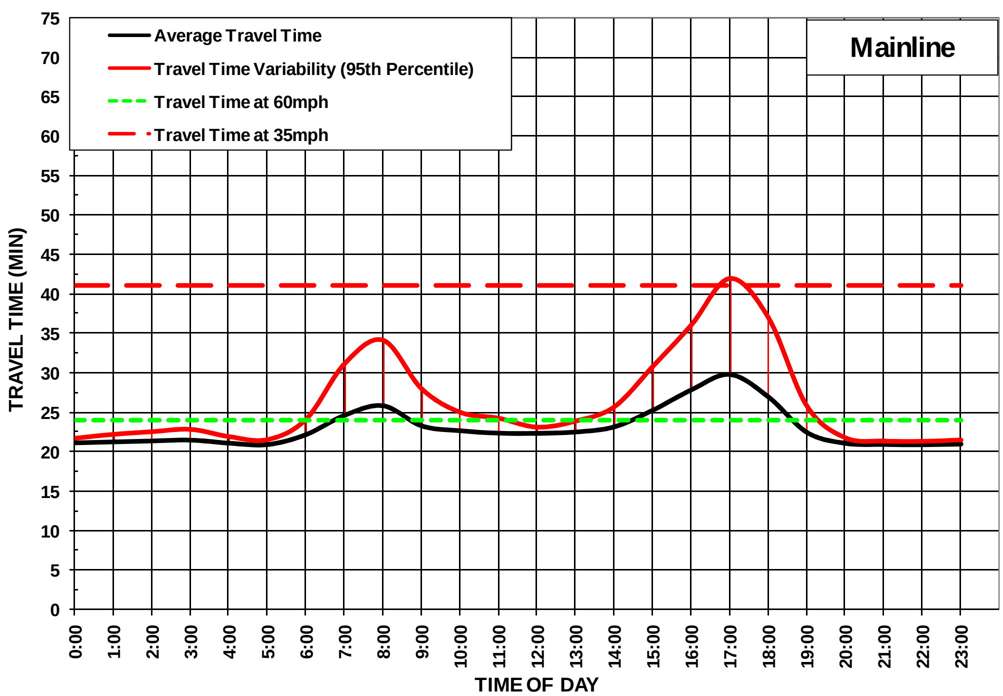
Traveling on the HOV facility saved motorists an average of almost 6 minutes in the northbound direction and 8 minutes in the southbound direction during their respective peak hours in 2004-2008. In 2008, the savings in travel time was less than the average at about 3 minutes in the northbound direction and 4 minutes in the southbound direction during their peak hours.

Exhibit 3-57: Northbound I-405 ML Travel Time Variation (2004)



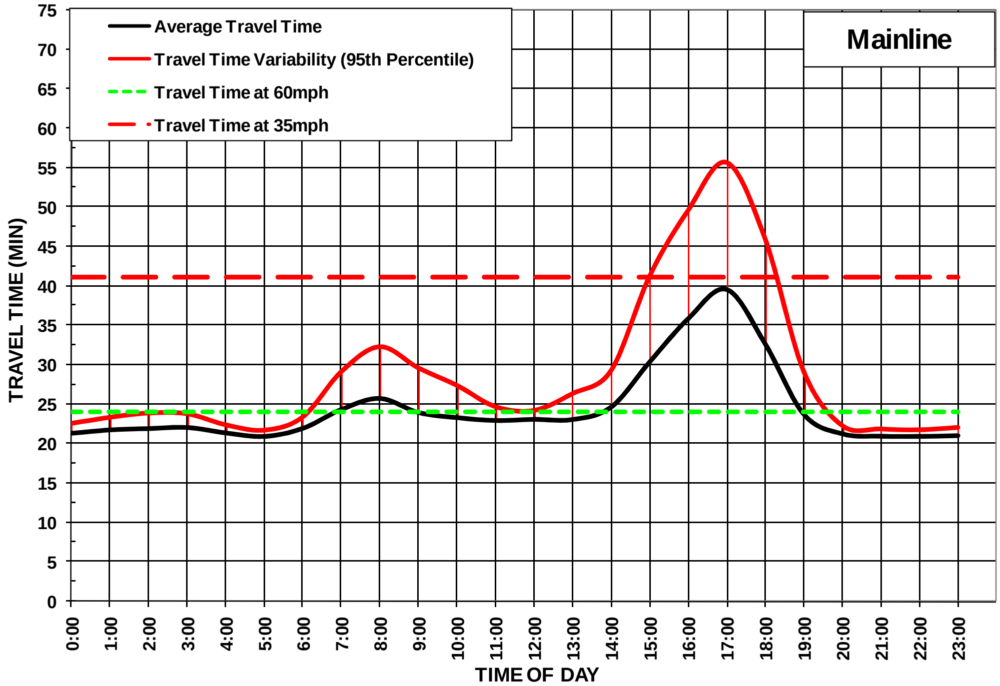
Source: SMG Analysis of PeMS Data

Exhibit 3-58: Northbound I-405 ML Travel Time Variation (2005)



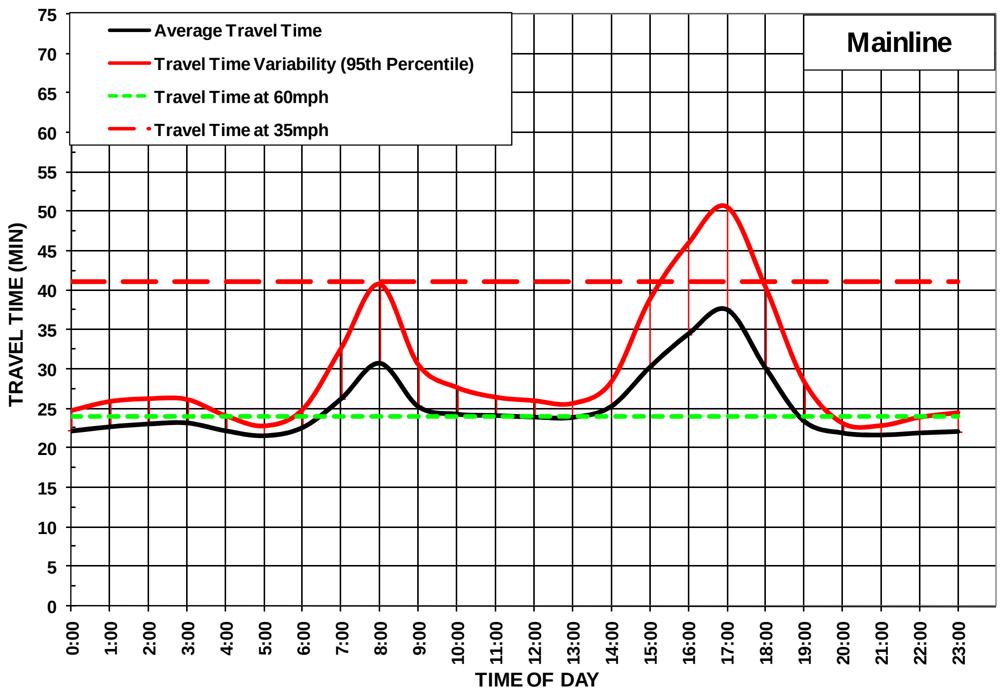
Source: SMG Analysis of PeMS Data

Exhibit 3-59: Northbound I-405 ML Travel Time Variation (2006)



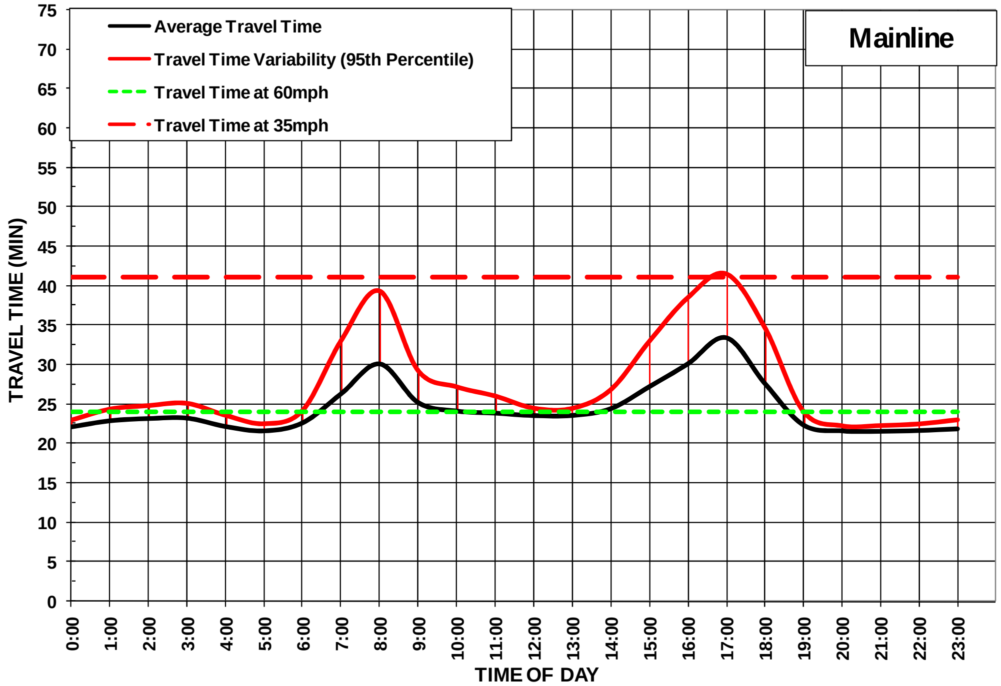
Source: SMG Analysis of PeMS Data

Exhibit 3-60: Northbound I-405 ML Travel Time Variation (2007)



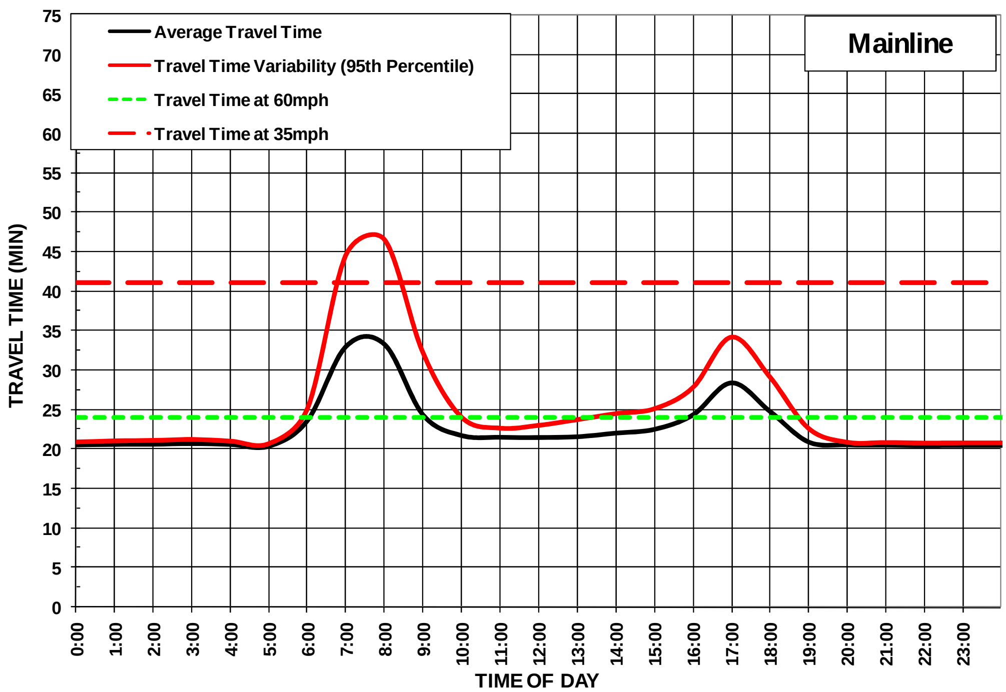
Source: SMG Analysis of PeMS Data

Exhibit 3-61: Northbound I-405 ML Travel Time Variation (2008)



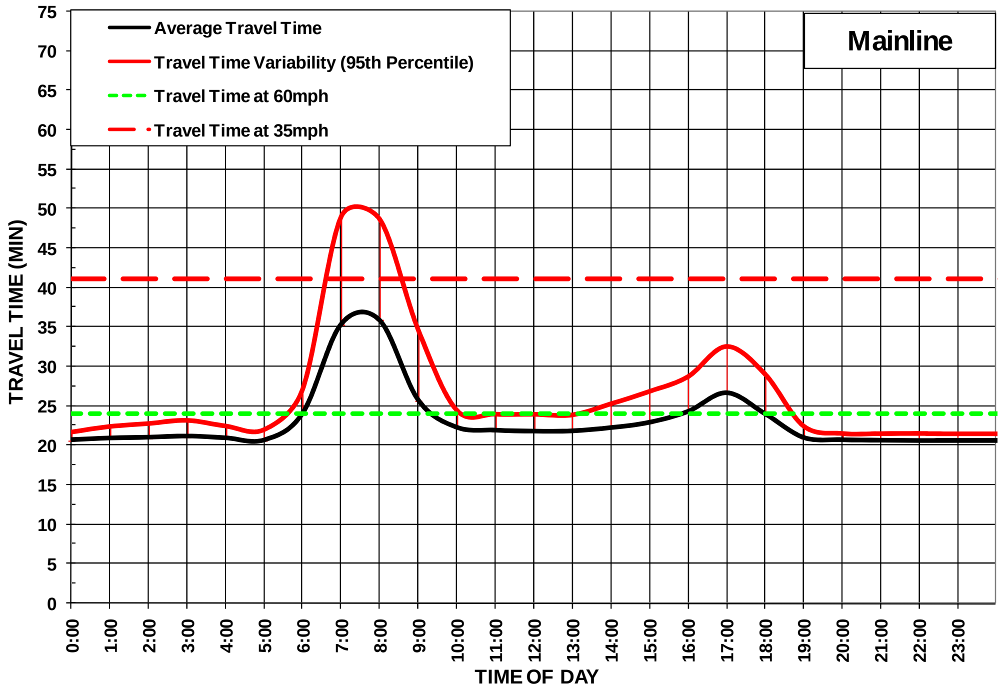
Source: SMG Analysis of PeMS Data

Exhibit 3-62: Southbound I-405 ML Travel Time Variation (2004)



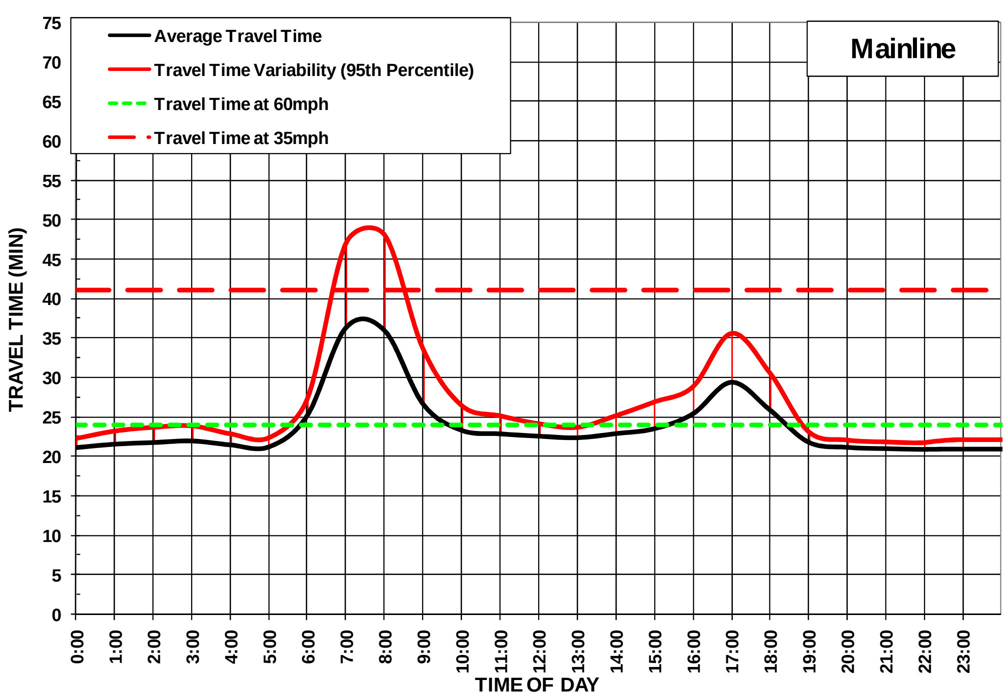
Source: SMG Analysis of PeMS Data

Exhibit 3-63: Southbound I-405 ML Travel Time Variation (2005)



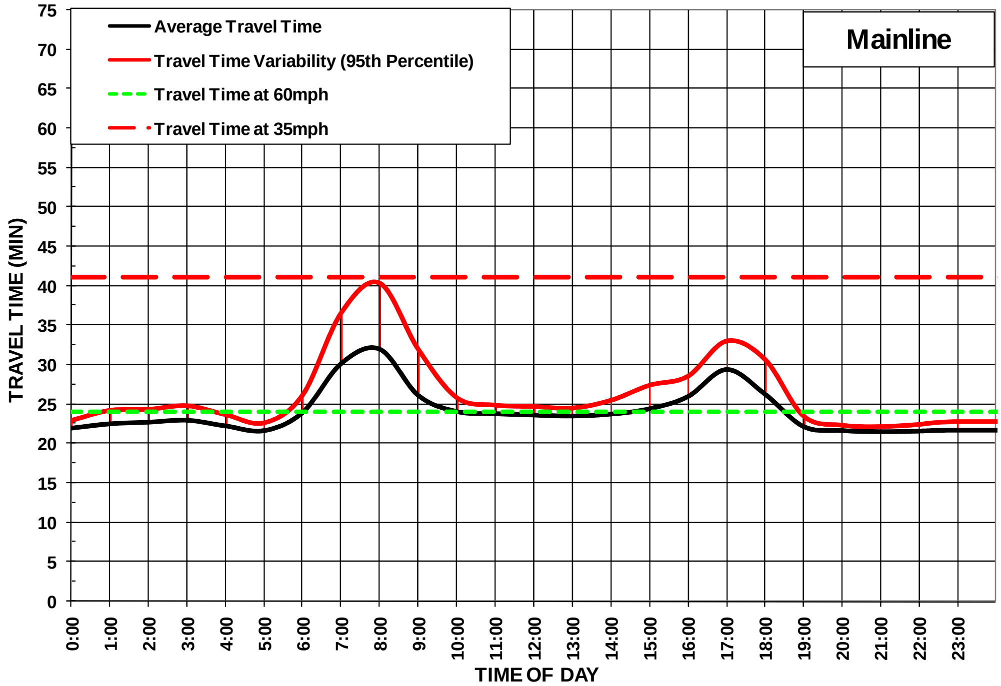
Source: SMG Analysis of PeMS Data

Exhibit 3-64: Southbound I-405 ML Travel Time Variation (2006)



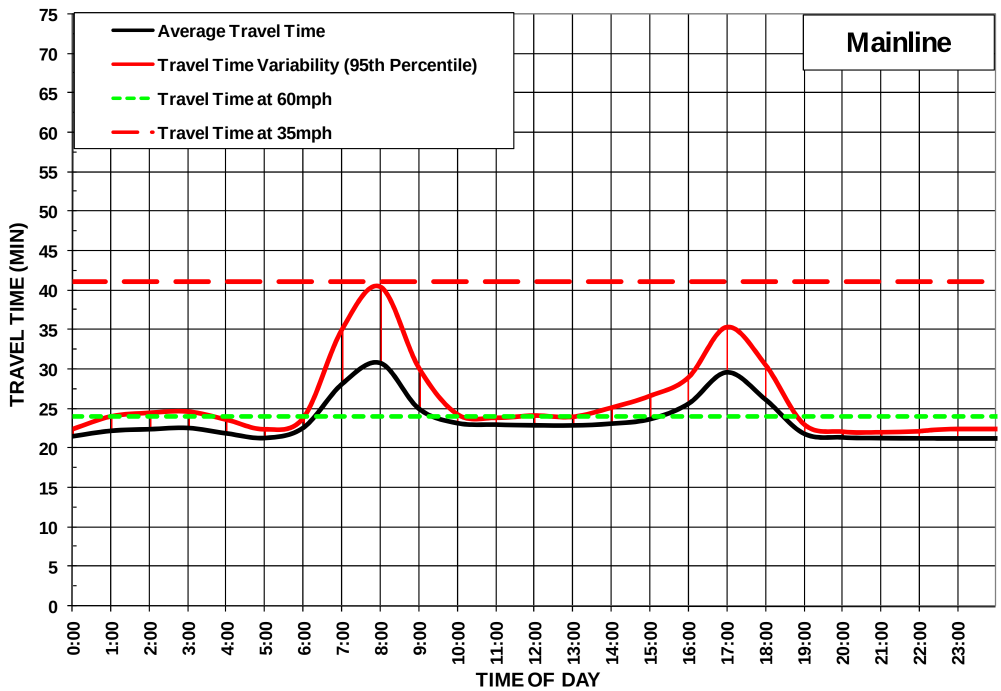
Source: SMG Analysis of PeMS Data

Exhibit 3-65: Southbound I-405 ML Travel Time Variation (2007)



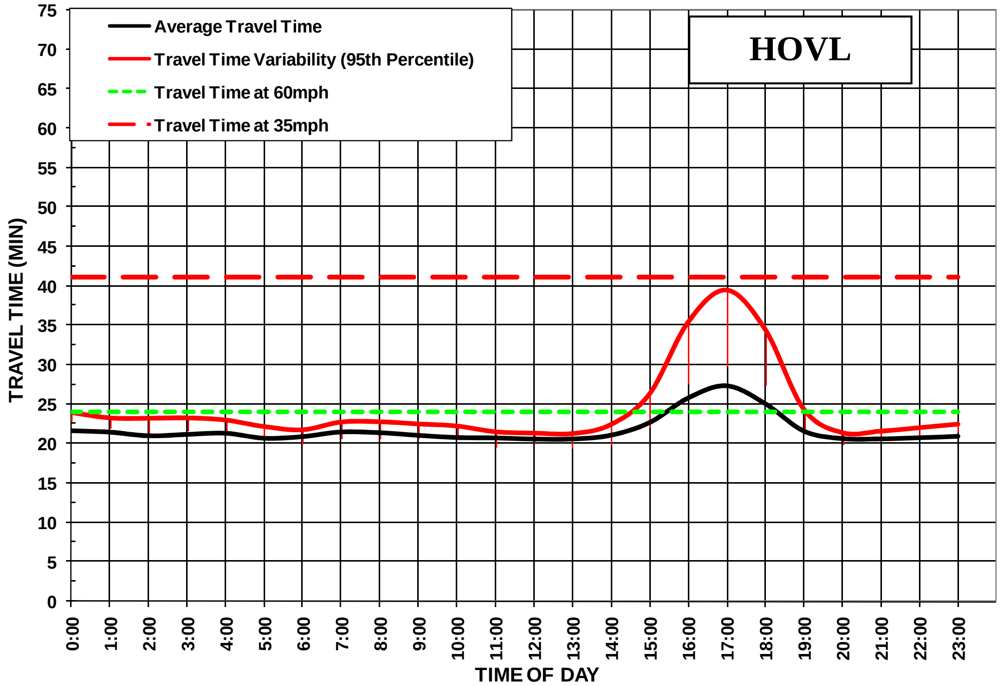
Source: SMG Analysis of PeMS Data

Exhibit 3-66: Southbound I-405 ML Travel Time Variation (2008)



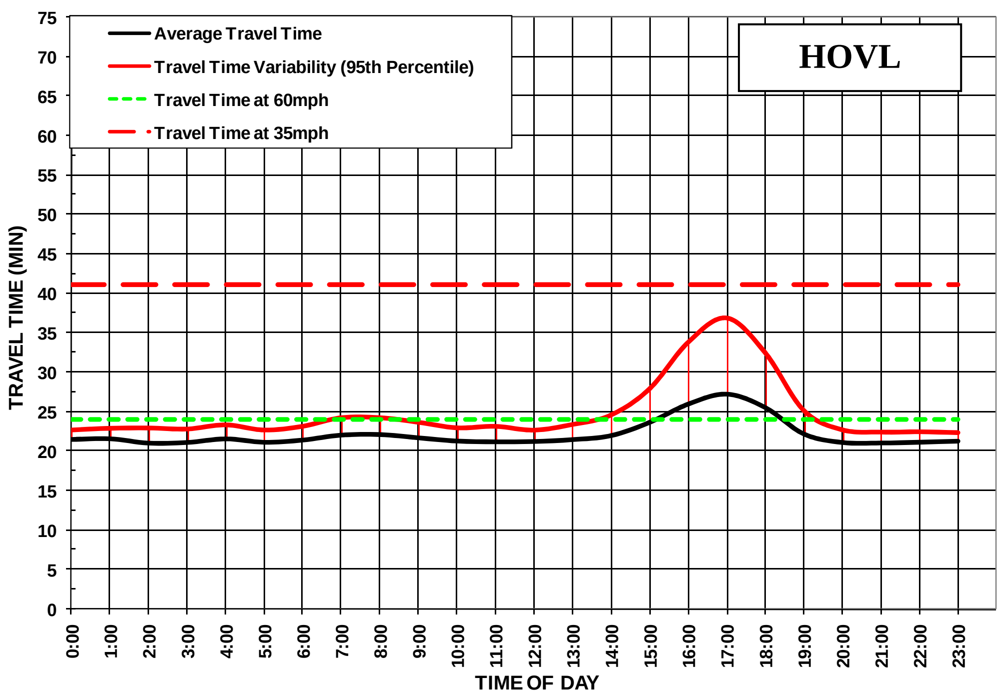
Source: SMG Analysis of PeMS Data

Exhibit 3-67: Northbound I-405 HOVL Travel Time Variation (2004)



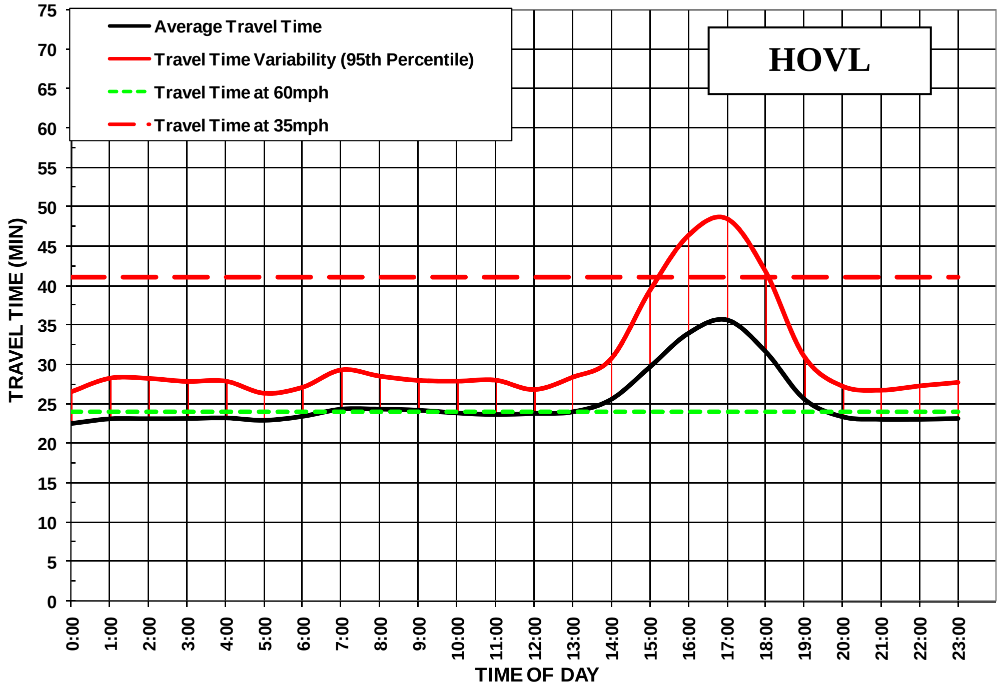
Source: SMG Analysis of PeMS Data

Exhibit 3-68: Northbound I-405 HOVL Travel Time Variation (2005)



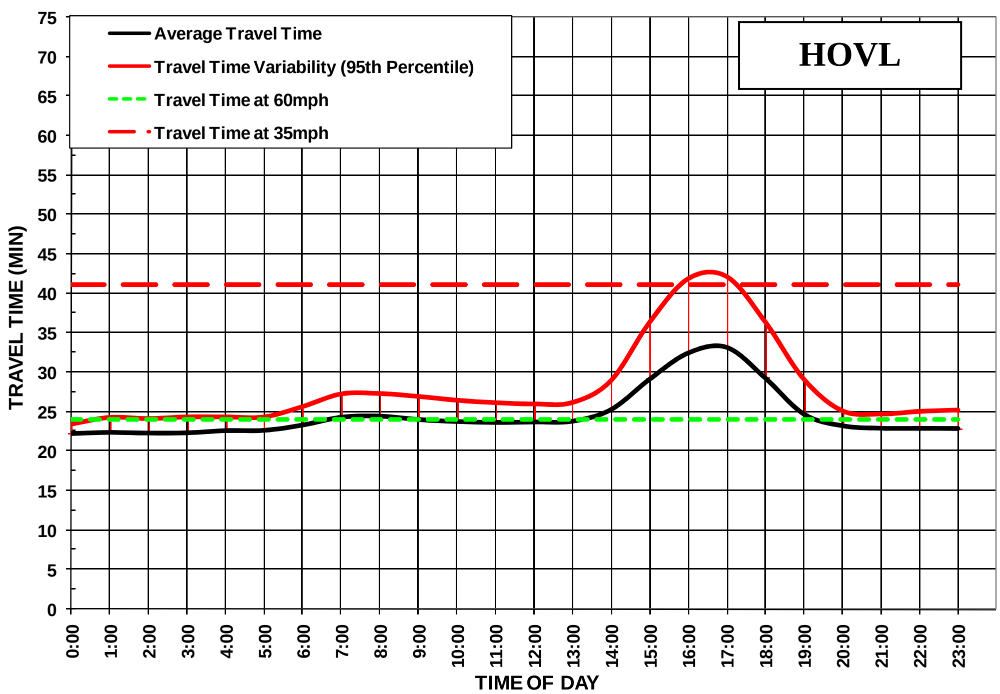
Source: SMG Analysis of PeMS Data

Exhibit 3-69: Northbound I-405 HOVL Travel Time Variation (2006)



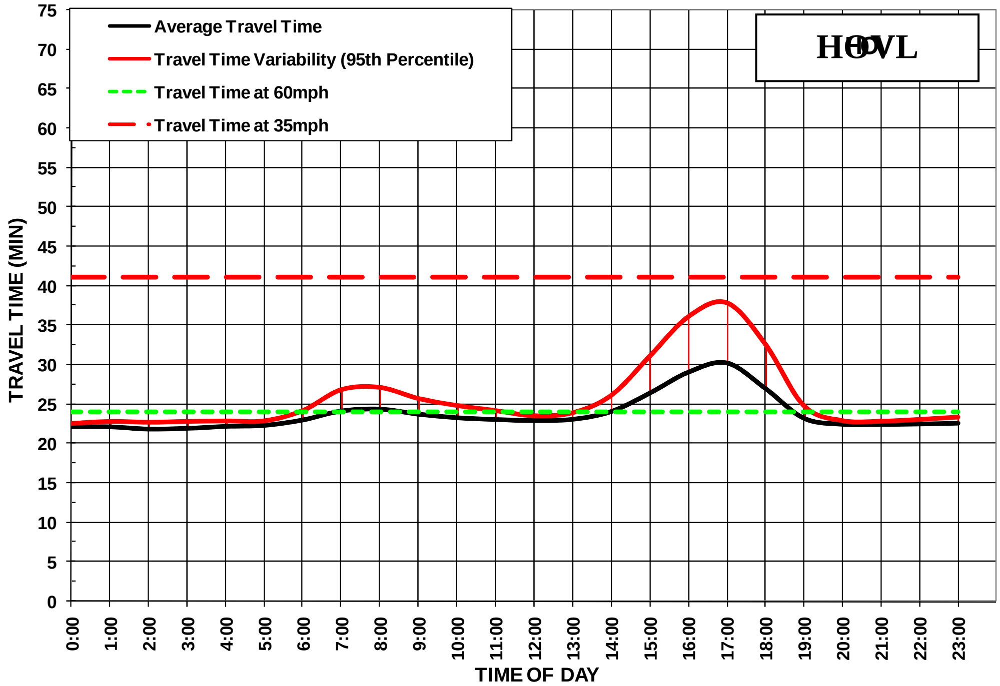
Source: SMG Analysis of PeMS Data

Exhibit 3-70: Northbound I-405 HOVL Travel Time Variation (2007)



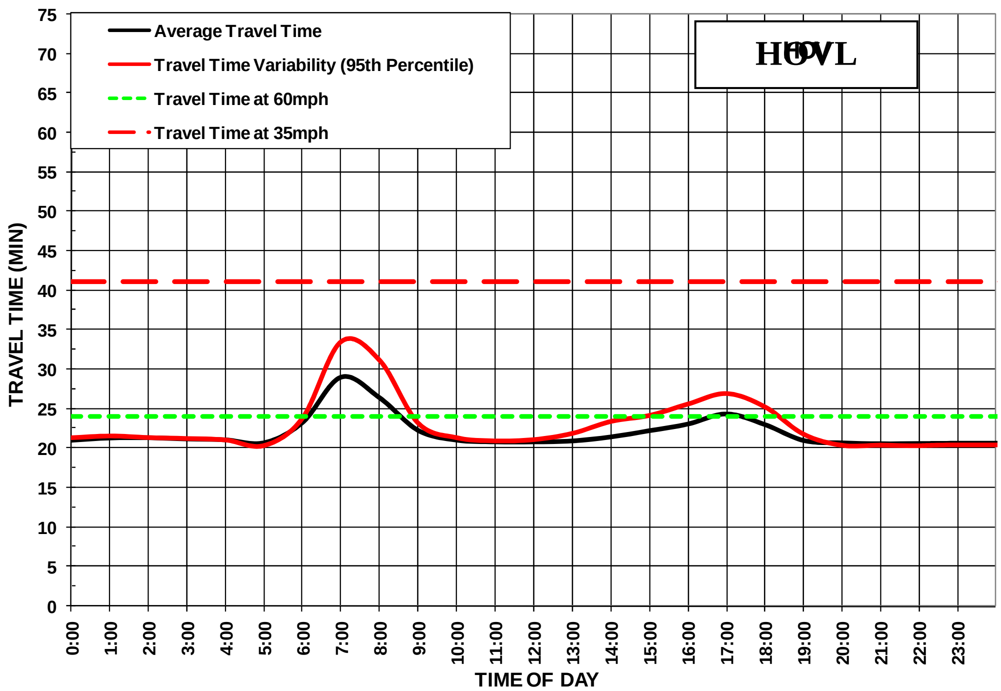
Source: SMG Analysis of PeMS Data

Exhibit 3-71: Northbound I-405 HOVL Travel Time Variation (2008)



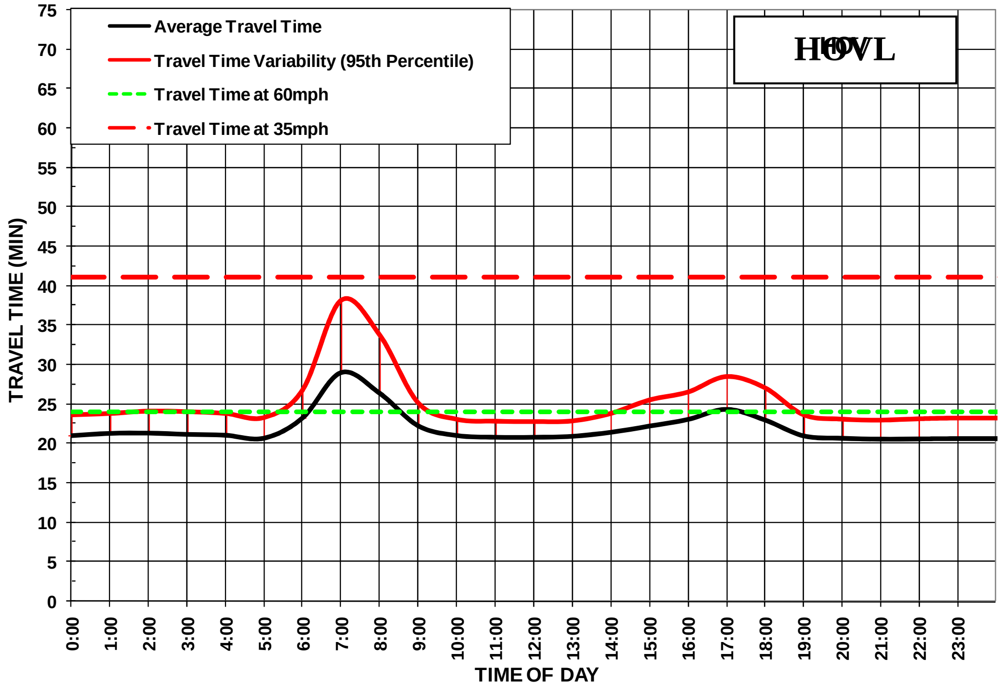
Source: SMG Analysis of PeMS Data

Exhibit 3-72: Southbound I-405 HOVL Travel Time Variation (2004)



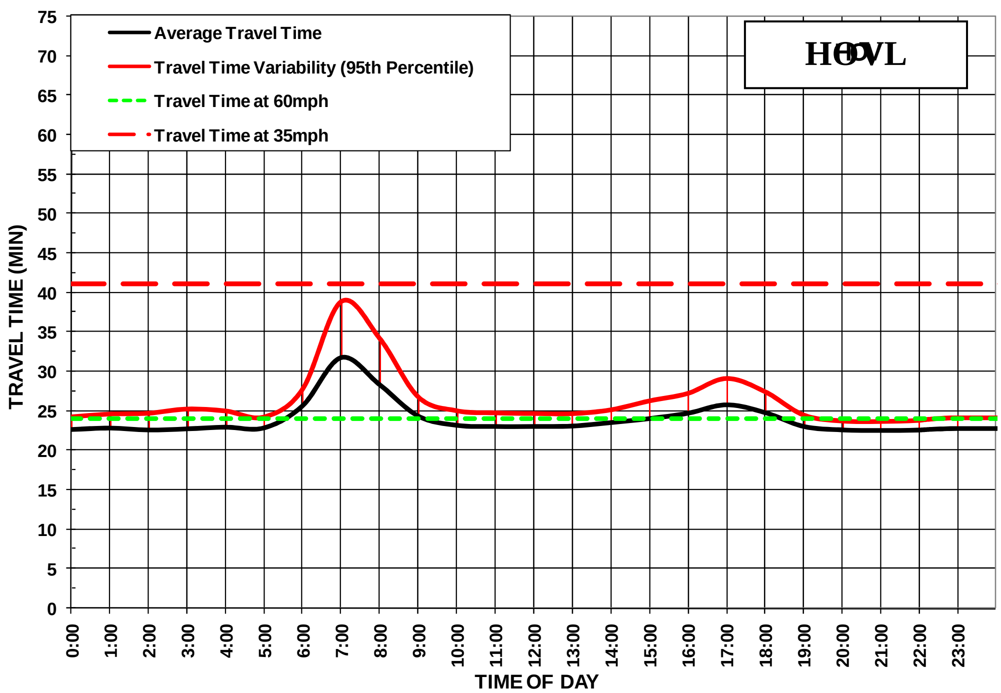
Source: SMG Analysis of PeMS Data

Exhibit 3-73: Southbound I-405 HOVL Travel Time Variation (2005)



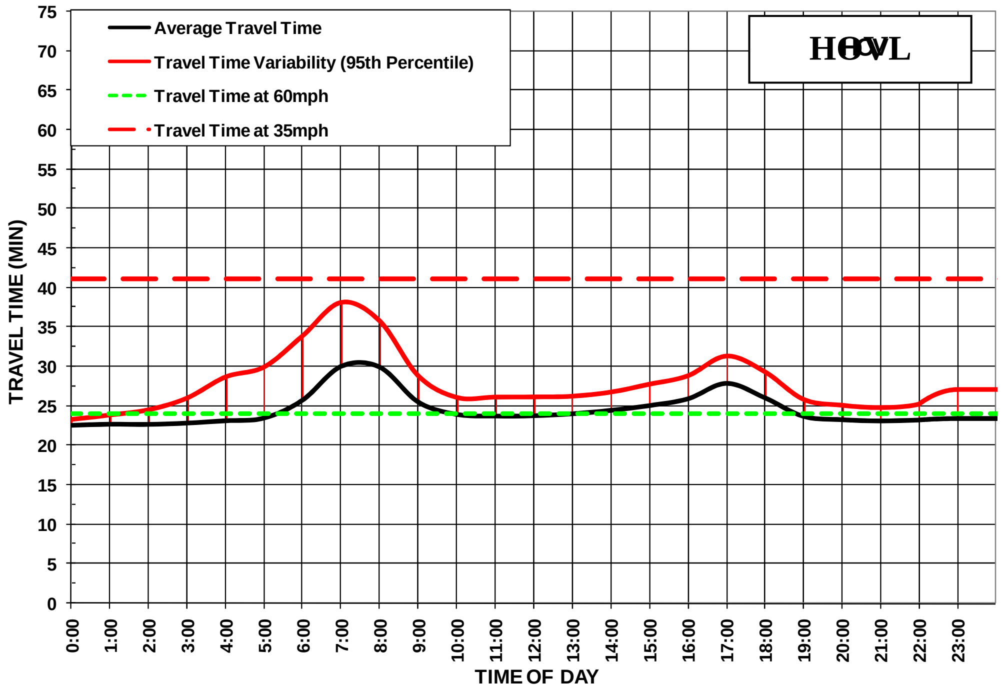
Source: SMG Analysis of PeMS Data

Exhibit 3-74: Southbound I-405 HOVL Travel Time Variation (2006)



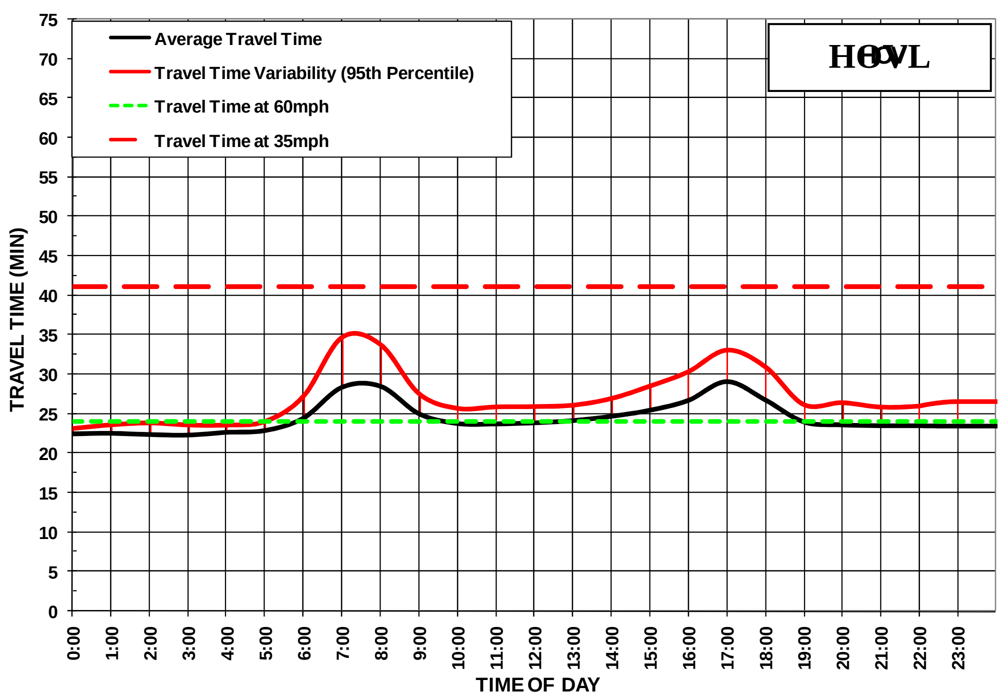
Source: SMG Analysis of PeMS Data

Exhibit 3-75: Southbound I-405 HOVL Travel Time Variation (2007)



Source: SMG Analysis of PeMS Data

Exhibit 3-76: Southbound I-405 HOVL Travel Time Variation (2008)



Source: SMG Analysis of PeMS Data

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SAFETY

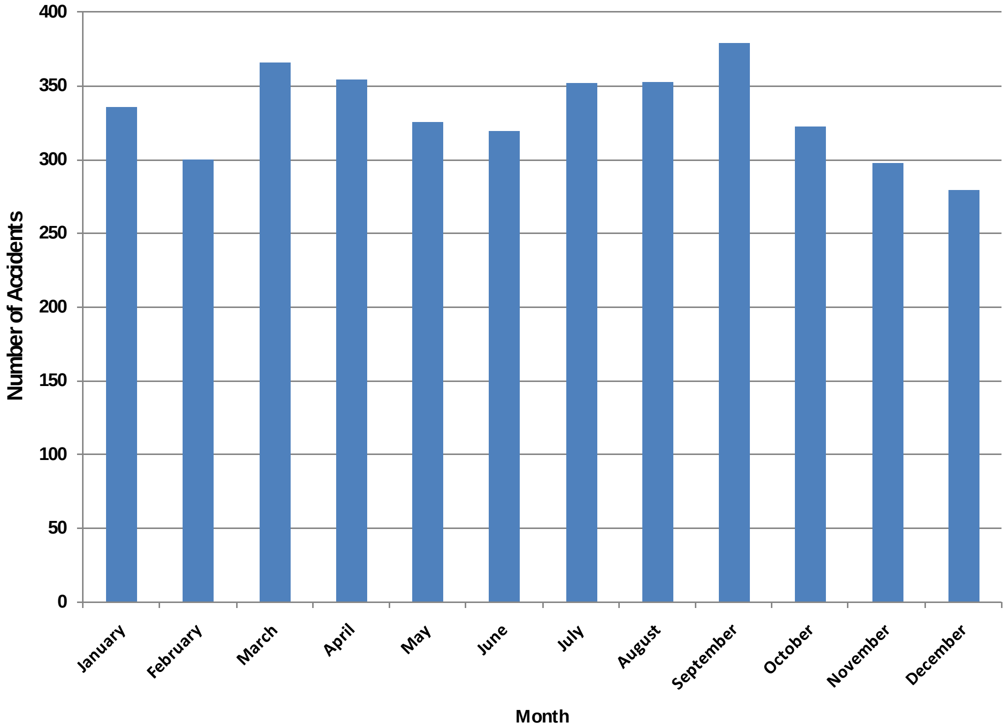
The adopted performance measures to assess safety include the number of accidents and accident rates computed from the Caltrans Traffic Accident Surveillance and Analysis System (TASAS). TASAS is a traffic records system containing an accident database linked to a highway database. The highway database contains description elements of highway segments, intersections and ramps, access control, traffic volumes, and other data. TASAS contains specific data for accidents on State highways, but not other roads (e.g., local streets and roads). The TASAS information presented in this analysis does not distinguish between mainline and HOV facilities.

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

The safety analysis conducted for the SR-22 Corridor is based on data provided by Caltrans District 12. Unfortunately, safety data for the 2008 base year is not yet available. Therefore, the safety assessment analyzes the years that are available for each source, which may include the time period when the corridor was undergoing construction (2005-2007). When the 2008 safety data is made available, it is expected to show a decrease in accidents compared to the pre-construction years.

Caltrans typically analyzes the latest three-year safety data. Caltrans District 12 provided safety data from January 1, 2005 to December 31, 2007. Exhibit 3-77 summarizes the number of accidents on the SR-22 Corridor by month during the entire three-year period of 2005-2007. From this exhibit, the month of September experienced the highest number of accidents (378), followed by March (365).

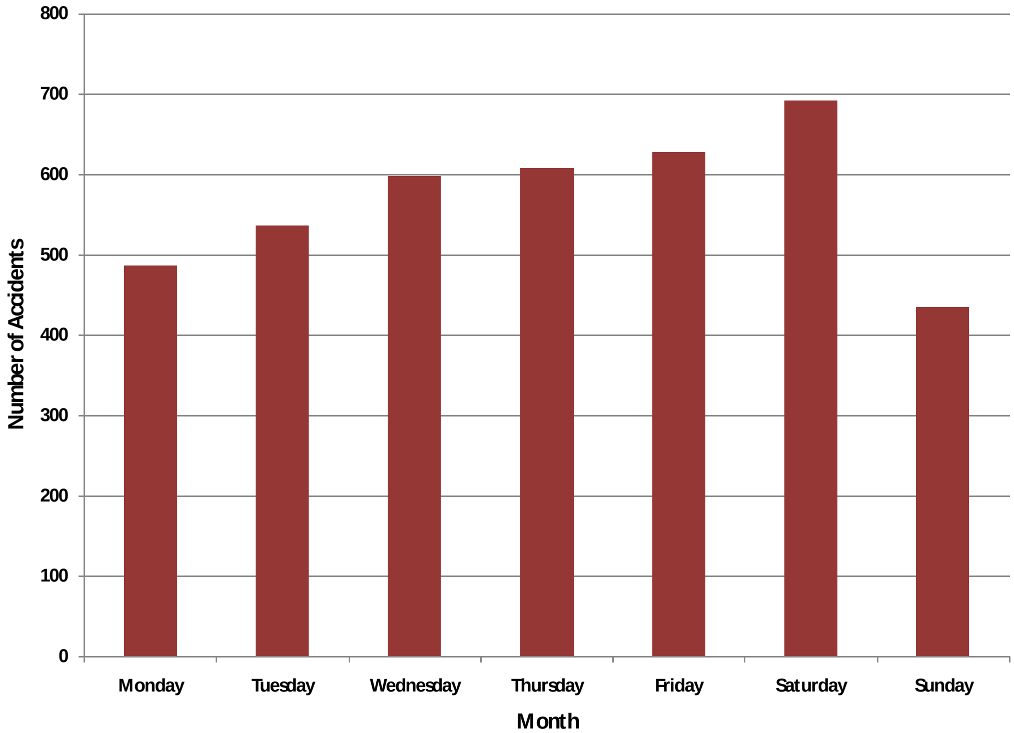
Exhibit 3-77: Total SR-22 Accidents by Month (2005-2007)



Source: Caltrans TASAS Selective Accident Retrieval Report

Exhibit 3-78 summarizes the same SR-22 accident data for the three-year period, but groups it by day of the week. This exhibit shows that Saturday experienced the highest number of accidents (691) on SR-22.

Exhibit 3-78: Total SR-22 Accidents by Day of the Week (2005-2007)



Source: Caltrans TASAS Selective Accident Retrieval Report

Exhibit 3-79 shows that over the same three-year period (2005-2007), SR-22 experienced a total of 894 fatality and injury accidents. The rate of fatalities and injuries for this corridor is similar to the average rate on similar facilities. However, the total accident rate for the corridor (1.63) is higher than the rate on similar facilities (1.29), which reveals that there were a higher number of non-injury accidents on SR-22.

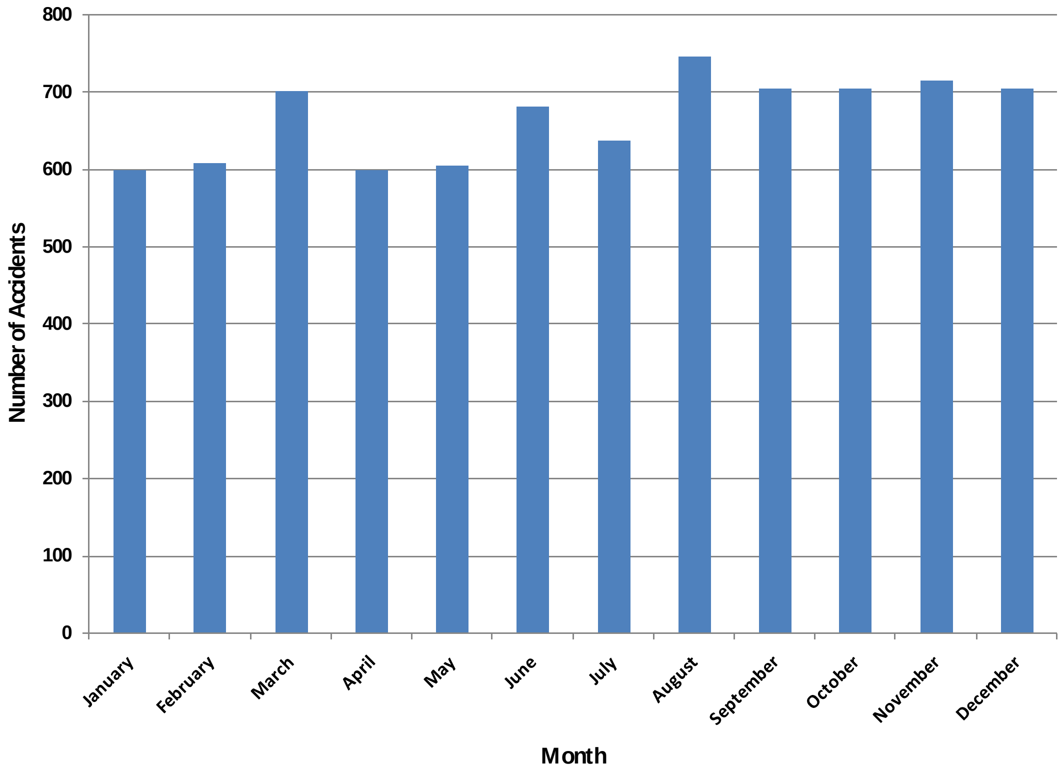
Exhibit 3-79: SR-22 Severe Accidents and Accident Rate (2005-2007)

Number of Accidents on SR-22			Accident Rates					
			Actual Rates on SR-22			Average Rates on Similar		
Fat	Inj	F+I	Fat	F+I	Total	Fat	F+I	Total
8	886	894	0.003	0.39	1.63	0.008	0.40	1.29

Source: Caltrans, TASAS, Table B.

The number of accidents which occurred on I-405 from 2005 to 2007 is depicted in the following two charts. Exhibit 3-80 summarizes the total number of accidents by month during the three-year period, and shows that August as the month with the highest number of accidents with 745.

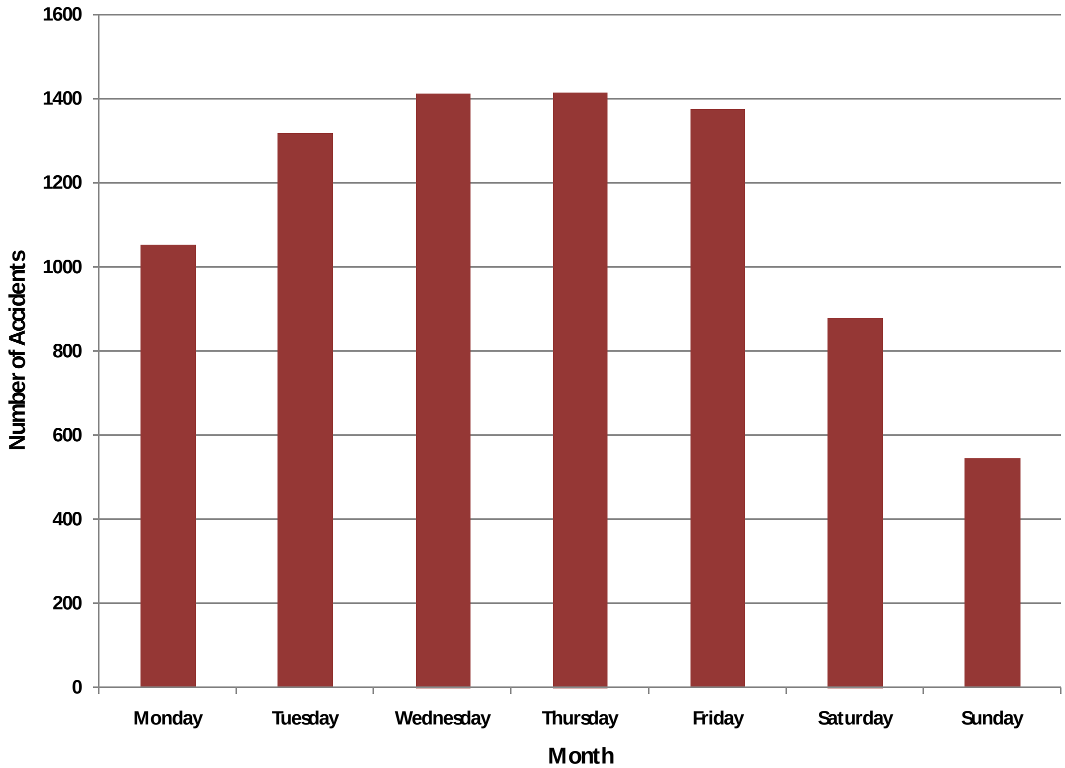
Exhibit 3-80: I-405 Total Accidents by Month (2005-2007)



Source: Caltrans TASAS Selective Accident Retrieval Report

Exhibit 3-81 illustrates the same data but grouped by day of the week when the accidents occurred. The exhibit shows that Wednesdays and Thursdays experienced the most accidents on I-405 during the 2005-2007 period with a little over 1,400 accidents.

Exhibit 3-81: I-405 Total Accidents by Day of the Week (2005-2007)



Source: Caltrans TASAS Selective Accident Retrieval Report

Comparable TASAS data (provided by Caltrans District 12) is presented in Exhibit 3-82. During the three-year period from 2005 to 2007, I-405 experienced a total of 26 fatalities and 1,902 injuries, which is below the average accident rate on similar facilities.

Exhibit 3-82: I-405 Severe Accidents and Accident Rate (2005-2007)

Number of Accidents on I-405			Accident Rates					
			Actual Rates on I-405			Average Rates on Similar		
Fat	Inj	F+I	Fat	F+I	Total	Fat	F+I	Total
26	1902	1928	0.003	0.25	0.98	0.006	0.37	1.19

Source: Caltrans, TASAS, Table B.

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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.

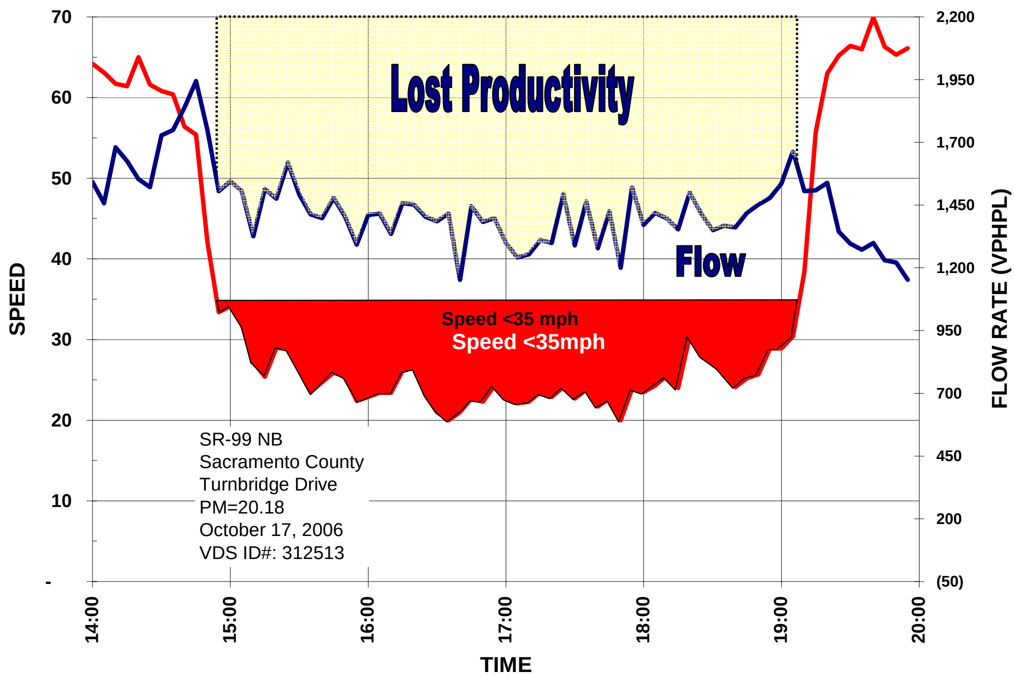
For the corridor analysis, productivity is defined as the percent utilization of a facility or mode under peak conditions. The highway productivity performance measure is calculated as actual volume divided by the capacity of the highway. Travel demand models generally do not project capacity loss for 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 3-83. As traffic flows increase 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 adding a new lane along a six-mile section of freeway to improve productivity.

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

$$LostLaneMiles = \left(1 - \frac{ObservedLaneThroughput}{2200vphpl}\right) \times Lanes \times CongestedDistance$$

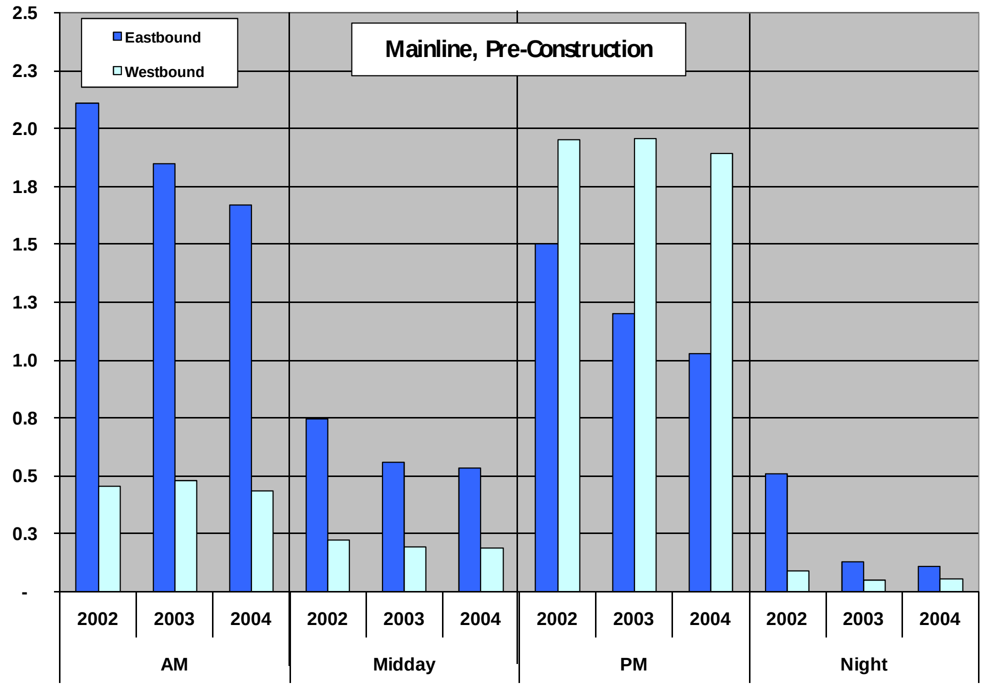
Exhibit 3-83: Lost Productivity Illustrated



Exhibits 3-84 and 3-85 summarize the productivity losses on the SR-22 mainline facility during both pre-construction and post-construction periods. The trends in the productivity losses are comparable to the delay trends. The largest productivity losses occurred in the AM peak hours in the eastbound direction and the PM peak hours in the westbound direction, which is the time period and direction that experienced the most congestion. These exhibits show that productivity improved during the post-construction period (Exhibit 3-85) as compared to the pre-construction period (Exhibit 3-84). In the eastbound direction during the AM peak period, lost-lane miles decreased from 1.7 in 2004 to 1.2 in February 2009. Similarly, in the westbound direction during the PM peak, lost-lane miles declined from 1.9 in 2004 to 0.9 in February 2009. Again, data from 2008 was not discussed in this section given the poor detection during that year. The same analysis was performed for the SR-22 HOV facility (Exhibit 3-86), which shows that the westbound direction, particularly in the PM, experienced the greatest loss in productivity.

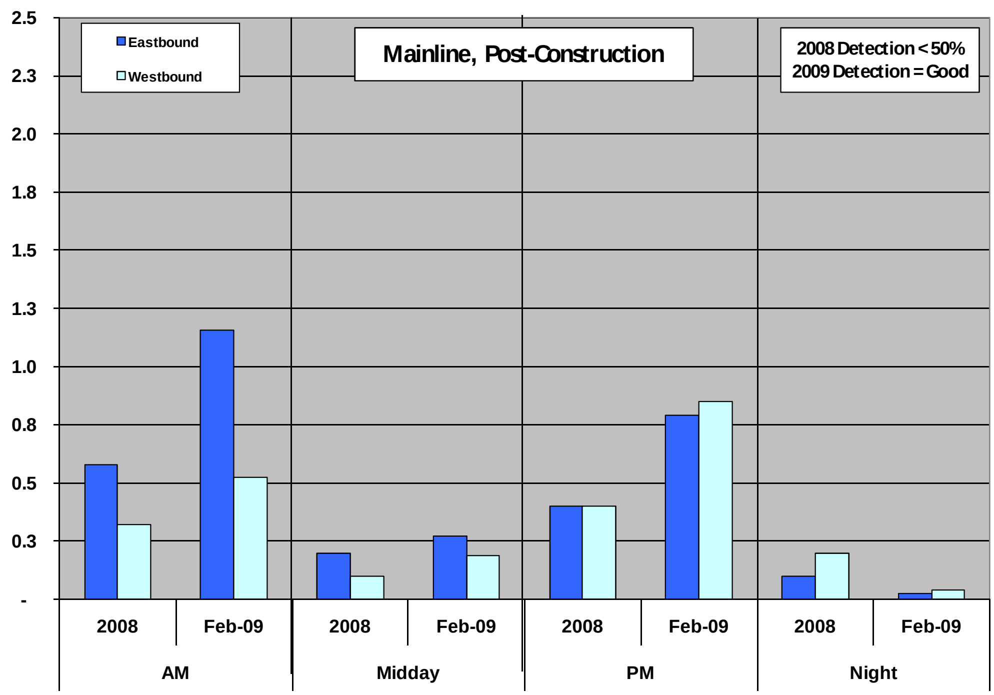
Strategies to combat productivity losses are primarily related to operations and include building new or extending auxiliary lanes, developing more aggressive ramp metering strategies without negatively influencing the arterial network, and improvements in incident clearance times.

Exhibit 3-84: SR-22 ML Lost Lane-Miles by Direction, Time Period (2002-2004)



Source: SMG Analysis of PeMS Data

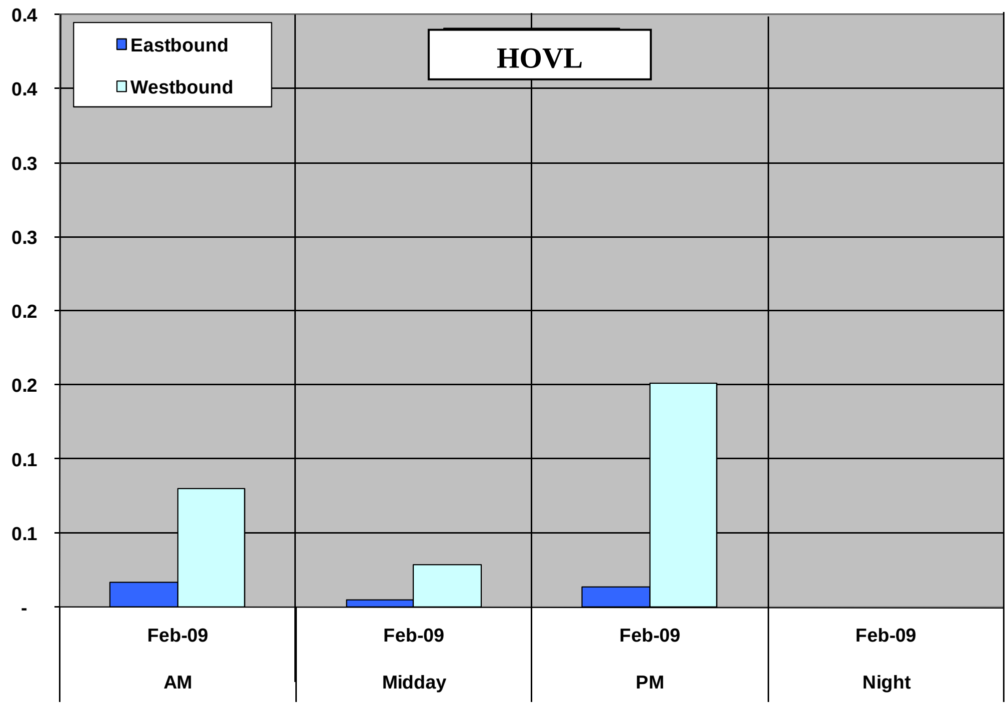
Exhibit 3-85: SR-22 ML Lost Lane-Miles by Direction, Time Period (2008, Feb 2009)



Source: SMG Analysis of PeMS Data

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

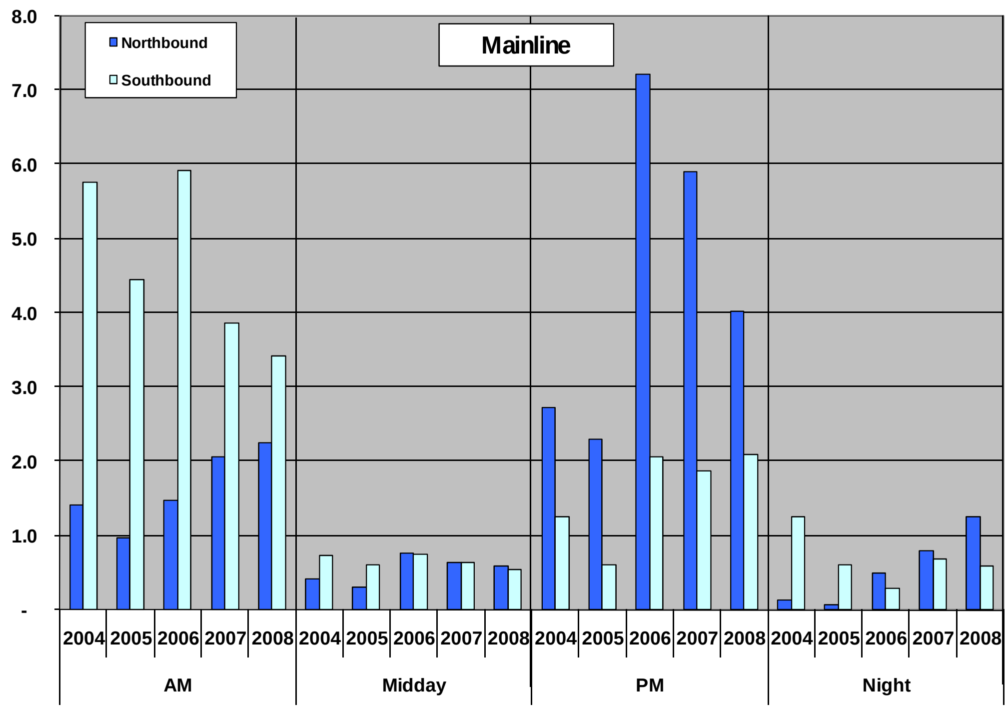
Exhibit 3-86: SR-22 HOVL Lost Lane-Miles by Direction, Time Period (Feb 2009)



Source: SMG Analysis of PeMS Data
Note: Detection on the SR-22 HOV facility was not available until February 5, 2009.

Exhibits 3-87 and 3-88 summarize the productivity losses on the I-405 mainline and HOV facilities for the 2004-2008 period. Again, the trends in the productivity losses are comparable to the delay trends. On the mainline facility, the largest productivity losses occurred during the AM peak period in the southbound direction and during the PM peak period in the northbound direction, which is the time period and direction that experienced the most congestion. From 2004 to 2008, productivity gains were made in both directions of the mainline. The most notable occurred during the AM in the southbound direction from 2006 to 2007 when lost-lane miles decreased from 6.0 to 3.9. In the northbound direction, a significant improvement was evident during the PM peak from 2007 to 2008 when lost-lane miles declined from 6.0 to 4.0.

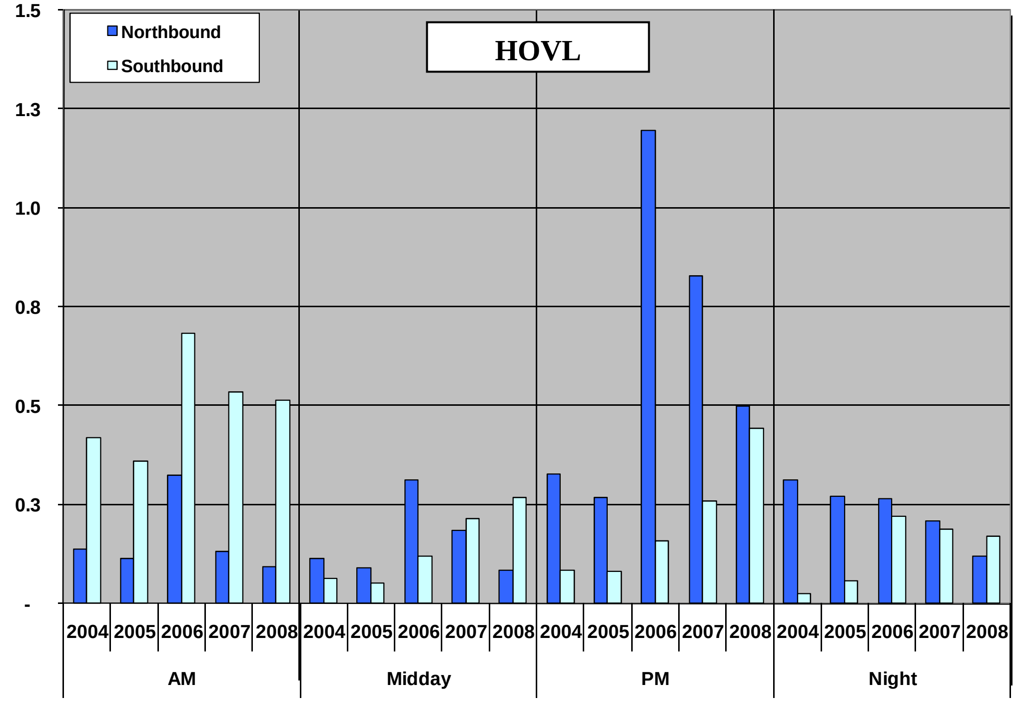
Exhibit 3-87: I-405 ML Lost Lane-Miles by Direction, Time Period (2004-2008)



Source: SMG Analysis of PeMS Data

Exhibit 3-88 also shows that on the HOV facility, the productivity losses are comparable to the delay trends. Like the mainline, the highest productivity also occurred in the southbound direction during the AM peak and in the northbound direction during the PM peak. Exhibit 3-88 also identified 2006 as the year with the highest lost-lane miles, which is consistent with the delay results presented earlier that showed 2006 had the highest delay of any year of analysis.

Exhibit 3-88: I-405 HOVL Lost Lane-Miles by Direction, Time Period (2004-2008)



Source: SMG Analysis of PeMS Data

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PAVEMENT CONDITION

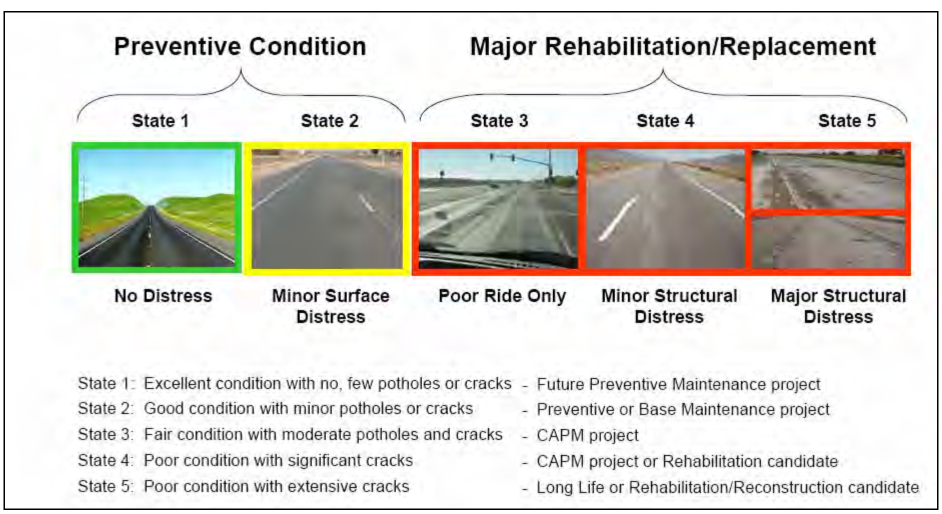
The condition of the roadway pavement (or ride quality) on the corridor can influence its traffic performance. Rough or poor pavement conditions can decrease the mobility, reliability, safety, and productivity of the corridor, whereas smooth pavement can have the opposite effect. Pavement preservation 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.

Pavement 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 3-89 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 3-89: Pavement Condition States



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 Conditions

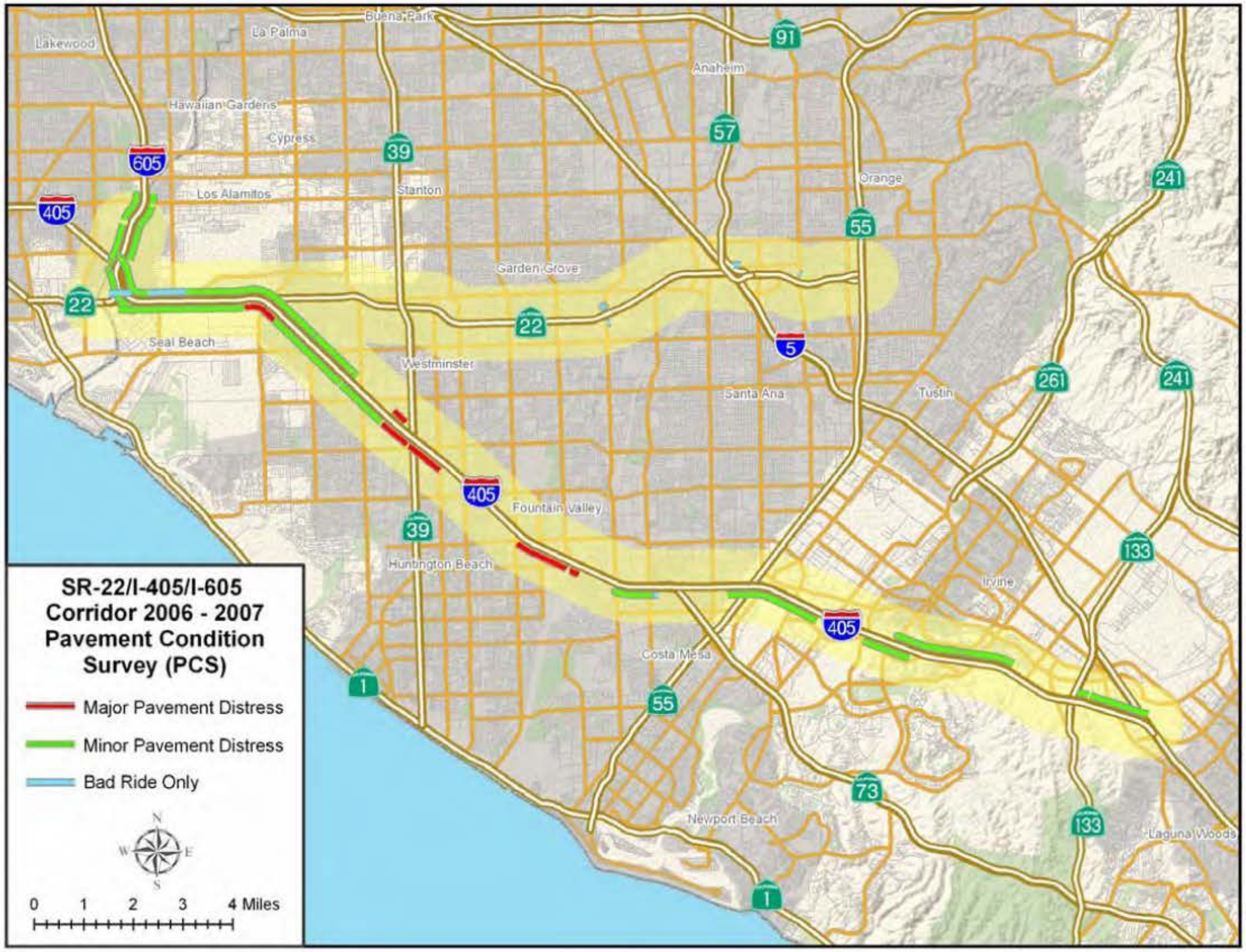
The most recent pavement condition survey, completed in November 2007, recorded 12,998 distressed lane-miles statewide. Unlike prior surveys, the 2007 PCS included pavement field studies for a period longer than a year, due to an update in the data collection methodology. The survey includes data for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

The field work 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 3-90 uses 2007 PCS data to show pavement distress along all three freeways (SR-22, I-405, and I-605) that comprise the SR-22 CSMP corridor in Orange County. The three categories shown in this exhibit represent the distressed conditions that require major rehabilitation or replacement and were presented earlier in Exhibit 3-89.

The three freeways in the corridor provide a fairly representative sample of conditions for freeways in Orange County. SR-22 has almost no distress as a result of the recent roadway work on the freeway. About half of I-405 and the small section of I-605 included in the corridors have portions of minor pavement distress. There are small one-mile sections with major pavement distress near Huntington Beach as well as some areas with only ride quality issues near the SR-22, I-405, and I-605 interchanges. However, in December 2007, 40 lane-miles of distressed pavement from Beach Boulevard to the LA County Line were repaired. This project is not reflected in the most current PCS since it was completed after the PCS reporting date of December 14, 2006.

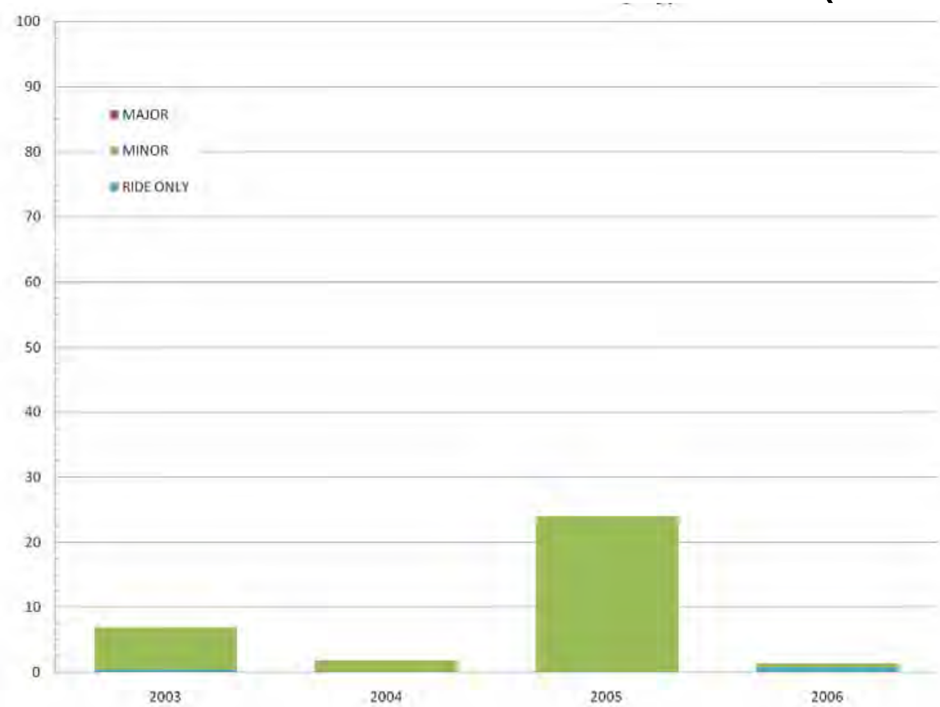
Exhibit 3-90: Distressed Lane-Miles for Entire Corridor (2006-2007)



Source: SMG mapping of 2007 Pavement Condition Survey data

Exhibit 3-91 compares results from prior pavement condition surveys along SR-22. As the exhibit shows, the freeway typically has very few distressed lane-miles with the exception of the roadway construction during 2005. Exhibit 3-92 presents the percent mix of distressed lane-miles along SR-22. In most years, the distressed lane-miles represent minor pavement distress. In the most recent survey, the distressed lane-miles were compressed of roughly half minor pavement distress and half ride quality issues.

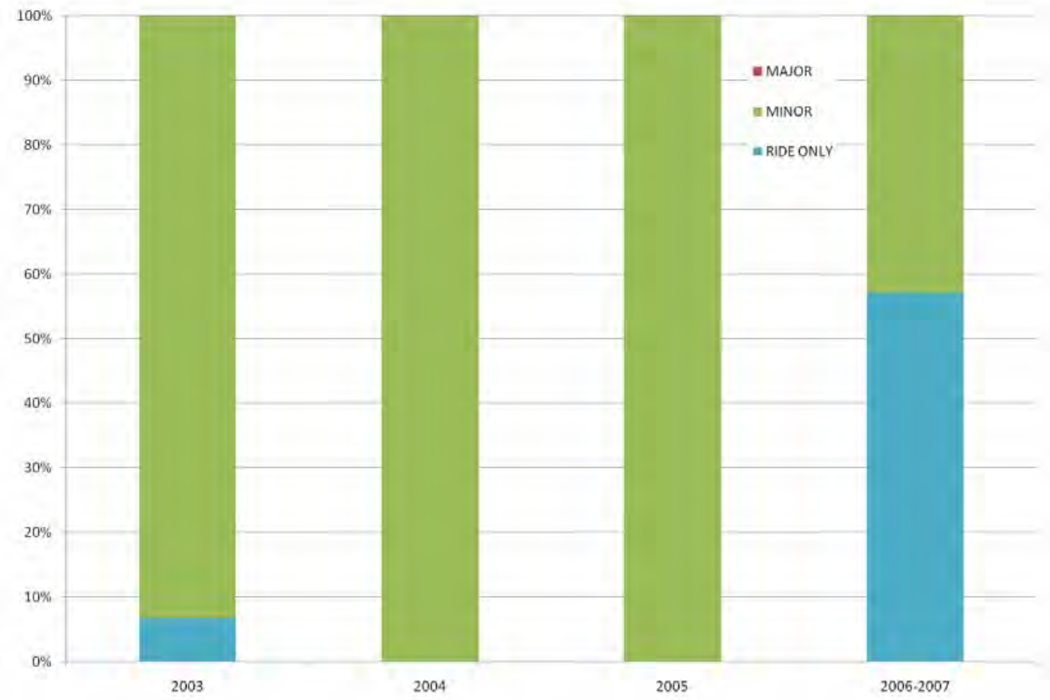
Exhibit 3-91: SR-22 Distressed Lane-Miles Trends (2003-2007)



Source: SMG analysis of 2003 to 2007 Pavement Condition Survey data

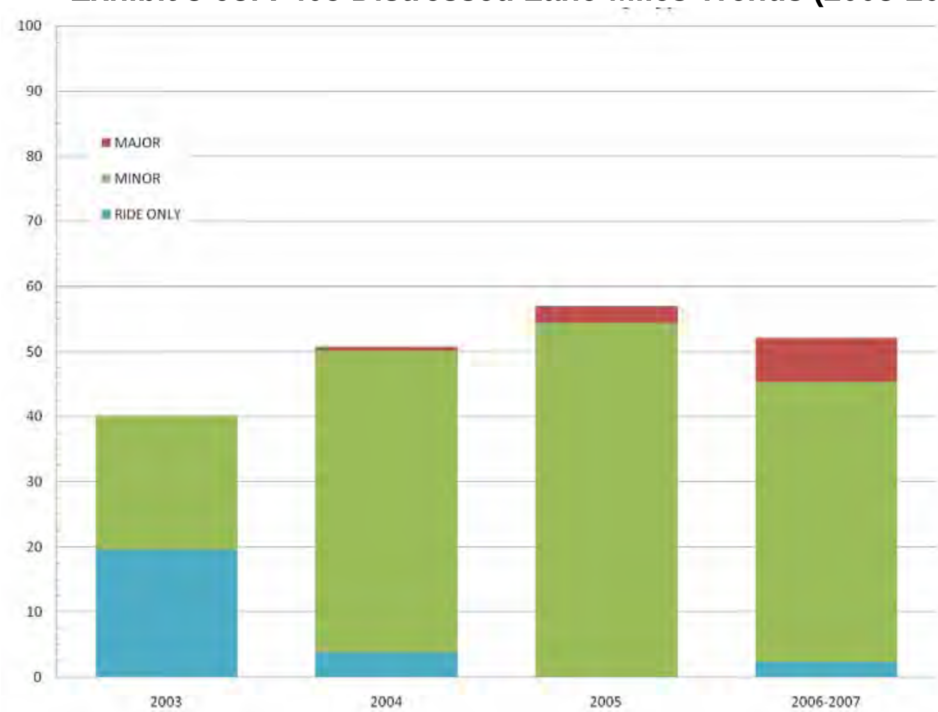
Exhibit 3-93 shows pavement conditions along I-405 for the last several years. The number of distressed lane-miles increased from 2003 to 2005, but the trend has reversed in the most recent PCS. Sections with only ride quality issues have been addressed in the last few years and the remaining issues involve major and minor pavement distress. This change in the mix of distressed-lane miles can be seen more clearly in Exhibit 3-94.

Exhibit 3-92: SR-22 Distressed Lane-Miles by Type (2003-2007)



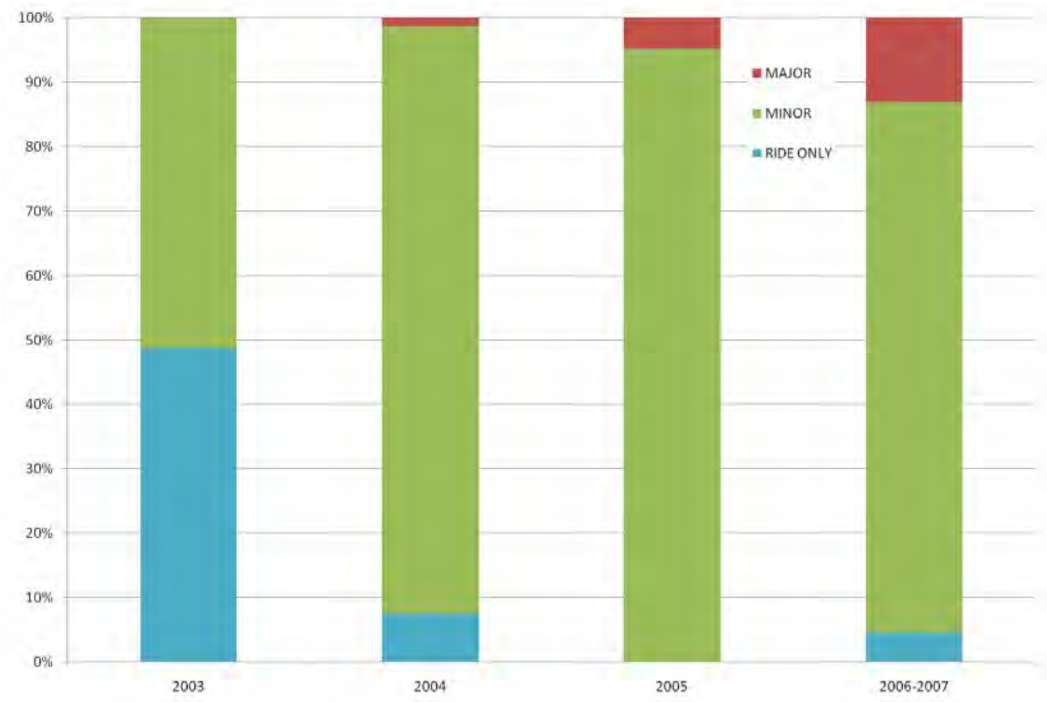
Source: SMG analysis of 2003 to 2007 Pavement Condition Survey data

Exhibit 3-93: I-405 Distressed Lane-Miles Trends (2003-2007)



Source: SMG analysis of 2003 to 2007 Pavement Condition Survey data

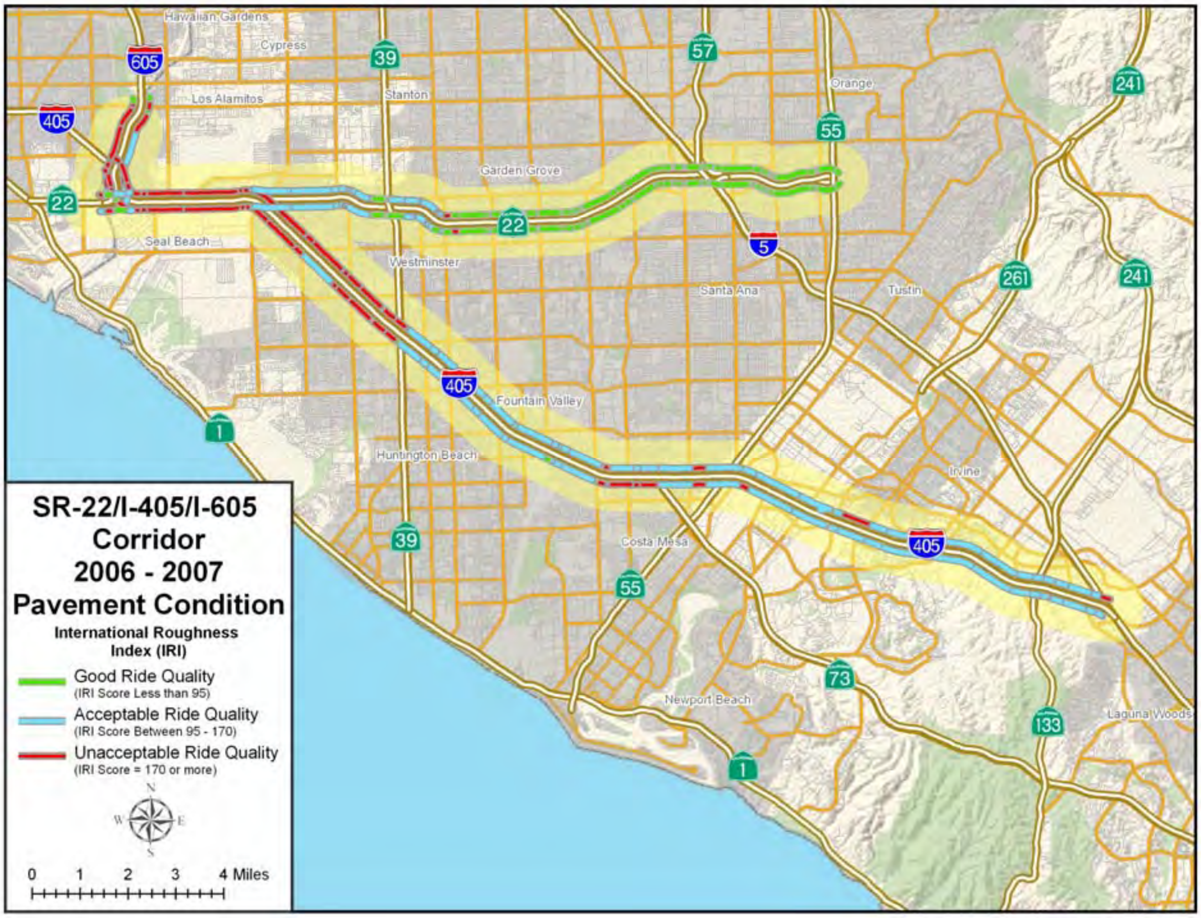
Exhibit 3-94: I-405 Distressed Lane-Miles by Type (2003-2007)



Source: SMG analysis of 2003 to 2007 Pavement Condition Survey data

Exhibit 3-95 shows IRI along all three freeways in the study corridor for the lane with the poorest pavement condition in each freeway segment. The poorest condition is shown because investment decisions are made on this basis. As the exhibit demonstrates, the majority of the corridor has either good or acceptable ride quality. Most of the sections with unacceptable ride quality are where I-405, SR-22, and I-605 converge. Good ride quality is found along SR-22 as a result of the recent road construction.

Exhibit 3-95: Road Roughness for Entire Corridor (2006-2007)



Source: SMG mapping of 2007 Pavement Condition Survey data

The portion of the study corridor along SR-22 comprises roughly 95 lane-miles, when the conditions of all lanes are considered. Of these lanes:

- 36 lane-miles, or 38 percent, are considered to have good ride quality (IRI ≤ 95)
- 54 lane-miles, or 56 percent, are considered to have acceptable ride quality (95 < IRI ≤ 170)
- 6 lane miles, or 6 percent, are considered to have unacceptable ride quality (IRI > 170).

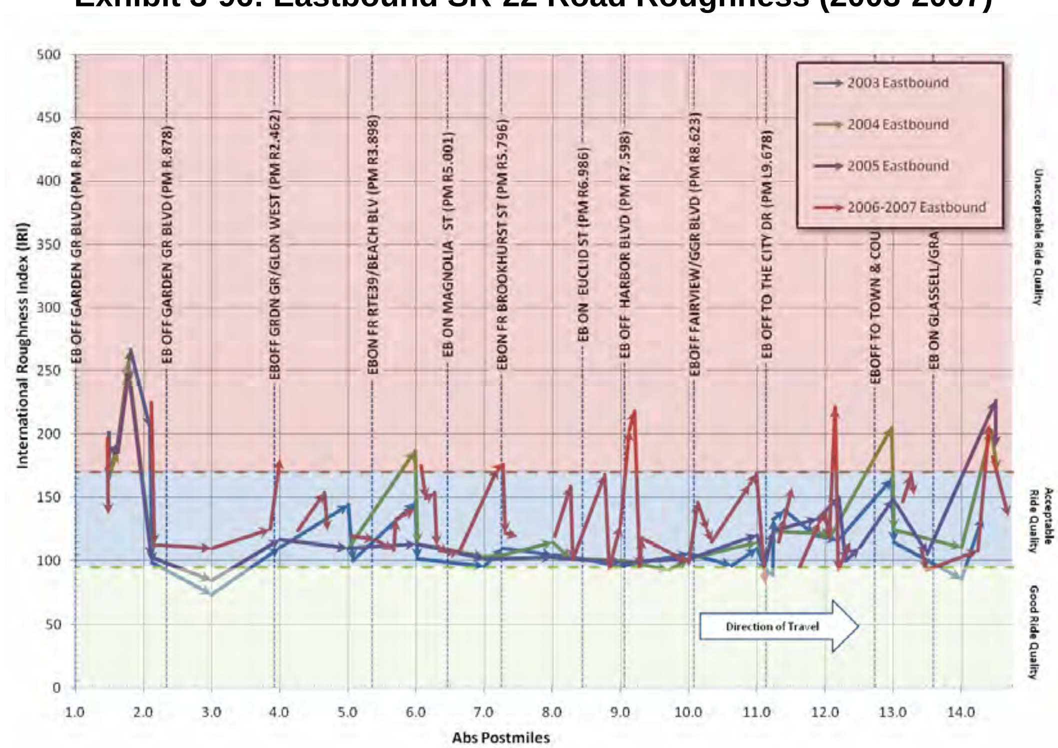
The portion along I-405 includes 261 lane-miles, of which:

- 110 lane-miles, or 42 percent, are considered to have good ride quality (IRI ≤ 95)
- 95 lane-miles, or 37 percent, are considered to have acceptable ride quality (95 < IRI ≤ 170)
- 55 lane miles, or 21 percent, are considered to have unacceptable ride quality (IRI > 170).

I-605 includes only 15 lane-miles of the study corridor. Of these lane-miles, just over 50 percent are considered to have unacceptable ride quality. The remaining lane-miles on I-605 are split fairly evenly between good and acceptable ride quality.

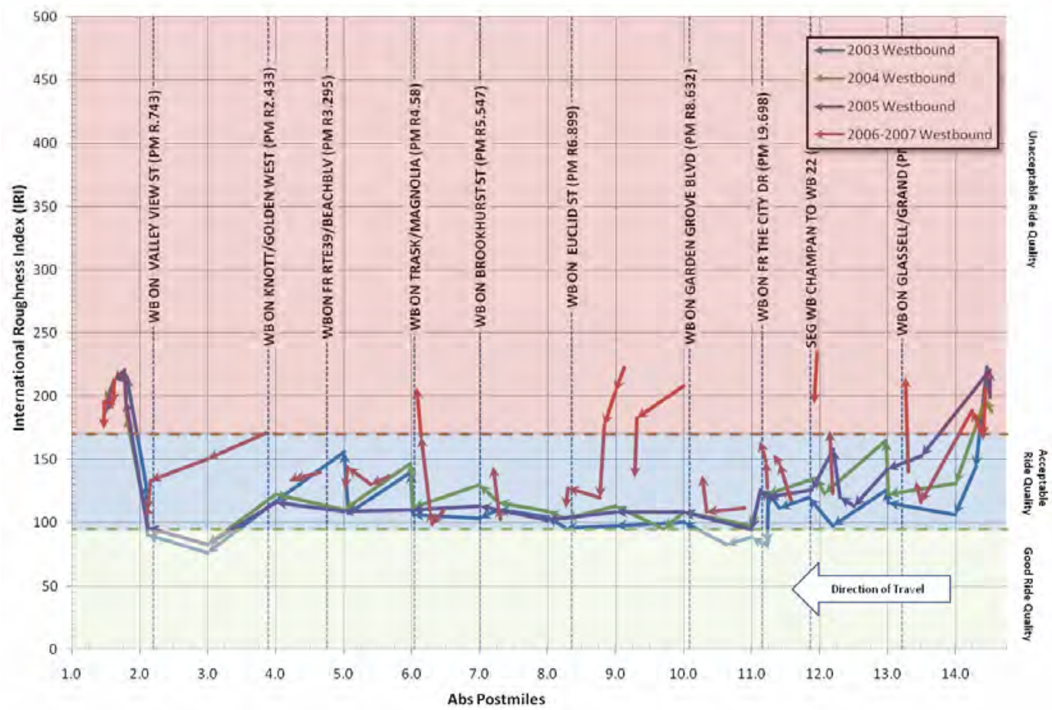
Exhibits 3-96 through 3-99 present ride conditions for the study corridor using IRI from the last four pavement surveys. The first two exhibits cover SR-22, while the last two exhibits show data for I-405. The information is presented by postmile and direction in all four exhibits. The exhibits include 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). The surveys show fairly consistent patterns of good, acceptable, and unacceptable ride quality. Unlike many freeways in the state, the freeways in the study corridor have had fairly steady ride quality over the last few surveys. The exhibits exclude a number of sections that were not measured or had calibration issues (i.e., IRI = 0) in the 2006-07 period.

Exhibit 3-96: Eastbound SR-22 Road Roughness (2003-2007)



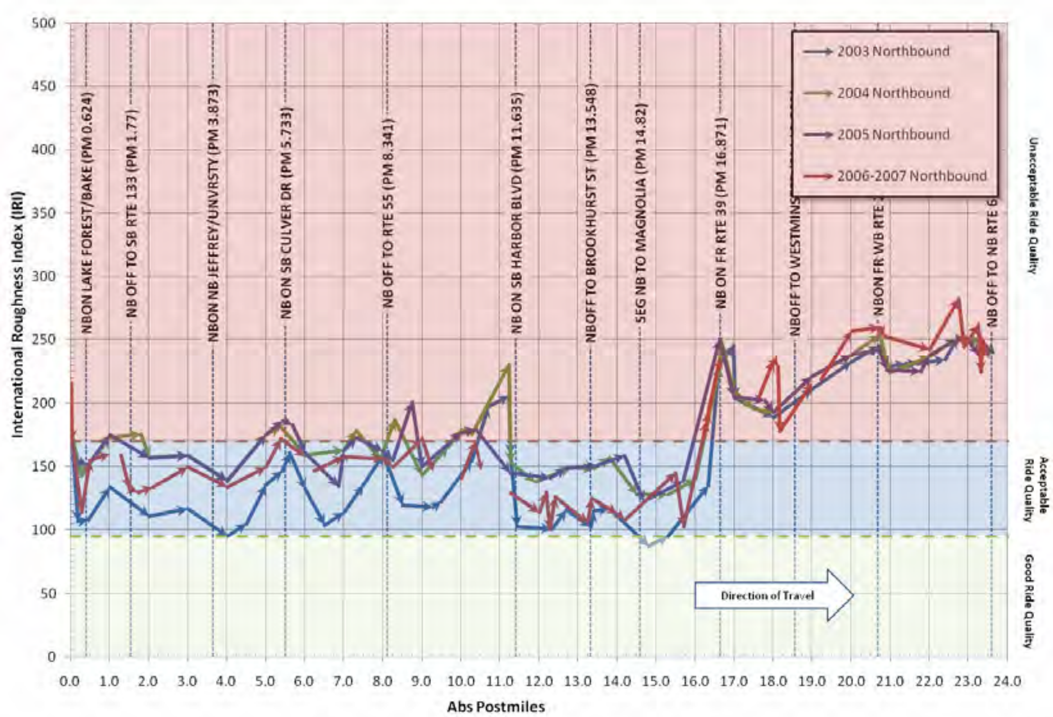
Source: SMG analysis of 2003 to 2007 Pavement Condition Survey data

Exhibit 3-97: Westbound SR-22 Road Roughness (2003-2007)



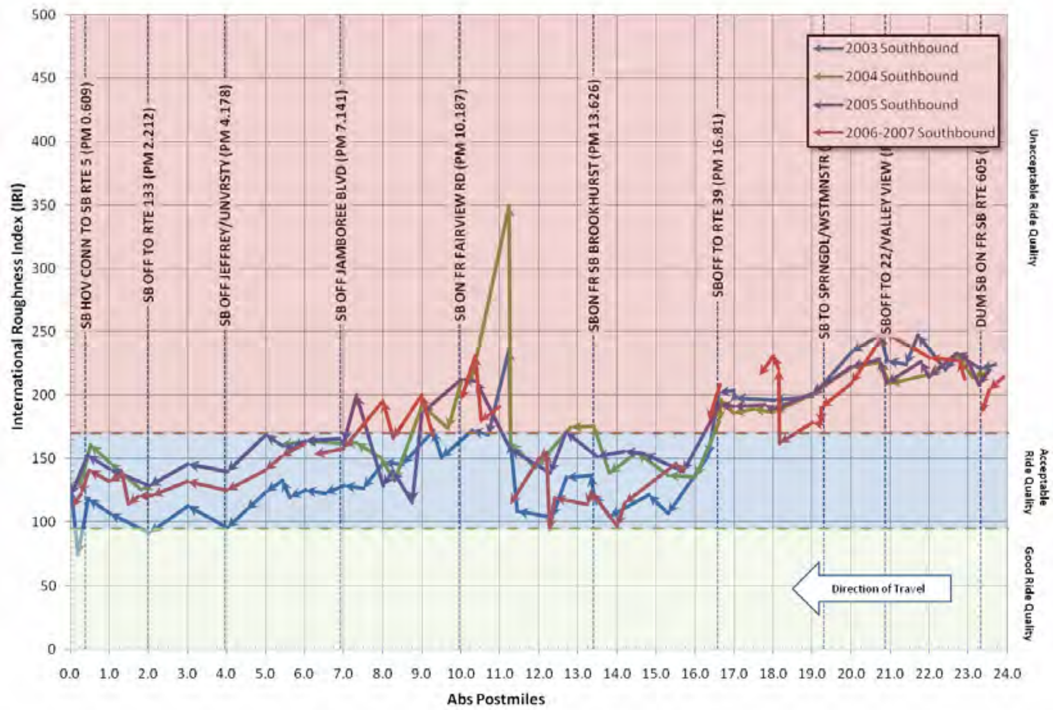
Source: SMG analysis of 2003 to 2007 Pavement Condition Survey data

Exhibit 3-98: Northbound I-405 Road Roughness (2003-2007)



Source: SMG analysis of 2003 to 2007 Pavement Condition Survey data

Exhibit 3-99: Southbound I-405 Road Roughness (2003-2007)



Source: SMG analysis of 2003 to 2007 Pavement Condition Survey data

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4. BOTTLENECK IDENTIFICATION AND ANALYSIS

Potential bottlenecks were identified in the Preliminary Performance Assessment document in May 2008. They were identified based on a variety of data sources, including HICOMP, probe vehicle runs, and PeMS. Limited field observations were conducted as well, but not enough to verify each bottleneck. Since the Preliminary Performance Assessment, significant field observations as well as additional analysis of PeMS data have been conducted. As a result of these additional efforts, the consistent bottlenecks are identified for both directions. The initial analysis from the Preliminary Performance Assessment is found in the Appendix.

State Route 22

Eastbound Bottlenecks

Starting from the Los Angeles/Orange County Line and moving eastbound, the following bottlenecks were found:

- Euclid On – This bottleneck occurs when there are high volumes on the on-ramp and mainlines.
- Harbor On – This bottleneck also occurs when there are high volumes on the on-ramp and mainlines.
- Fairview On – A lane drop causes vehicles to weave between the Fairview on-ramp and the City Drive/I-5, creating the bottleneck.
- I-5 Off/City Drive IC – The inability of the exit facility to accommodate the demand creates this bottleneck.
- I-5 On/Town and Country Off – Heavy cross-weaving between the I-5 on-ramp and Town and Country exit contributes to this bottleneck.

Westbound Bottlenecks

Starting from SR-55 and moving westbound, the following bottlenecks were identified:

- Northbound I-5 On-Ramp –This bottleneck relates to high volumes and cross-weaving and queuing of vehicles destined for SR-22.
- Garden Grove On – Congestion and queuing can be seen from the southbound I-5 connector on-ramp
- Valley View Off – A lane drop from four to three lanes contributes to this bottleneck.
- I-405 On-Ramp – This bottleneck relates to a lane drop from three to two lanes and cross-weaving of vehicles destined for I-405.

Interstate 405

Northbound Bottlenecks

Starting from I-5 and moving northbound, the following bottlenecks were identified:

- Sand Canyon Off-ramp: A lane drop contributes to this bottleneck location.
- Jeffrey/University On-ramp: Consecutive on-ramp merges contribute to this bottleneck location.
- SR-73/Fairview On-ramp: An uphill grade and reduced mainline capacity creates a bottleneck.
- Euclid On-ramp: Weaving at this location creates a bottleneck.
- Brookhurst On-ramp: A platoon of vehicles from the collector/distributor contributes to this bottleneck.
- SR-39 On-ramp: The platoon of vehicles from the collector/distributor also contributes to this bottleneck.
- SR-22 On-ramp: A lane drop on the SR-22 ramp does not provide enough capacity for the vehicles merging on the I-405 mainline.

Southbound Bottlenecks

Starting from the Los Angeles/Orange County Line and moving southbound, the following bottlenecks were identified:

- I-605 On-ramp: A lane drop occurs at the I-405 merge reducing the total lanes from six to five lanes.
- Seal Beach On-ramp: Although not a major bottleneck location, congestion occurs as a result of cross-weaving between the Seal Beach Boulevard on-ramp and SR-22 off-ramp.
- Valley View/SR-22: High demand likely contributes to this bottleneck location.
- SR-39 On-ramp: Consecutive on-ramp merges occur at this location.
- Warner On-ramp: This location is the most significant bottleneck on this corridor with queues extending for many miles.
- Talbert On-ramp: The mainline capacity cannot accommodate the flow of vehicles during the peak hours.
- Bristol Off-ramp: Cross-weaving traffic between two ramps contributes to this bottleneck location.
- MacArthur Off-ramp: Consecutive SR-55 on-ramp merges contributes to this bottleneck.
- Culver On-ramp: The mainline cannot accommodate the flow from back-to-back merges.
- Jeffrey/University On-ramp: Again, the mainline cannot accommodate the flow from back-to-back merges.
- Sand/Shady Canyon On-ramp: The high demand on the on-ramp combined with the already high demand on the mainline creates this bottleneck.

Interstate 605

Southbound Bottleneck

- Southbound I-405 On-ramp: this bottleneck location occurs during the PM peak as a result of lane drop that occurs after the I-405 merge.

Analysis of Bottleneck Areas

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, specific performance statistics that were presented for the entire corridor can now be broken down 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:

- Mobility
- Safety
- Productivity

The analysis of bottleneck areas is based on 2008 data for SR-22 and 2006 data for I-405, and is limited to the mainline facility since the mainline has greater detection coverage than the HOV facility. Based on this segmentation approach, the study corridor comprises several bottleneck areas, which differ by direction. Exhibit 4-1 illustrates the concept of bottleneck areas for the eastbound direction of SR-22. The red lines in the exhibit represent the bottleneck locations and the arrows represent the bottleneck areas. Given that the I-605 study corridor is less than a mile long, a bottleneck area analysis was not conducted for this corridor.

Exhibit 4-1: Dividing a Corridor into Bottleneck Areas

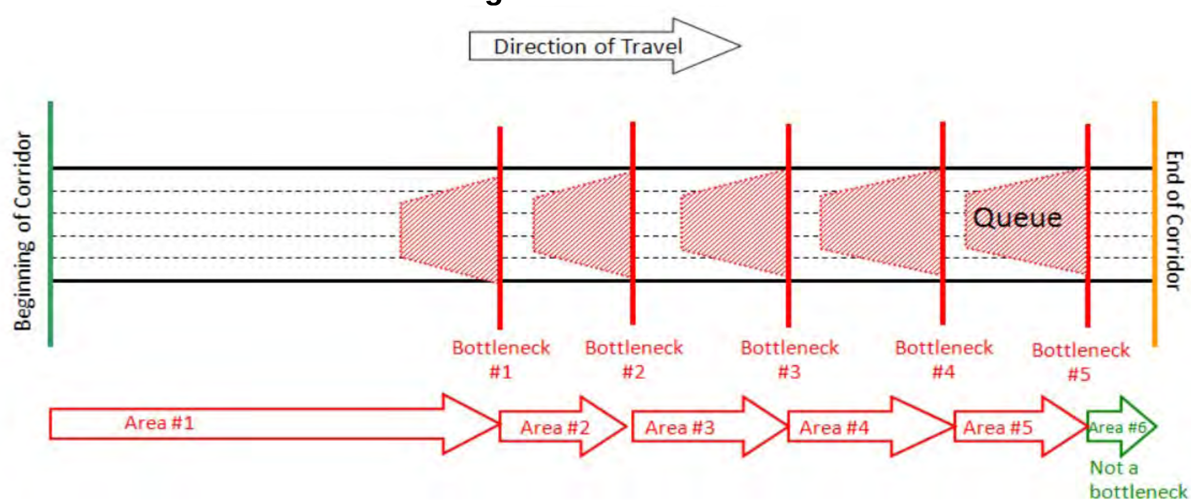
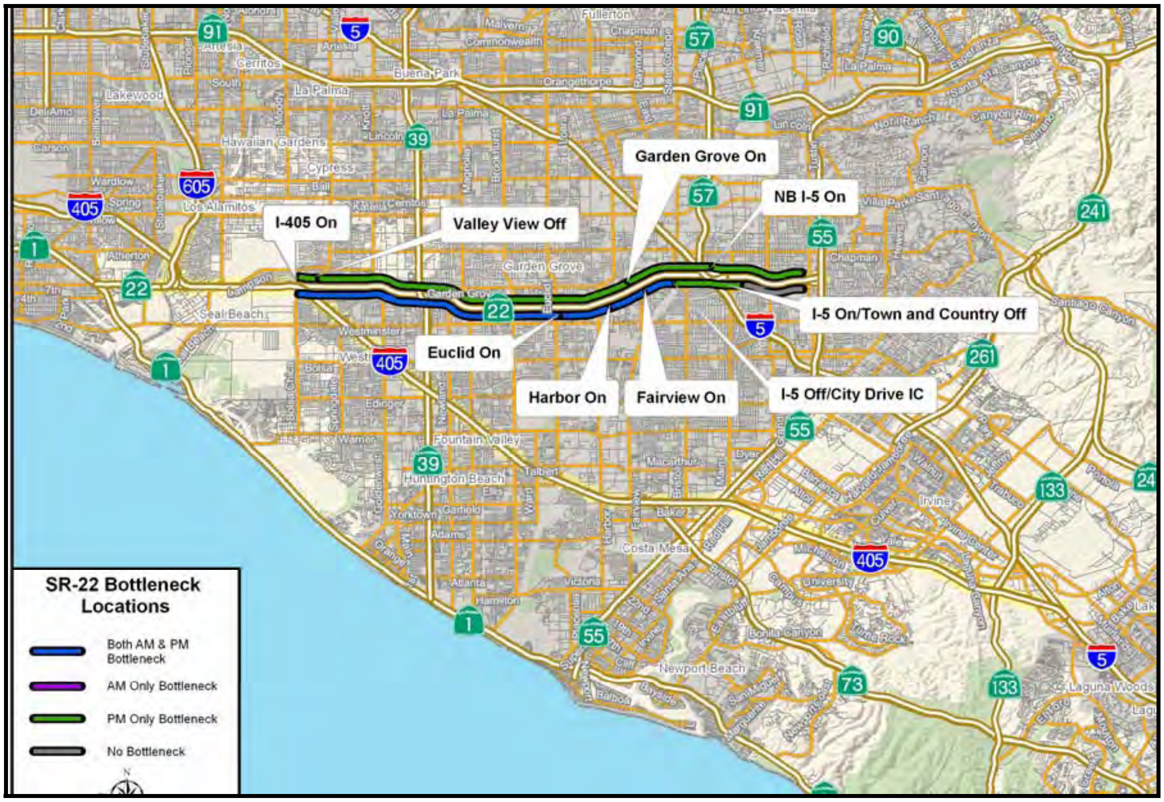


Exhibit 4-2 graphically illustrates the location of each of the bottleneck locations and areas for the SR-22 Corridor.

Exhibit 4-2: SR-22 Bottleneck Locations and Bottleneck Areas



Dividing the corridor into bottleneck areas makes it easier to compare the various segments of the freeway with each other. This section will use the previously discussed performance measures of mobility, safety, and productivity to evaluate each bottleneck area. The results from this bottleneck analysis will reveal which segments of the corridor should be prioritized for improvements.

Exhibit 4-3: Eastbound SR-22 Identified Bottleneck Areas

Bottleneck Location	Bottleneck Area	Active Period		From		To		Distance (miles)
		AM	PM	Abs	CA	Abs	CA	
Euclid On	I-405 to Euclid On	✓	✓	2.1	R0.7	8.4	R7.0	6.3
Harbor On	Euclid On to Harbor On	✓	✓	8.4	R7.0	9.5	R8.1	1.1
Fairview On	Harbor On to Fairview On	✓	✓	9.5	R8.1	10.4	R9.0	0.9
I-5 Off/City Drive IC	Fairview On to I-5 Off/City Drive IC	✓	✓	10.4	R9.0	11.3	R9.7	0.9
I-5 On/Town and Country Off	I-5 Off/City Drive IC to I-5 On/Town and Country Off		✓	11.3	R9.7	12.8	R11.3	1.5
Not a bottleneck area	I-5 On/Town and Country Off to SR-55	N/A		12.8	R11.3	14.3	R12.7	1.5

Exhibit 4-4: Westbound SR-22 Identified Bottleneck Areas

Bottleneck Location	Bottleneck Area	Active Period		From		To		Distance (miles)
		AM	PM	Abs	CA	Abs	CA	
NB I-5 On	SR-55 to NB I-5 On		✓	14.3	R12.7	12.1	R10.5	2.2
Garden Grove On	NB I-5 On to Garden Grove On		✓	12.1	R10.5	10.1	R8.6	2.0
Valley View Off	Garden Grove On to Valley View Off		✓	10.1	R8.6	2.5	R1.1	7.6
I-405 On	Valley View Off to I-405		✓	2.5	R1.1	2.1	R0.7	0.4

Exhibit 4-5 graphically illustrates the location of each of the bottleneck locations and areas for the I-405 portion of the corridor.

Exhibit 4-5: I-405 Bottleneck Locations and Bottleneck Areas

Exhibit 4-6: Northbound I-405 Identified Bottleneck Areas

Bottleneck Location	Bottleneck Area	Active Period		From		To		Distance (miles)
		AM	PM	Abs	CA	Abs	CA	
Sand Canyon Off	I-5 to Sand Canyon Off	✓		0.0	0.2	2.4	2.6	2.4
Jeffrey/University On	Sand Canyon Off to Jeffrey/University On	✓	✓	2.4	2.6	3.9	4.1	1.5
SR-73/Fairview On	Jeffrey/University On to SR-73/Fairview On		✓	3.9	4.1	10.7	10.9	6.9
Euclid On	SR-73/Fairview On to Euclid On		✓	10.7	10.9	12.6	12.9	1.9
Brookhurst On	Euclid On to Brookhurst On		✓	12.6	12.9	13.8	14.0	1.2
SR-39 On	Brookhurst On to SR-39 On	✓	✓	13.8	14.0	16.6	16.8	2.8
SR-22 On	SR-39 On to SR-22 On	✓	✓	16.6	16.8	20.7	20.9	4.1
Not a bottleneck area	SR-22 On to LA County Line	N/A		20.7	20.9	24.0	24.2	3.3

Exhibit 4-7: Southbound I-405 Identified Bottleneck Areas

Bottleneck Location	Bottleneck Area	Active Period		From		To		Distance (miles)
		AM	PM	Abs	CA	Abs	CA	
I-605 On	LA County Line to I-605 On	✓	✓	24.0	24.2	23.3	23.5	0.7
Seal Beach On	I-605 On to Seal Beach On	✓	✓	23.3	23.5	22.3	22.5	1.0
Valley View/SR-22	Seal Beach On to Valley View/SR-22	✓	✓	22.3	22.5	20.3	20.5	2.0
SR-39 On	Valley View/SR-22 On to SR-39 On	✓	✓	20.3	20.5	16.4	16.6	3.9
Warner On	SR-39 On to Warner On	✓	✓	16.4	16.6	14.5	14.7	1.9
Talbert On	Warner On to Talbert On	✓		14.5	14.7	13.1	13.3	1.4
Bristol Off	Talbert On to Bristol Off	✓		13.1	13.3	9.5	9.7	3.6
MacArthur Off	Bristol Off to MacArthur Off	✓	✓	9.5	9.7	7.6	7.8	1.9
Culver On	MacArthur Off to Culver On	✓	✓	7.6	7.8	5.4	5.7	2.2
Jeffrey/University On	Culver On to Jeffrey/University On	✓	✓	5.4	5.7	3.8	4.0	1.6
Sand/Shady Canyon On	Jeffrey/University On to Sand/Shady Canyon On	✓	✓	3.8	4.0	2.7	2.9	1.1
Not a bottleneck area	Sand/Shady Canyon On to I-5	N/A		2.7	2.9	0.0	0.0	2.7

As previously indicated, bottleneck areas were not identified for the I-605 study corridor since the corridor is less than a mile long and has only one identifiable bottleneck location in the southbound direction. This bottleneck location is listed in Exhibit 4-8.

Exhibit 4-8: I-605 Identified Bottleneck Location

Bottleneck Location	Active Period		Post Mile	
	AM	PM	Abs	CA
NORTHBOUND				
none				
SOUTHBOUND				
Southbound I-405 On		✓	0.4	3.5

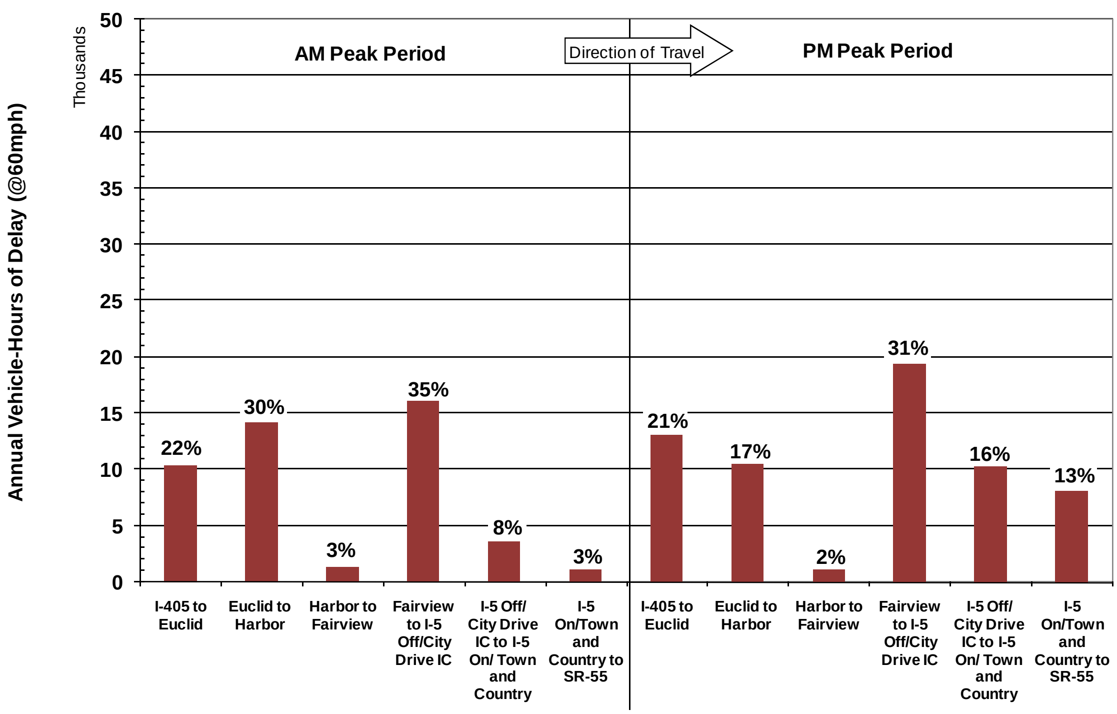
Mobility by Bottleneck Area

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

Mobility on SR-22

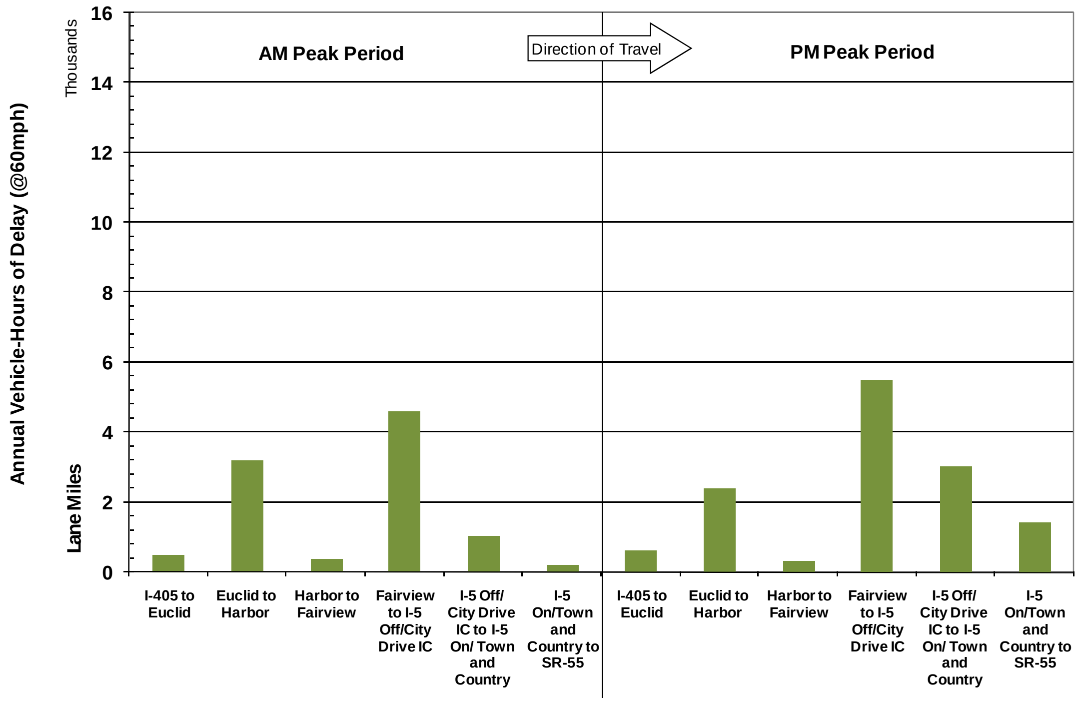
This mobility analysis is based on 2008 PeMS data for the mainline facility. Exhibits 4-9 and 4-11 illustrate the vehicle-hours of delay experienced by each bottleneck area on SR-22. As depicted in Exhibit 4-9, eastbound delay is slightly greater during the PM peak than the AM peak period. During both the AM and PM peaks, the bottleneck area between Fairview and I-5 Off/City Drive experienced the most delay with over 15,000 vehicle-hours in the AM and about 20,000 annual vehicle-hours in the PM. In the westbound direction (Exhibit 4-11), delay was overwhelmingly concentrated in the PM peak with four times more delay in the PM peak than the AM peak period. The bottleneck area between Northbound I-5 and Garden Grove experienced the highest delay of any other segment, followed closely by the area from Garden Grove Boulevard to Valley View. Both of these segments experienced over 35,000 vehicle-hours of delay each during the PM peak.

Exhibit 4-9: Eastbound SR-22 Annual Vehicle-Hours of Delay (2008)



Source: SMG analysis of PeMS data

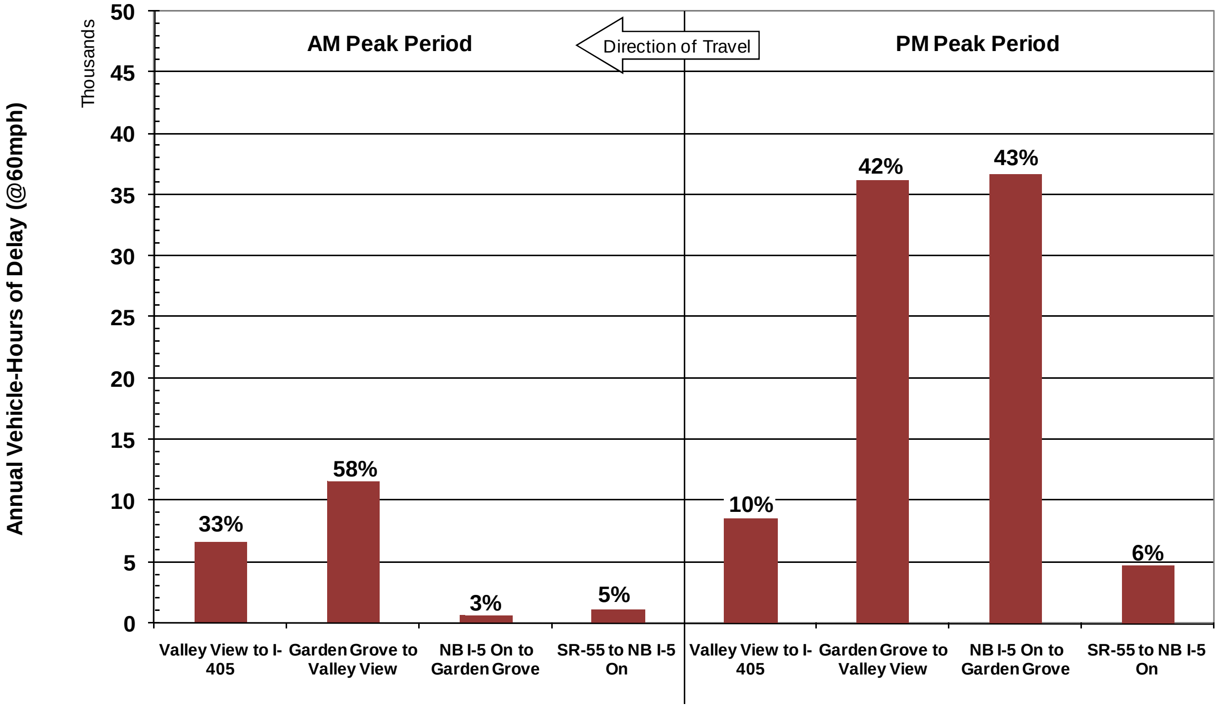
Exhibit 4-10: Eastbound SR-22 Delay per Lane-Mile (2008)



Source: SMG analysis of PeMS data

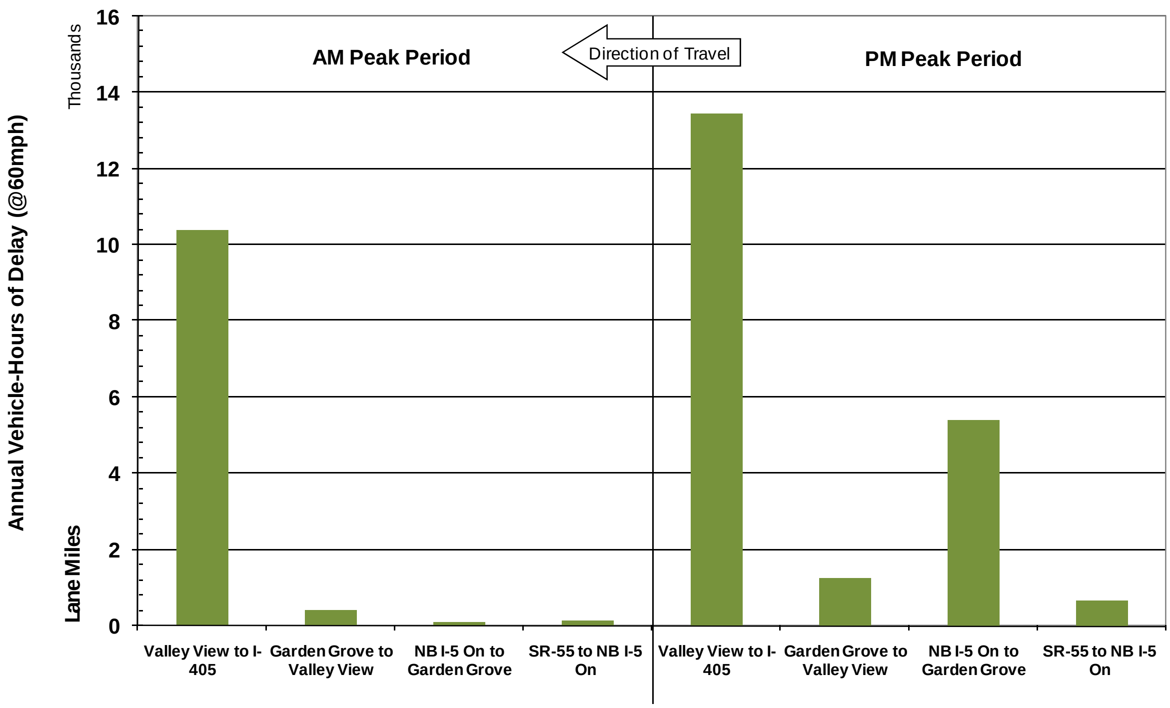
Exhibits 4-10 and 4-12 have been normalized to reflect delay per lane-mile. The delay calculated for each bottleneck area was divided by the total lane-miles for each bottleneck area to obtain delay per lane-mile. In the eastbound direction, normalizing lane-miles resulted in similar delay results as Exhibit 4-9, but in the westbound direction, the results were different. In the westbound direction, the segment from Valley View to I-405 experienced the highest levels of delay per lane-mile, which contrasts the delay results in Exhibit 4-11. In Exhibit 4-11, Valley View to I-405 experienced lower levels of delay during both peak periods compared to the other bottleneck areas along the corridor, specifically the segments from Northbound I-5 to Garden Grove and from Garden Grove to Valley View.

Exhibit 4-11: Westbound SR-22 Annual Vehicle-Hours of Delay (2008)



Source: SMG analysis of PeMS data

Exhibit 4-12: Westbound SR-22 Delay per Lane-Mile (2008)

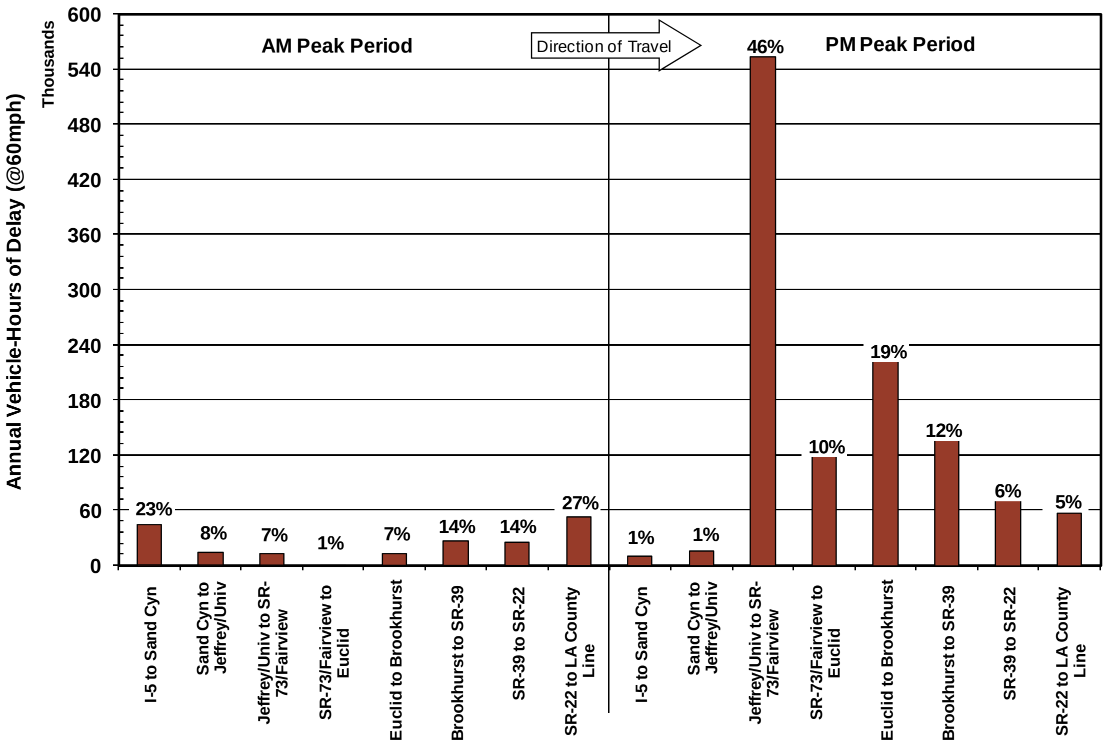


Source: SMG analysis of PeMS data

Mobility on I-405

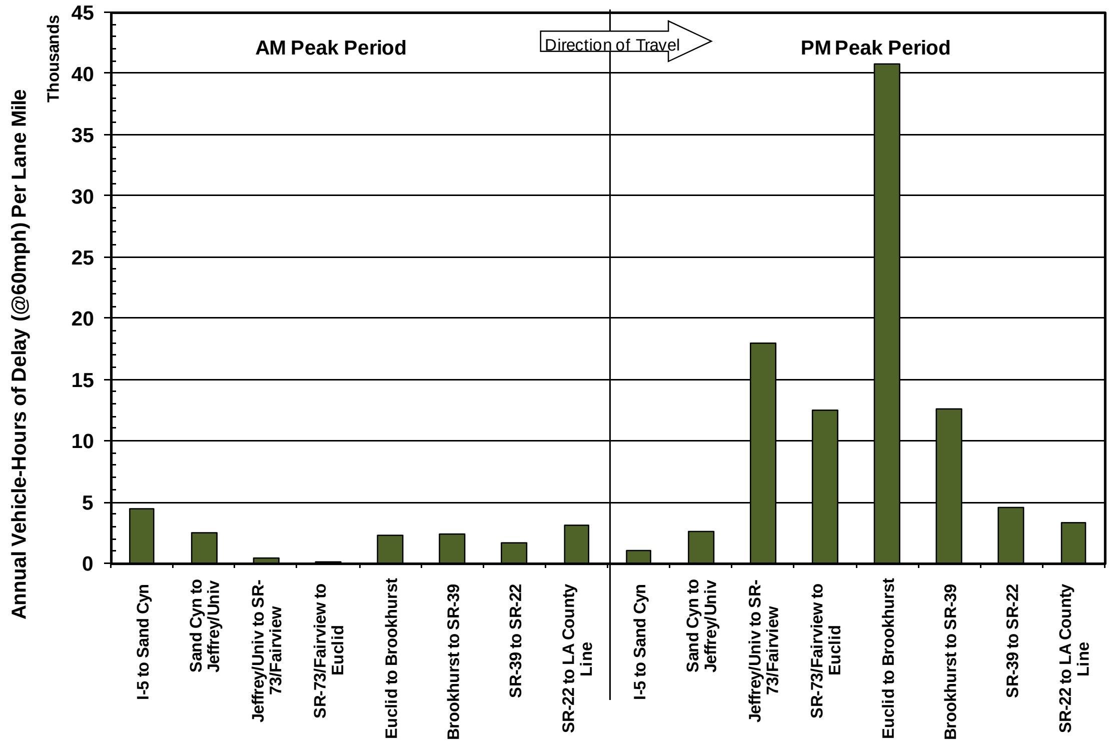
Delay on I-405 is illustrated in Exhibits 4-13 through 4-16. As depicted in Exhibits 4-13 and 4-15, delay is greater during the PM in the northbound direction and during the AM in the southbound direction, indicating a directional pattern of travel. In the northbound direction (Exhibit 4-13), the segment between Jeffrey/University to SR-73 experienced the greatest delay of any segment on the corridor with over 550,000 annual vehicle-hours accrued during the PM peak. During the AM peak, the segment between SR-22 to the Los Angeles County Line experienced the greatest delay. In the southbound direction (Exhibit 4-15), the segment between Valley View/SR-22 and SR-39 (Beach Boulevard), and the segment from MacArthur to Culver, experienced the heaviest delay during the AM and PM peaks, respectively.

Exhibit 4-13: Northbound I-405 Annual Vehicle-Hours of Delay (2006)



Source: SMG analysis of PeMS data

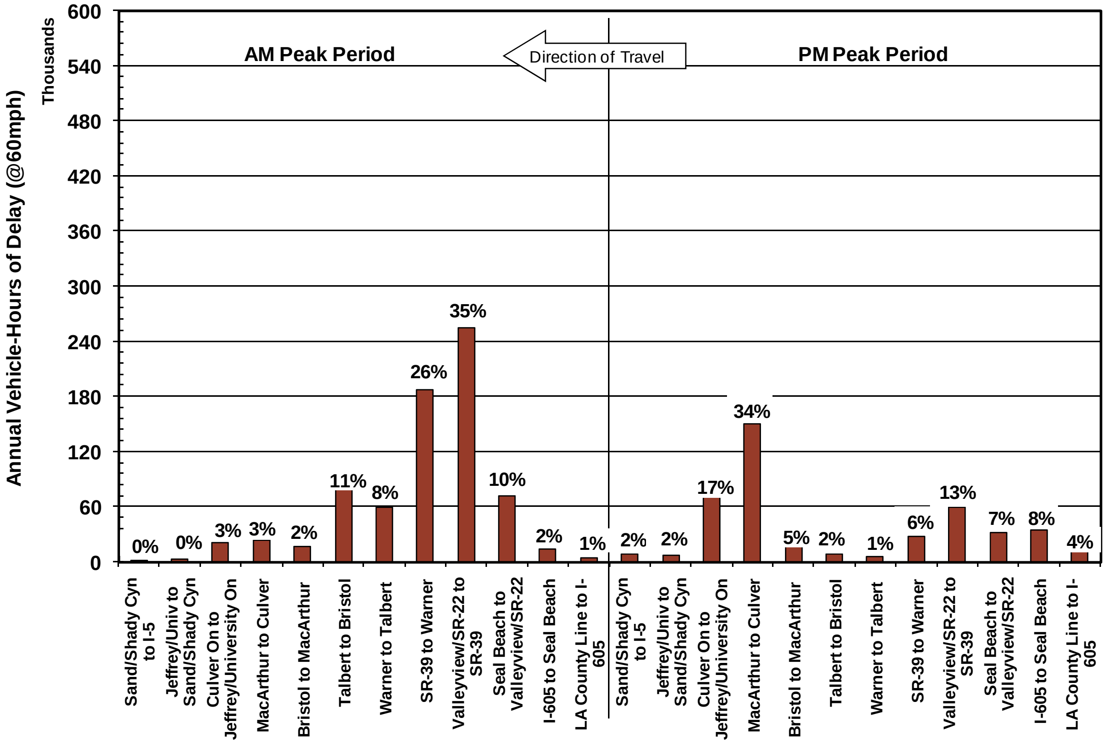
Exhibit 4-14: Northbound I-405 Delay per Lane-Mile (2006)



Source: SMG analysis of PeMS data

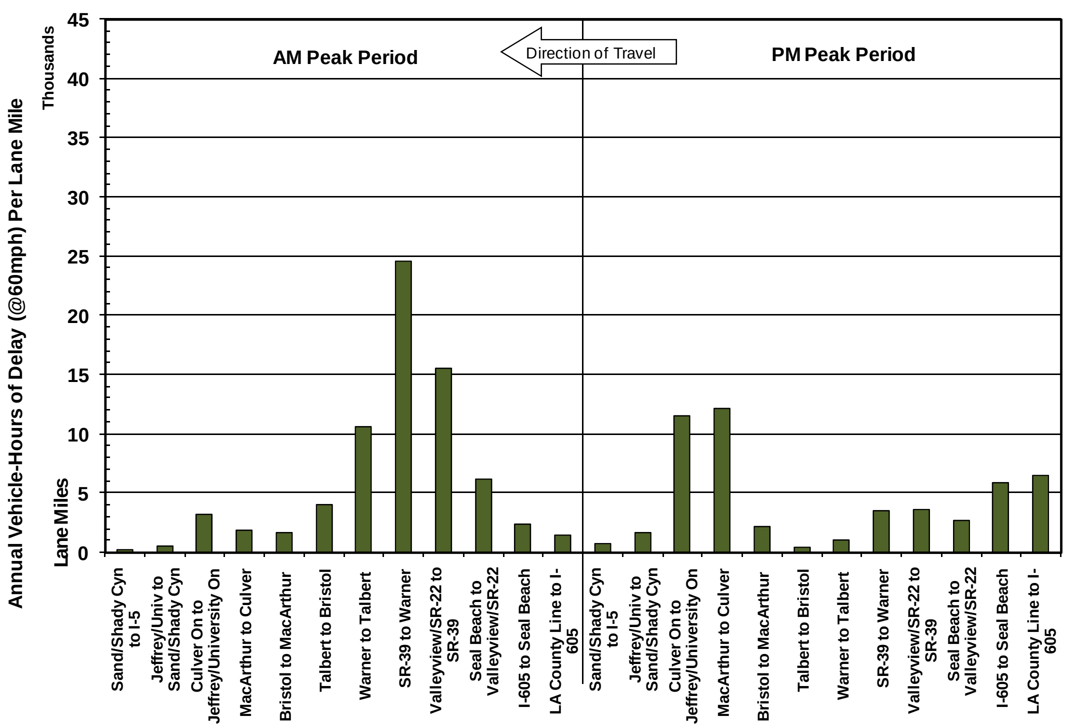
Exhibits 4-14 and 4-16 have been normalized to reflect delay per lane-mile. The delay calculated for each bottleneck area was divided by the total lane-miles for each bottleneck area to obtain delay per lane-mile. In both directions, the results were similar to the delay shown in Exhibits 4-13 and 4-15 with a clear directional pattern of travel. However, in the northbound direction during the PM peak, the segment which experienced the heaviest delay per lane mile was Euclid to Brookhurst, rather than Jeffrey/University to SR-73. Similarly, in the southbound direction during the AM peak (Exhibit 4-16), the segment with the highest delay per lane mile was SR-39 to Warner rather than Valley View/SR-22 to SR-39.

Exhibit 4-15: Southbound I-405 Annual Vehicle-Hours of Delay (2006)



Source: SMG analysis of PeMS data

Exhibit 4-16: Southbound I-405 Delay per Lane-Mile (2006)



Source: SMG analysis of PeMS data

Safety by Bottleneck Area

As previously indicated in Section 3, 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. The following discussion examines the pattern of collisions by bottleneck area for the SR-22 and I-405 Corridors.

Safety on SR-22

The safety analysis in this section conducted for the SR-22 Corridor is based on a combination of PeMS data and data provided by Caltrans District 12. Unfortunately, safety data for the 2008 base year is not yet available from these two sources. Therefore, the safety assessment analyzes the years that are available for each source, which may include the time period when the corridor was undergoing construction (2005-2007).

Concentrated highway collisions may be indicative of safety issues. TASAS produces a "Table C" that reports collision concentrations. It counts the total number of collisions for three, six, 12, 24, and 36-month periods. Locations with four or more collisions and significance in the three, six, or 12-month period are flagged as requiring investigation. Exhibits 4-17 and 4-18 shows the number of Table C collisions by bottleneck area during three different 12-month periods for the SR-22 Corridor. In the eastbound direction, the bottleneck area from I-5 On to I-5 Off experienced the most Table C collisions with 201. In the westbound direction, the bottleneck area from Garden Grove to Valley View experienced the most Table C collisions, 46, during the July 2004-June 2007 period. The eastbound direction clearly experienced more Table C collisions than the westbound direction.

Exhibit 4-17: Eastbound SR-22 Table C Locations and Collisions (2004-2007)

From		To		Bottleneck Area	Number of Table C Accidents[1]			
Abs	CA	Abs	CA		July 04-June 05	July 05-June 06	July 06-June 07	36 Mo Total
2.1	0.7	8.4	R7.0	I-405 to Euclid On	19	13	25	57
8.4	R7.0	9.5	R8.1	Euclid On to Harbor On	22	22	28	72
9.5	R8.1	10.4	R9.0	Harbor On to Fairview On	59	57	63	179
10.4	R9.0	11.3	R9.7	Fairview On to I-5 Off/City Drive IC	16	10	5	31
11.3	R9.7	12.8	R11.3	I-5 Off/City Drive IC to I-5 On/Town and Country Off	67	44	90	201
12.8	R11.3	14.3	R12.7	I-5 On/Town and Country Off to SR-55	Not a Table C Location			
				Eastbound Total	183	146	211	540

[1] accidents reported quarterly in Caltrans' Table C. Table C reports list high accident concentration locations.

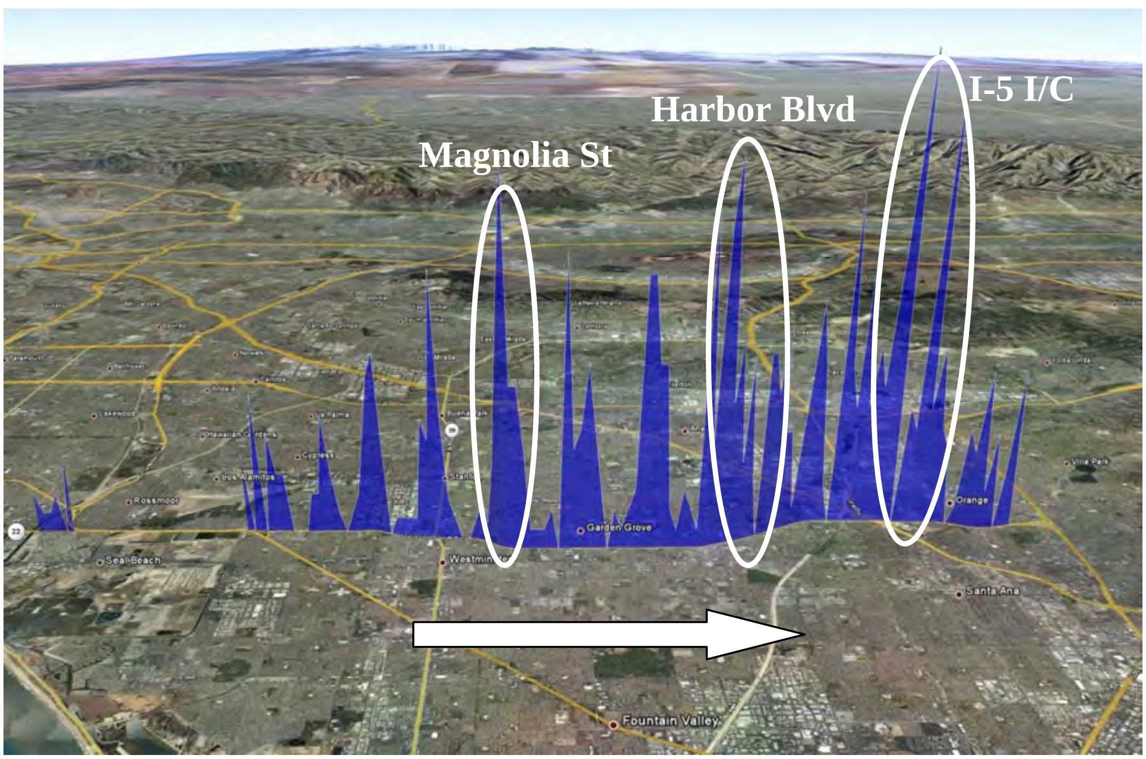
Exhibit 4-18: Westbound SR-22 Table C Locations and Collisions (2004-2007)

From		To		Bottleneck Area	Number of Table C Accidents[1]			
Abs	CA	Abs	CA		July 04-June 05	July 05-June 06	July 06-June 07	36 Mo Total
14.3	R12.7	12.1	R10.5	SR-55 to NB I-5 On	Not a Table C Location			
12.1	R10.5	10.1	R8.6	NB-5 On to Garden Grove On	Not a Table C Location			
10.1	R8.6	2.5	R1.1	Garden Grove On to Valley View Off	22	14	10	46
2.5	R1.1	2.1	R0.7	Valley View Off to I-405	16	7	11	34
				Westbound Total	38	21	21	80
				Eastbound and Westbound Total	221	167	232	620

[1] accidents reported quarterly in Caltrans' Table C. Table C reports list high accident concentration locations.

Exhibit 4-19 shows the location of all collisions (Table C and others) plotted along SR-22 in the eastbound direction. The spikes show the total number of collisions (fatality, injury, and property damage only) occurring within a 0.1 mile segments in 2006. The highest spike corresponds to roughly 22 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.

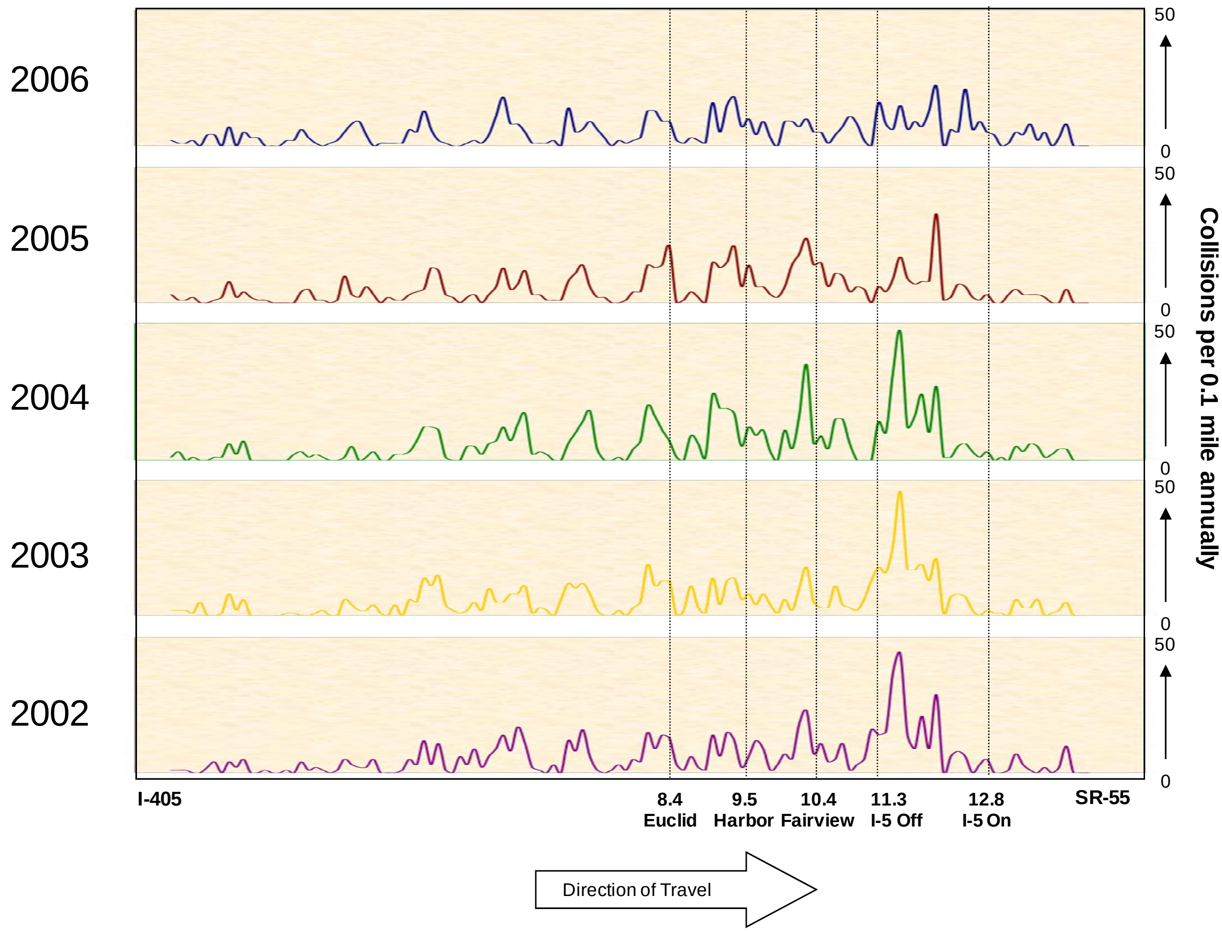
Exhibit 4-19: Eastbound SR-22 Collision Locations (2006)



Source: SMG analysis of TASAS data

As evident in Exhibit 4-19, the study corridor has a high concentration of collisions at many locations. Starting from I-405 and moving eastbound, the largest number of collisions occurred around Magnolia Street, near Harbor Boulevard, and the highest occurred at the I-5 Interchange. The location at the I-5 Interchange also experienced the most Table C collisions, as previously noted in Exhibit 4-17. In many cases, a spike in the number of collisions occurs in the same location as a bottleneck. For example, a spike occurred at Harbor Boulevard and the I-5 Interchange, which are also bottleneck locations.

Exhibit 4-20: Eastbound SR-22 Collision Locations (2002-2006)

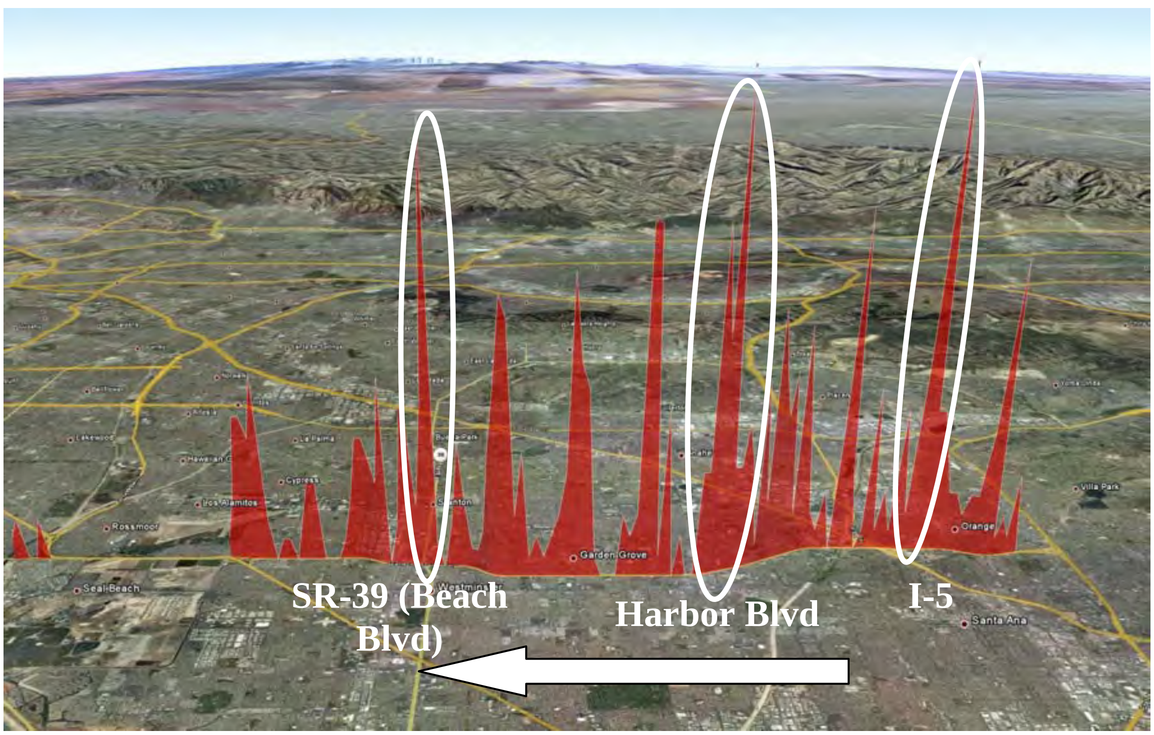


Source: SMG analysis of TASAS data

Exhibit 4-20 illustrates the same collision data as the previous exhibit, but for the entire five-year period from 2002 to 2006. Each graph within Exhibit 4-20 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 50 (the maximum) as reflected on the y-axis. The vertical lines in the exhibit separate the corridor by bottleneck area. Exhibit 4-19 showed that in 2006, the highest number of collisions occurred between the I-5 off-ramp and on-ramp. This is illustrated in Exhibit 4-20 as the bottleneck area between PM 11.3 and PM 12.8. Exhibit 4-20 also shows that the pattern of collisions has stayed consistent from one year to the next with an overall decrease in collisions since 2002, particularly between Harbor Boulevard and the I-5 on-ramp.

For the westbound direction of SR-22, Exhibit 4-21 maps similar 2006 collision data. The largest spike in this exhibit corresponds roughly to 22 collisions per 0.1 mile. Although the pattern in the westbound direction is similar to that in the eastbound direction, the spikes in the westbound are thinner than those in the eastbound direction, suggesting that a high number of accidents occurred at very specific locations along the corridor. Moving in the westbound direction from SR-55, spikes are most notable at the I-5 Interchange, around Harbor Boulevard, and near SR-39 (Beach Boulevard). Two out of these three locations (I-5 Interchange and Harbor Boulevard) are the same as those identified in the eastbound direction (Exhibit 4-19).

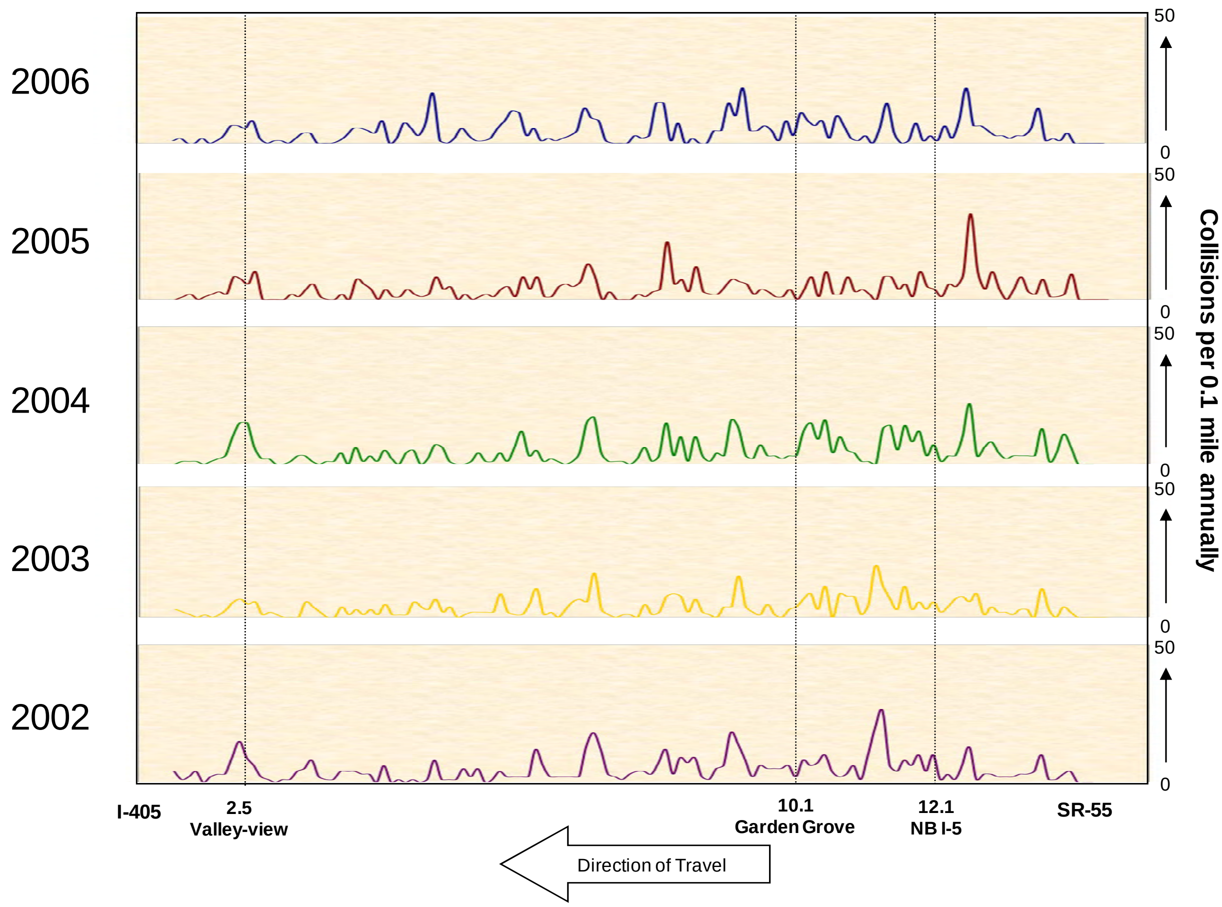
Exhibit 4-21: Westbound SR-22 Collision Locations (2006)



Source: SMG analysis of TASAS data

As done previously for the eastbound direction, Exhibit 4-22 shows the trend of collisions in the westbound direction during the 2002-2006 period by bottleneck area. As the exhibit shows, the pattern of collisions has been fairly steady from one year to the next with an overall increase of accidents since 2002. Unlike the eastbound direction where a high number of accidents clustered around the bottleneck locations, the westbound direction experienced relatively fewer accidents near its respective bottleneck locations.

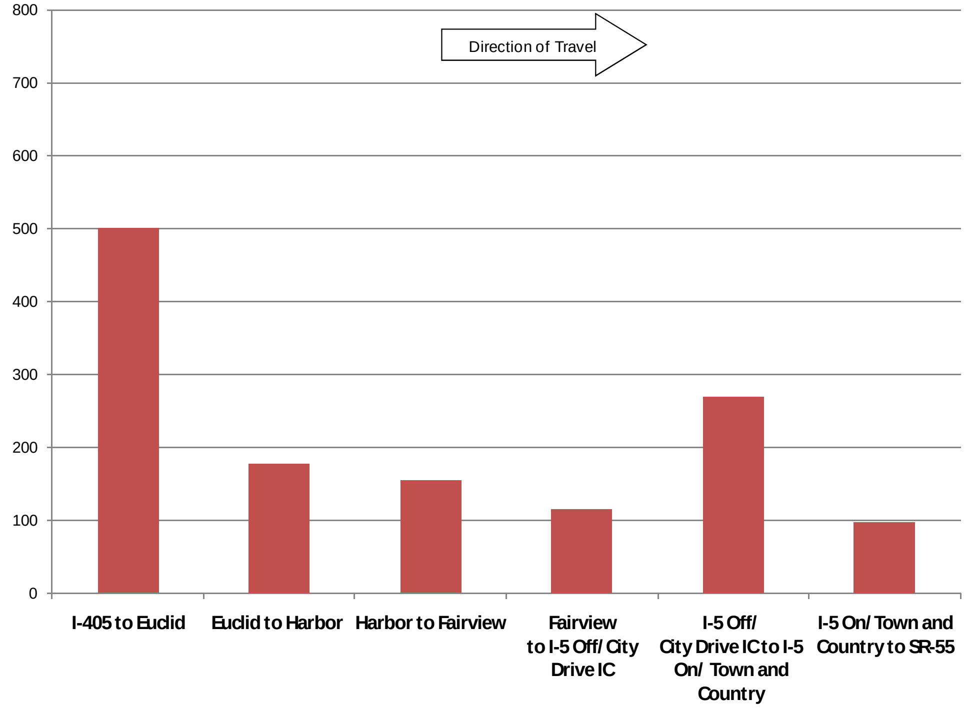
Exhibit 4-22: Westbound SR-22 Collision Locations (2002-2006)



Source: SMG analysis of TASAS data

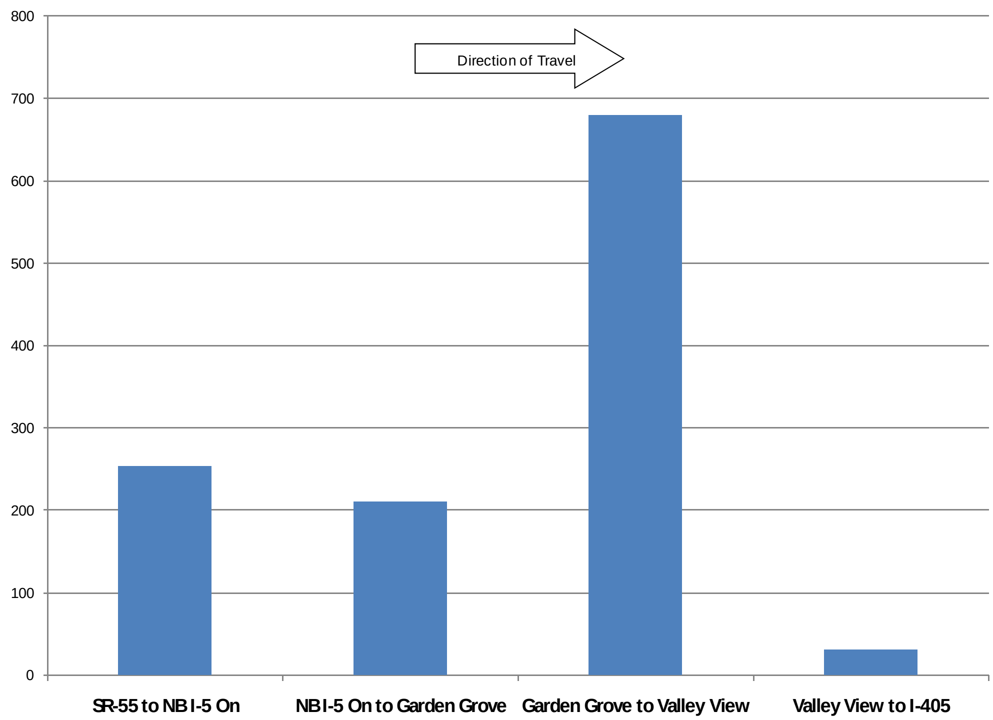
Exhibits 4-23 and 4-24 present the total number of accidents reported in TASAS by bottleneck area. The bars show the total of accidents that occurred in 2005 and 2006, the latest two years available in TASAS. In the eastbound direction, the segment from I-405 to Euclid experienced the highest number of accidents with 500. In the westbound direction, the segment between Garden Grove and Valley View exceeded every other segment in accidents with slightly under 700. This should be expected, since this bottleneck area is the longest in distance of any other segment on the corridor.

Exhibit 4-23: Eastbound SR-22 Total Accidents (2005-2006)



Source: SMG analysis of TASAS data

Exhibit 4-24: Westbound SR-22 Total Accidents (2005-2006)



Source: SMG analysis of TASAS data

Safety on I-405

An analysis of Caltrans Table C data for the I-405 Corridor reveals that in the northbound direction, the highest number of Table C accidents occurred within the bottleneck area from SR-73/Fairview to Euclid (216), followed by the bottleneck area from Jeffrey/University to SR-73/Fairview (206). In the southbound direction, the bottleneck area from SR-39 to Warner experienced the most Table C collisions with 150, as indicated in Exhibit 4-25. These bottleneck areas also experienced significant delay. The segment from Jeffrey/University to SR-73 comprised almost half of the total delay in the northbound direction during the PM peak, and the segment from SR-39 to Warner comprised 26 percent of the total delay in the southbound direction during the AM peak.

Exhibits 4-25 and 4-26 also demonstrate that the northbound direction experienced more Table C accidents than the southbound direction.

Exhibit 4-25: Northbound I-405 Table C Locations and Collisions (2004-2007)

From		To		Bottleneck Area	Number of Table C Accidents[1]			
Abs	CA	Abs	CA		July 04-June 05	July 05-June 06	July 06-June 07	36 Mo Total
0.0	0.2	2.4	2.6	I-5 to Sand Canyon	19	13	11	43
2.4	2.6	3.9	4.1	Sand Cyn to Jeffrey/University	Not a Table C Location			
3.9	4.1	10.7	10.9	Jeffrey/University to SR-73/Fairview	67	60	79	206
10.7	10.9	12.6	12.9	SR-73/Fairview to Euclid	77	79	60	216
12.6	12.9	13.8	14.0	Euclid to Brookhurst	Not a Table C Location			
13.8	14.0	16.6	16.8	Brookhurst to SR-39	Not a Table C Location			
16.6	16.8	20.7	20.9	SR-39 to SR-22	24	6	24	54
20.7	20.9	24.0	24.2	SR-22 to LA County Line	Not a Table C Location			
				Northbound Total	187	158	174	519

[1] accidents reported quarterly in Caltrans' Table C. Table C reports list high accident concentration locations.

Exhibit 4-26: Southbound I-405 Table C Locations and Collisions (2004-2007)

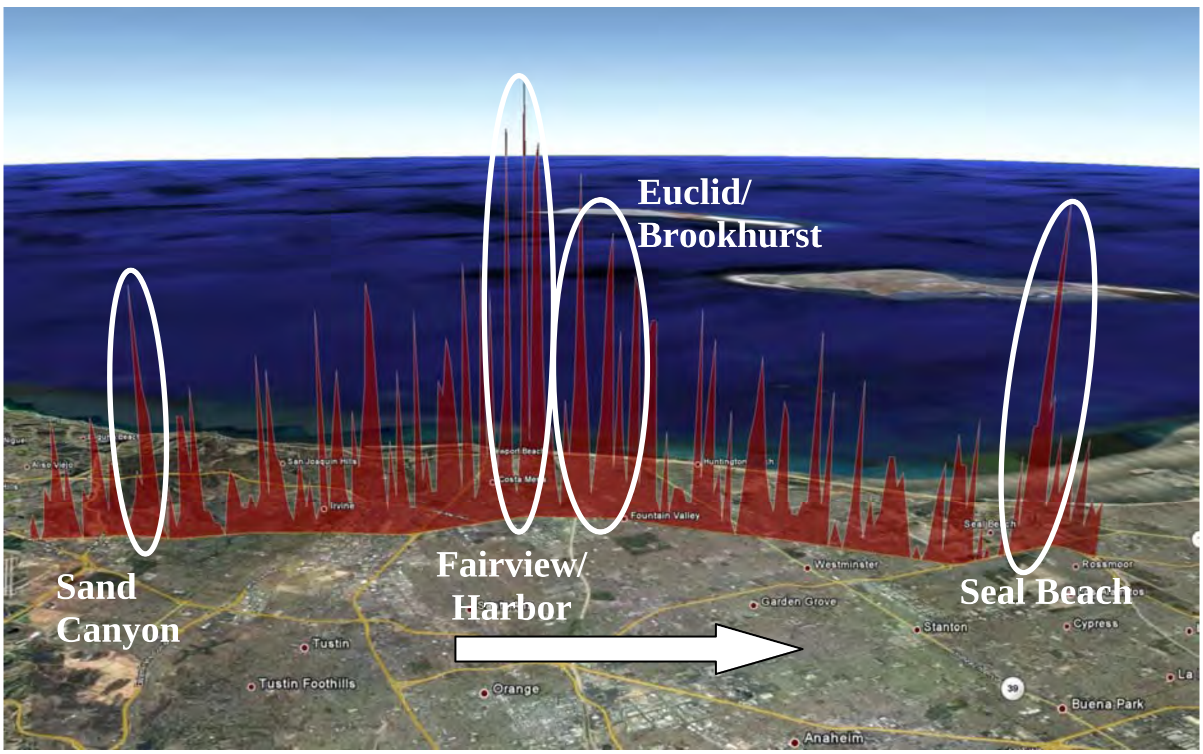
From		To		Bottleneck Area	Number of Table C Accidents			
Abs	CA	Abs	CA		July 04-June 05	July 05-June 06	July 06-June 07	36 Mo Total
24.0	24.2	23.3	23.5	LA County Line to I-605	0	0	0	0
23.3	23.5	22.3	22.5	I-605 On to Seal Beach On	36	29	15	80
22.3	22.5	20.3	20.5	Seal Beach to Valley View/SR-22	Not a Table C Location			
20.3	20.5	16.4	16.6	Valley View/SR-22 to SR-39	43	34	26	103
16.4	16.6	14.5	14.7	SR-39 to Warner	71	40	39	150
14.5	14.7	13.1	13.3	Warner to Talbert	Not a Table C Location			
13.1	13.3	9.5	9.7	Talbert to Bristol	21	9	9	39
9.5	9.7	7.6	7.8	Bristol to MacArthur	Not a Table C Location			
7.6	7.8	5.4	5.7	MacArthur to Culver	Not a Table C Location			
5.4	5.7	3.8	4.0	Culver to Jeffrey/Univ	Not a Table C Location			
3.8	4.0	2.7	2.9	Jeffrey/University to Sand/Shady Canyon	Not a Table C Location			
2.7	2.9	0.0	0.2	Sand/Shady Canyon to I-5	Not a Table C Location			
				Southbound Total	171	112	89	372
				Northbound and Southbound Total	358	270	263	891

[1] accidents reported quarterly in Caltrans' Table C. Table C reports list high accident concentration locations.

Exhibit 4-27 identifies the location of all collisions plotted along the I-405 Corridor in the northbound direction. The spikes show the total number of collisions (fatality, injury, and property damage only) which occurred within a 0.1 mile segment in 2006. The highest spike in Exhibit 4-27 corresponds to roughly 31 collisions in a single 0.1 mile location.

As evident in Exhibit 4-27, I-405 has a high concentration of collisions at many locations. Starting from I-5 and moving northbound, a large number of collisions occurred around Sand Canyon, between Fairview and Brookhurst, and around the Seal Beach and the SR-22 Interchange. In many cases, a spike in the number of collisions occurred in the same location as a bottleneck. For example, a spike occurred near the SR-73 Interchange/Fairview, which is also a bottleneck location.

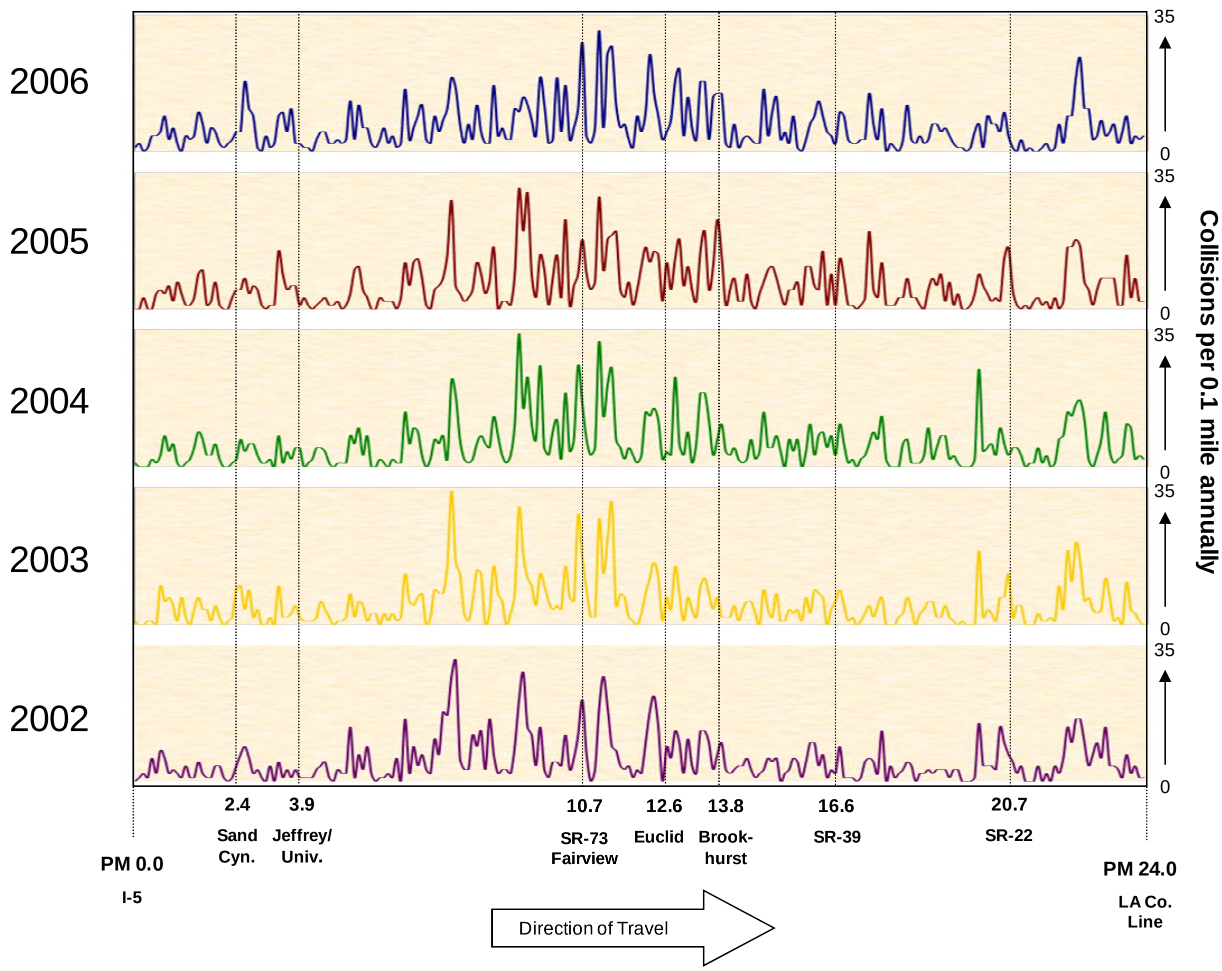
Exhibit 4-27: Northbound I-405 Collision Locations (2006)



Source: SMG analysis of TASAS data

Exhibit 4-28 illustrates the same safety data as the previous exhibit, but for the entire five-year period from 2002 to 2006. Each graph represents one year and the spikes indicate the number of collisions which occurred at a specific post mile location. The collisions range anywhere between zero (the minimum) and 35 (the maximum) on the y-axis. The vertical lines in the exhibit separate the corridor by bottleneck area. As indicated in this exhibit, a high number of collisions occurred between SR-73/Fairview (PM 10.7) and Brookhurst (PM 13.8). Exhibit 4-27 also shows that the pattern of collisions has stayed fairly consistent from one year to the next. However, the number of accidents (or spikes) that occurred between SR-73/Fairview and Brookhurst Avenue appeared to have increased in 2006 compared to prior years.

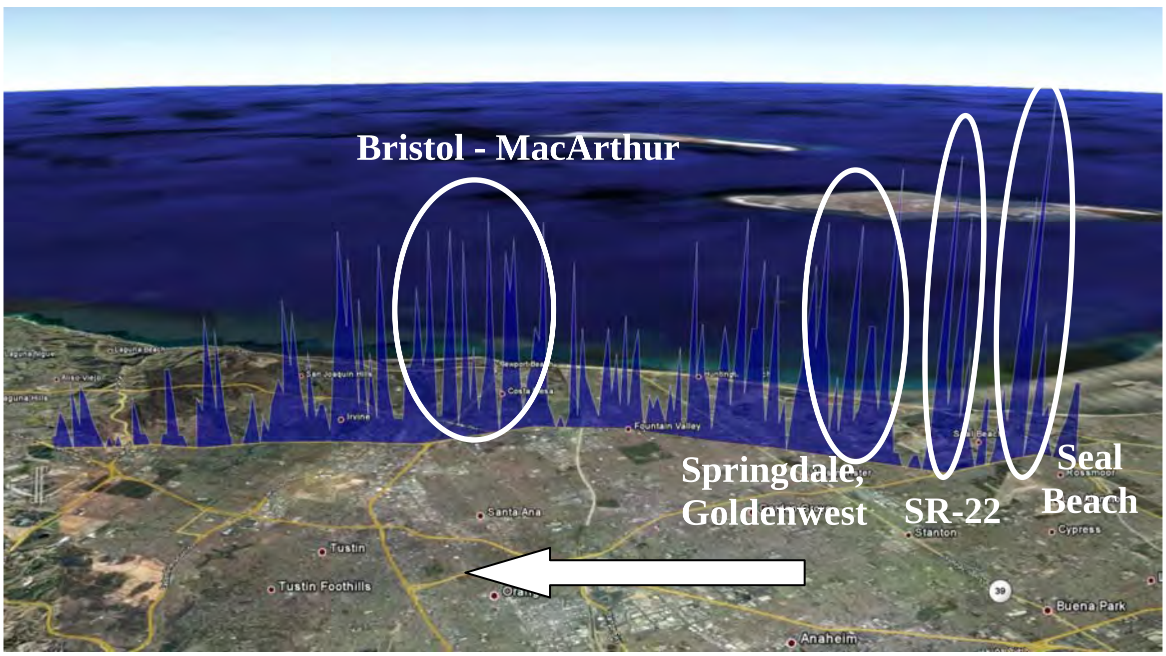
Exhibit 4-28: Northbound I-405 Collision Locations (2002-2006)



Source: SMG analysis of TASAS data

For the southbound direction of I-405, Exhibit 4-29 suggests that unlike the northbound direction, where the largest number of collisions occurred in the middle of the corridor, the largest spikes in the southbound direction occurred at the beginning of the corridor, near Seal Beach Boulevard and the SR-22 Interchange. The largest spike in this exhibit corresponds to 26 collisions per 0.1 miles, which occurred at Seal Beach Boulevard. Moving in the southbound direction from the LA County Line, spikes are most notable near Seal Beach, at the SR-22 Interchange, in the City of Westminster (Springdale, Goldenwest, Bolsa), and between Bristol and MacArthur. The locations at Seal Beach and Bristol-MacArthur are similar to the high-collision locations identified in the northbound direction in Exhibit 4-27.

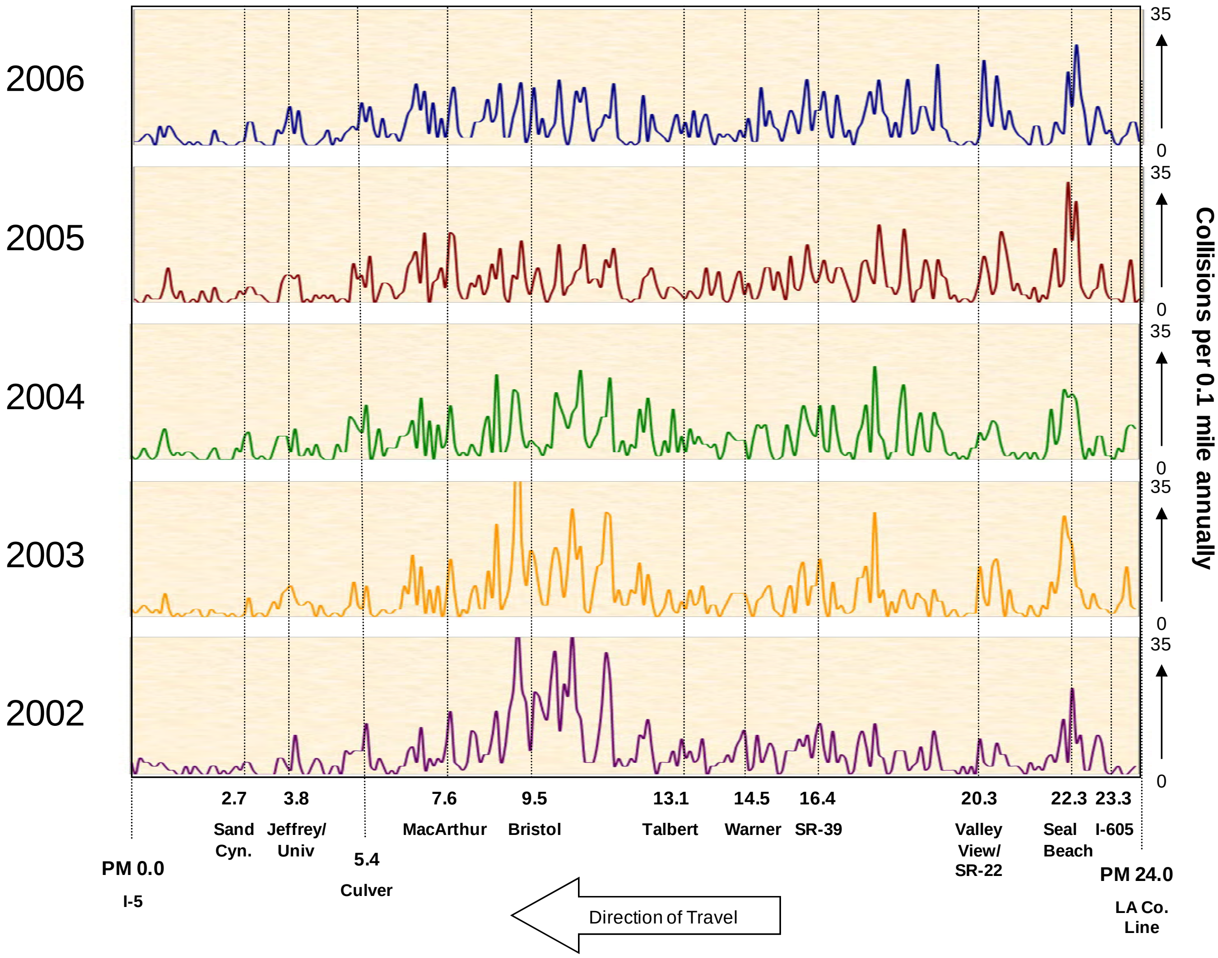
Exhibit 4-29: Southbound I-405 Collision Locations (2006)



Source: SMG analysis of TASAS data

The trend of collisions for the southbound direction during the 2002-2006 period by bottleneck area is depicted in Exhibit 4-30. As the exhibit shows, the number of collisions that occurred between Bristol and MacArthur decreased starting in 2004. Between 2004 and 2006, the pattern of collisions remained consistent with the highest number of collisions consistently occurring at Seal Beach (PM 22.3).

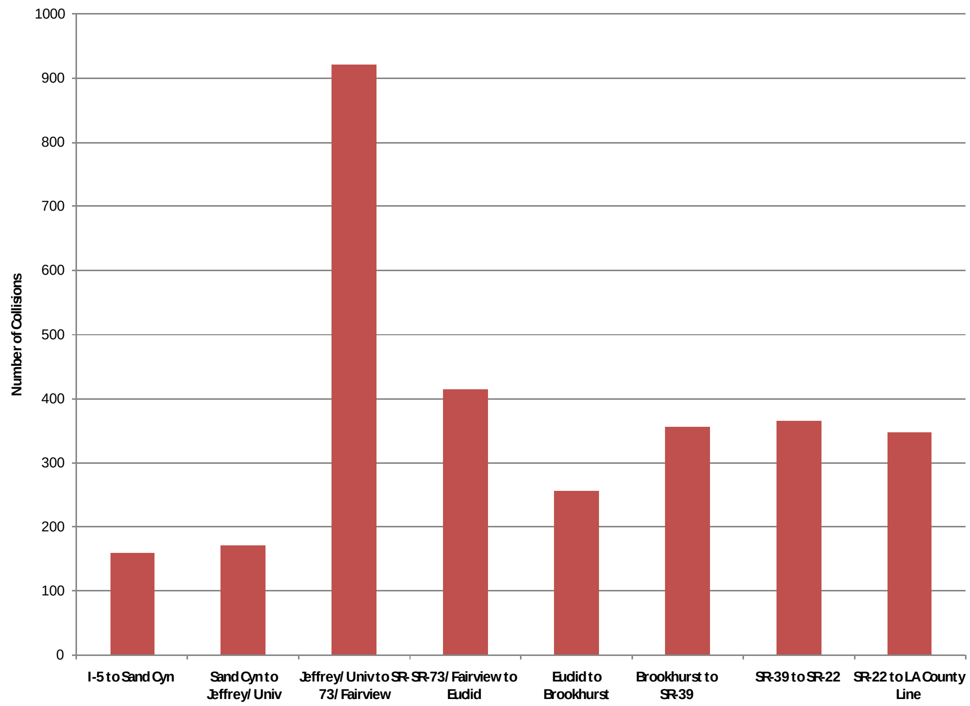
Exhibit 4-30: Southbound I-405 Collision Locations (2002-2006)



Source: SMG analysis of TASAS data

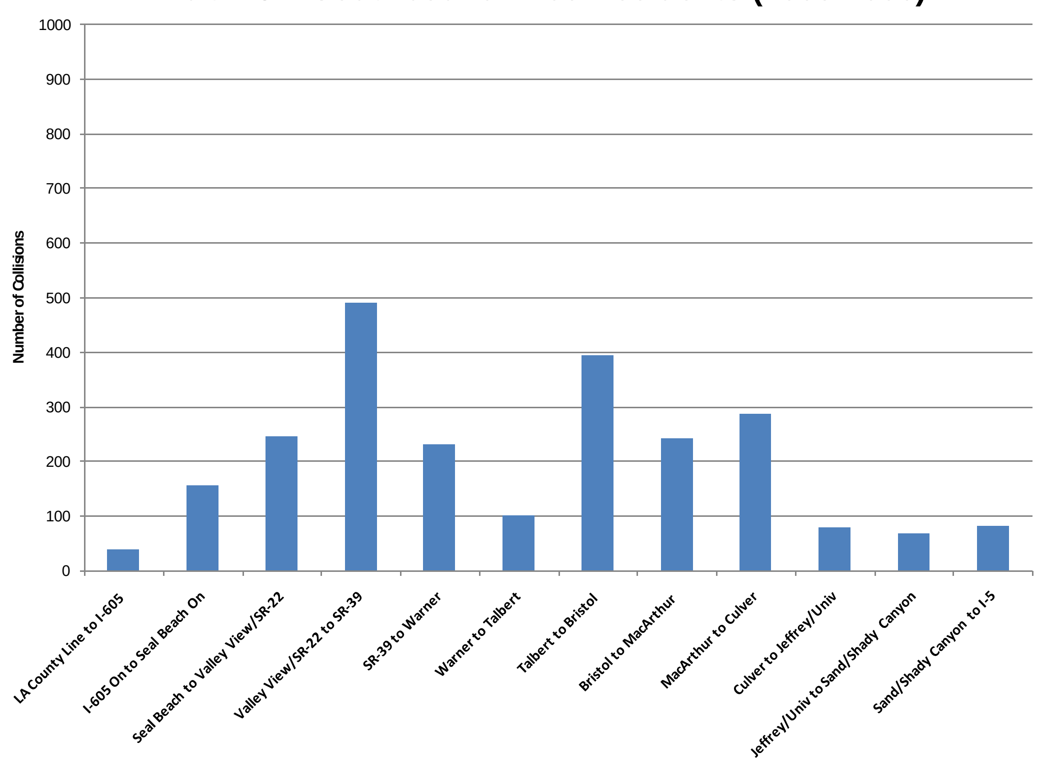
Exhibits 4-31 and 4-32 present the total number of accidents reported in TASAS by bottleneck area. The bars show the total of accidents that occurred in 2005 and 2006, the latest two years available in TASAS. The northbound direction clearly experienced more accidents than the southbound, with the highest number of accidents occurring between Jeffrey/University and SR-73/Fairview. In the southbound direction, the segment from Valley View/SR-22 to SR-39 experienced the most accidents.

Exhibit 4-31: Northbound I-405 Accidents (2005-2006)



Source: SMG analysis of TASAS data

Exhibit 4-32: Southbound I-405 Accidents (2005-2006)



Source: SMG analysis of TASAS data

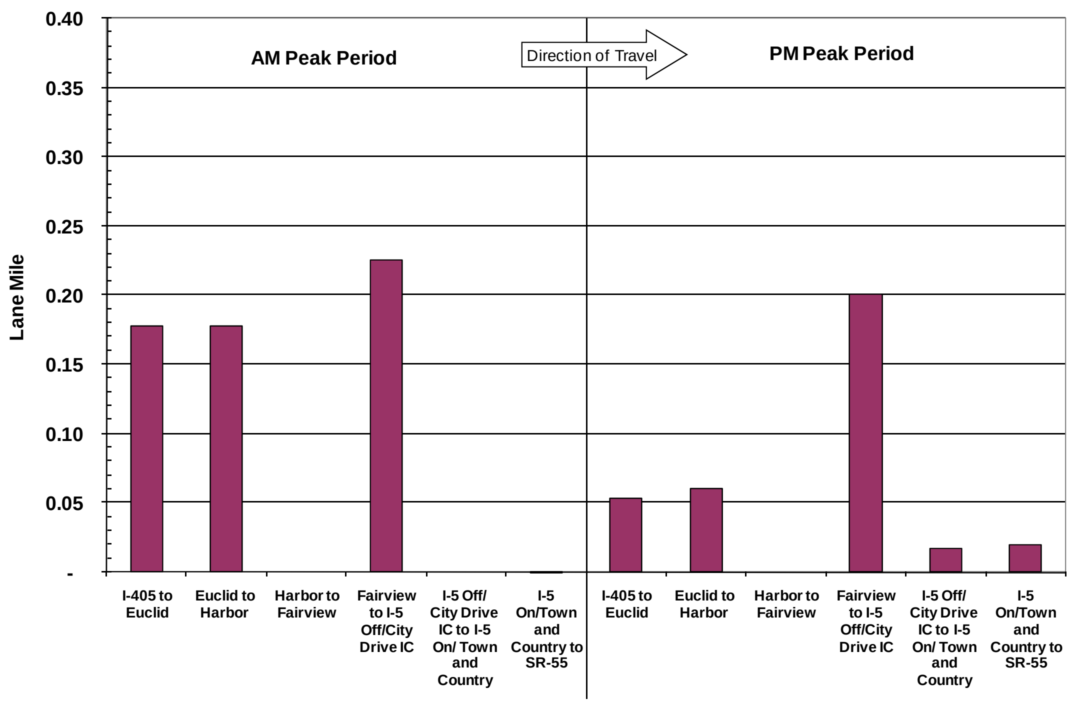
Productivity by Bottleneck Area

As previously discussed in Section 3, the productivity of a corridor is defined as the percent utilization of a facility or mode 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 level of capacity that would have to be added in order to achieve maximum productivity.

Productivity on SR-22

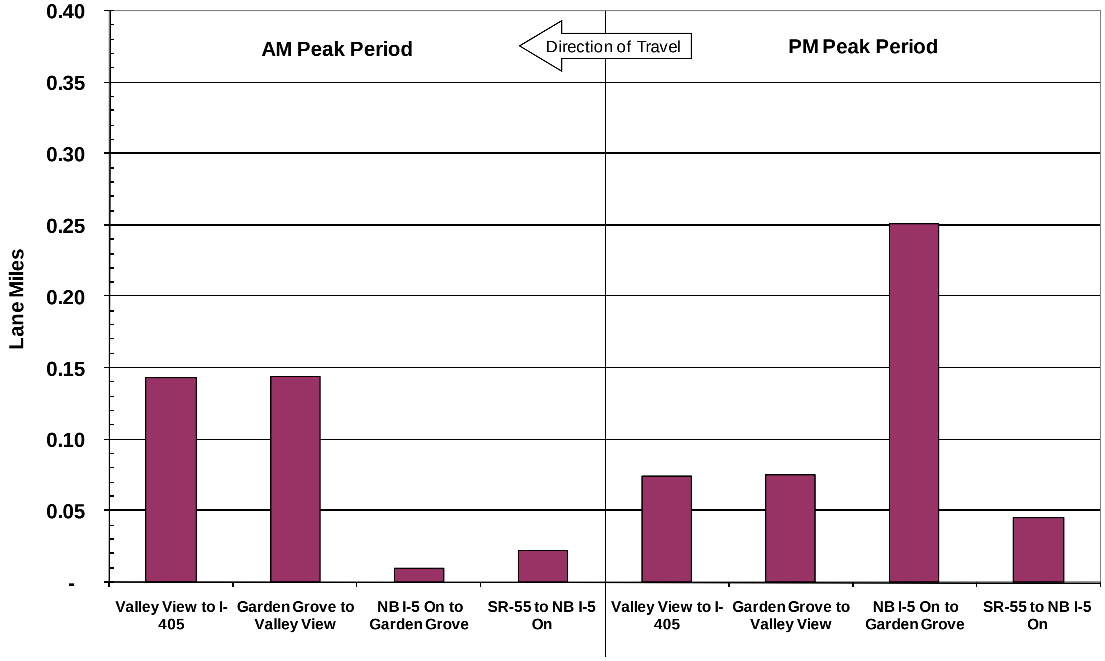
Similar to the mobility analysis, the productivity analysis is also based on 2008 PeMS data. Exhibits 4-33 and 4-34 show the productivity losses for both directions of the SR-22 Corridor. In the eastbound direction (Exhibit 4-33), the segment from Fairview to I-5 Off/City Drive suffered the highest productivity loss during both the AM and PM peak periods with over 0.20 lost-lane miles. In the westbound direction (Exhibit 4-34), Northbound I-5 On to Garden Grove had the worst productivity loss during the PM peak (0.25 lost lane-miles). These segments of the corridor also coincide with the segments that experienced the highest levels of annual vehicle-hours of delay.

Exhibit 4-33: Eastbound SR-22 Lost Lane-Miles (2008)



Source: SMG analysis of PeMS data

Exhibit 4-34: Westbound SR-22 Lost Lane-Miles (2008)



Source: SMG analysis of PeMS data

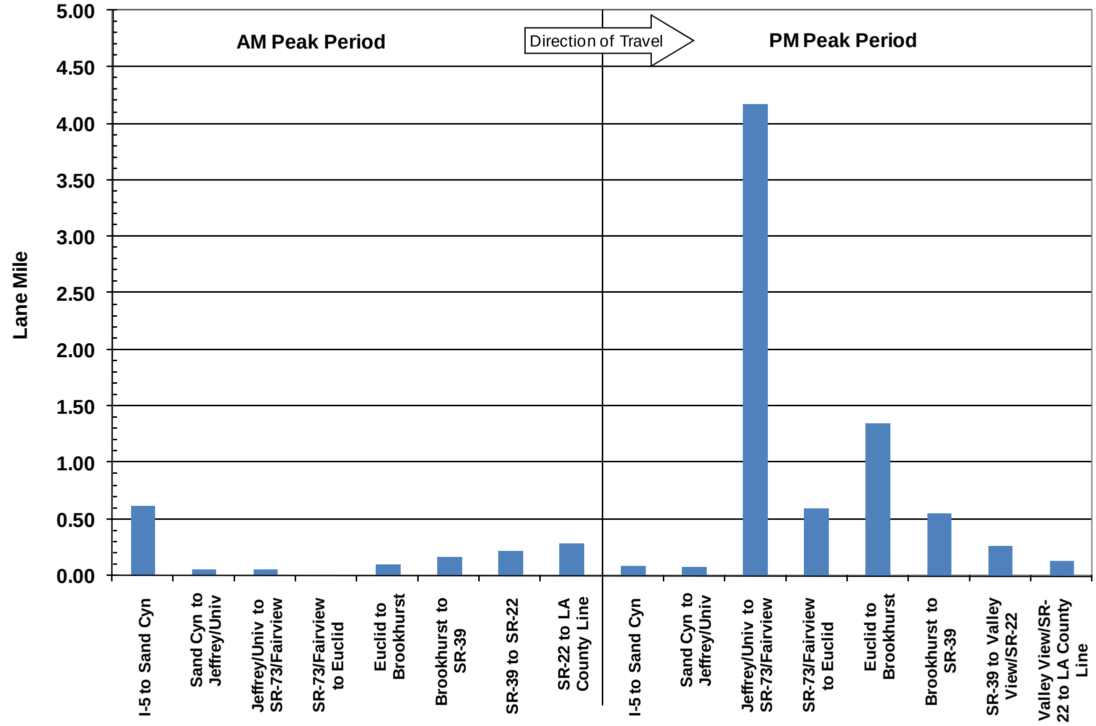
Productivity on I-405

Exhibits 4-35 and 4-36 show the productivity losses for both directions of I-405. In the northbound direction, the segment from Jeffrey/University to SR-73 had the worst productivity of any segment on the corridor with over 4.5 lost lane-miles during the PM peak. During the AM peak, the segments from I-5 to Sand Canyon suffered the worst productivity at 0.6 lost lane-miles, while the rest of the segments experienced relatively higher levels of productivity with under 0.5 lost lane-miles.

In the southbound direction, the segment from Valley View/SR-22 to SR-39 had the highest productivity loss during the AM peak, while the segment from MacArthur to Culver had the highest productivity loss during the PM peak.

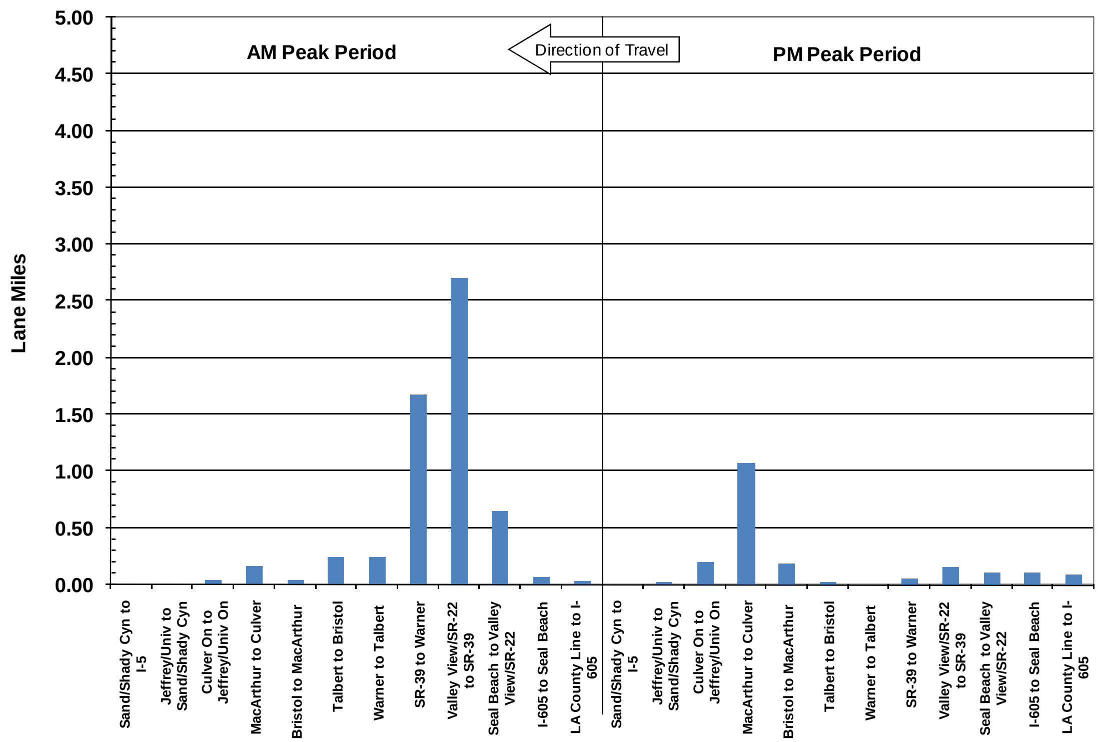
The segments of the corridor with the highest productivity losses coincide with the segments that experienced the greatest annual vehicle-hours of delay.

Exhibit 4-35: Northbound I-405 Lost Lane-Miles (2006)



Source: SMG analysis of PeMS data

Exhibit 4-36: Southbound I-405 Lost Lane-Miles (2006)



Source: SMG analysis of PeMS data

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

5. BOTTLENECK CAUSALITY ANALYSIS

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

The actual location of each major bottleneck is verified by multiple field observations on separate days. The cause(s) of each major bottleneck is also identified by field observations and additional traffic data analysis. For the SR-22 and I-405 mainline facilities, field observations were conducted by the project consultant team on multiple days (midweek) in October, November, and December 2008 during the AM and PM peak hours. The most recent field reviews were conducted on December 11 and 18, 2008.

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. In many cases, it is a combination of increased demand and capacity reductions. Below is a summary of the causes of the bottleneck locations.

MAINLINE (ML) FACILITY

Eastbound SR-22 ML Bottlenecks and Causes

Major eastbound bottlenecks and congestion often occur during both the AM and the PM peak hours. The following is a summary of the eastbound bottlenecks and the identified causes.

<u>Brookhurst Street, Euclid Street, and Harbor Boulevard On</u>

Exhibit 5-1 contains an aerial photograph of the eastbound SR-22 mainline at Brookhurst Street, Euclid Street, and Harbor Boulevard interchanges. As indicated in the exhibit, the on-ramp at each of the three locations carries about 700 to 800 vehicles per hour (vph). When the mainline traffic demand is high (e.g., 7,000 vph), a bottleneck condition and traffic congestion typically forms. Although this condition was not observed at Brookhurst Street or Euclid Street on any of the field visits during either peak hours, it was observed on several occasions at Harbor Boulevard, as evident in the inset pictures. Data analysis suggests that bottleneck and congestion occurred at all three locations at various times throughout 2008.

Exhibit 5-1: Eastbound SR-22 ML at Brookhurst St, Euclid St, and Harbor Blvd On

<u>Fairview Street On (mainline lane drop)</u>

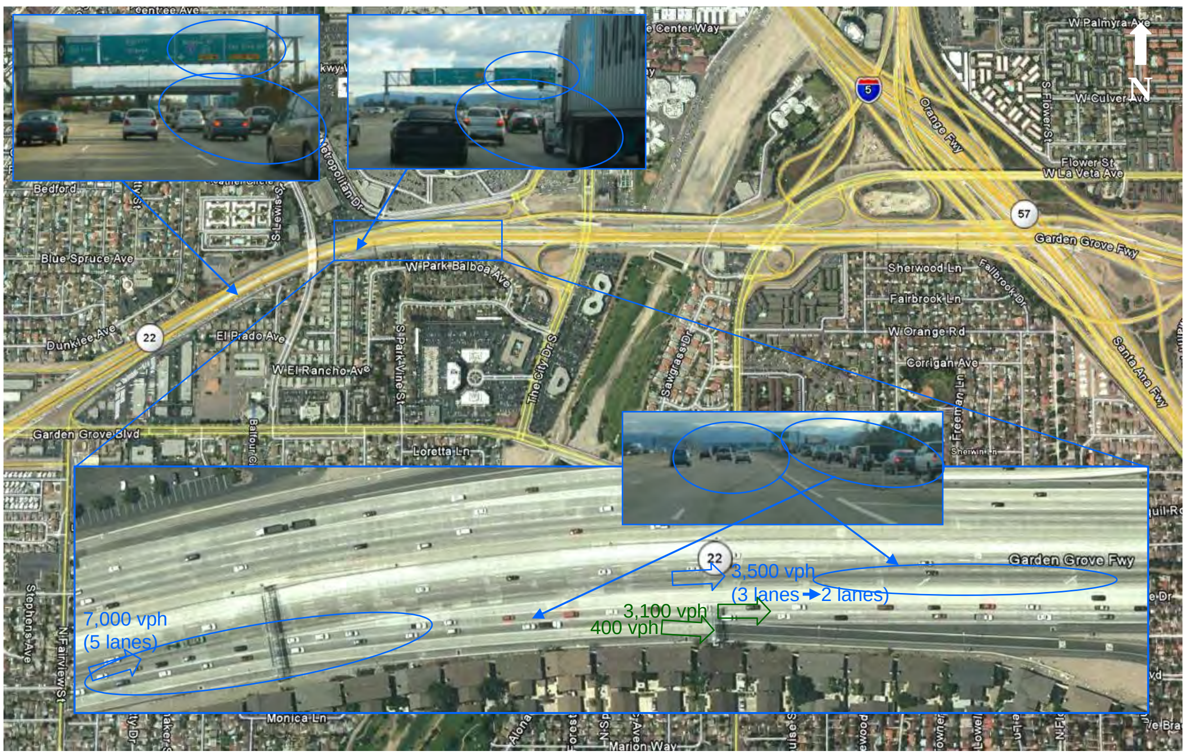
Exhibit 5-2 is an aerial photograph of the eastbound SR-22 mainline at the Fairview Street on-ramp leading on to the I-5 freeway interchange. As indicated, the mainline begins to drop a lane from four lanes to three with auxiliary lane markings (elephant tracks) signifying the lane drop and approaching exit. As a result, cross weaving occurs between the Fairview Street on-ramp traffic and mainline traffic bound for City Drive or I-5. As a result, the freeway mainline breaks down and results in the bottleneck condition and traffic congestion, as evident in the inset picture.

Exhibit 5-2: Eastbound SR-22 ML at Fairview Street and I-5 Interchange

City Drive/I-5 (mainline lane drop)

Exhibit 5-3 is an aerial photograph of eastbound SR-22 at the City Drive Interchange and approaching to the I-5 connector exits. As the exhibit illustrates, two lanes are separated from the mainline for the City Drive and I-5 bound traffic with an optional third lane. In addition, the outside lane is dropped on the mainline shortly past the separation from three lanes to two. The primary cause of the bottleneck, however, is the inability of the exit facility to accommodate the demand that exceeds 3,500 vph in two lanes, resulting in the congestion and queuing as evident in the inset pictures.

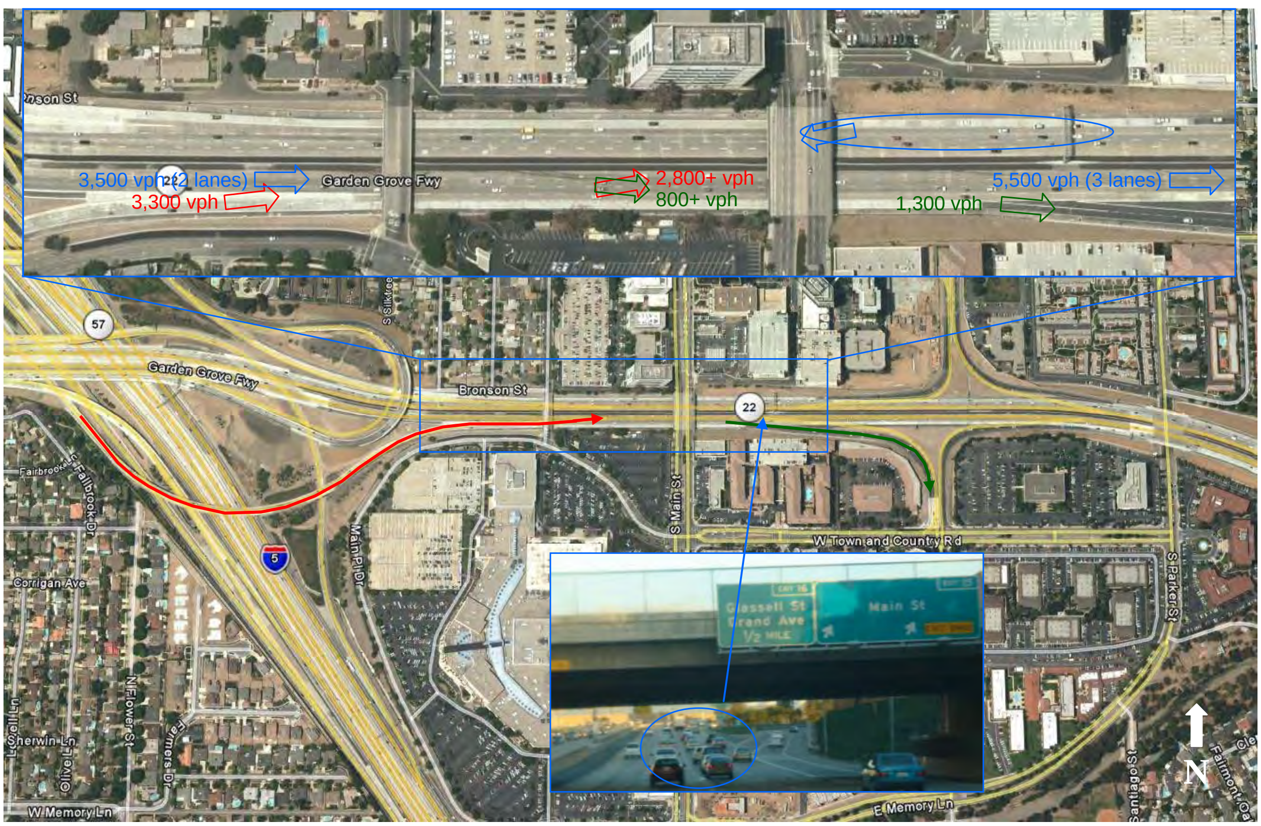
Exhibit 5-3: Eastbound SR-22 ML at City Drive and I-5 Interchange



<u>Southbound I-5 On/Town & Country Road (Main Street) Off</u>

Exhibit 5-4 is an aerial photograph of eastbound SR-22 between the southbound I-5 connector on-ramp and Town and Country Road off-ramp. As shown, the I-5 connector on-ramp adds over 3,300 vph onto the eastbound SR-22 mainline. Of the two lanes, the outer lane is an auxiliary lane to Town and Country Road exit. As a result, much of the connector on-ramp traffic must weave left, while the Town and Country exit traffic (nearly 1,300 vph) must weave right. This heavy cross-weaving of over 3,500 vehicles, causes the mainline traffic to breakdown, creating the bottleneck condition and resulting traffic congestion, as evident in the inset picture. Just past the Town and Country exit, the mainline flow is about 5,500 vph across 3 lanes. This equals 1,800 vphpl, which is near the threshold level.

Exhibit 5-4: Eastbound SR-22 ML at Southbound I-5 On/Town & Country Road Off



Westbound SR-22 ML Bottlenecks and Causes

Unlike the eastbound bottlenecks, which occur during both the AM and PM peaks, westbound bottlenecks and congestion typically occurs during the PM peak hours. The following is a summary of the westbound bottlenecks and the identified causes.

<u>Northbound I-5 On</u>

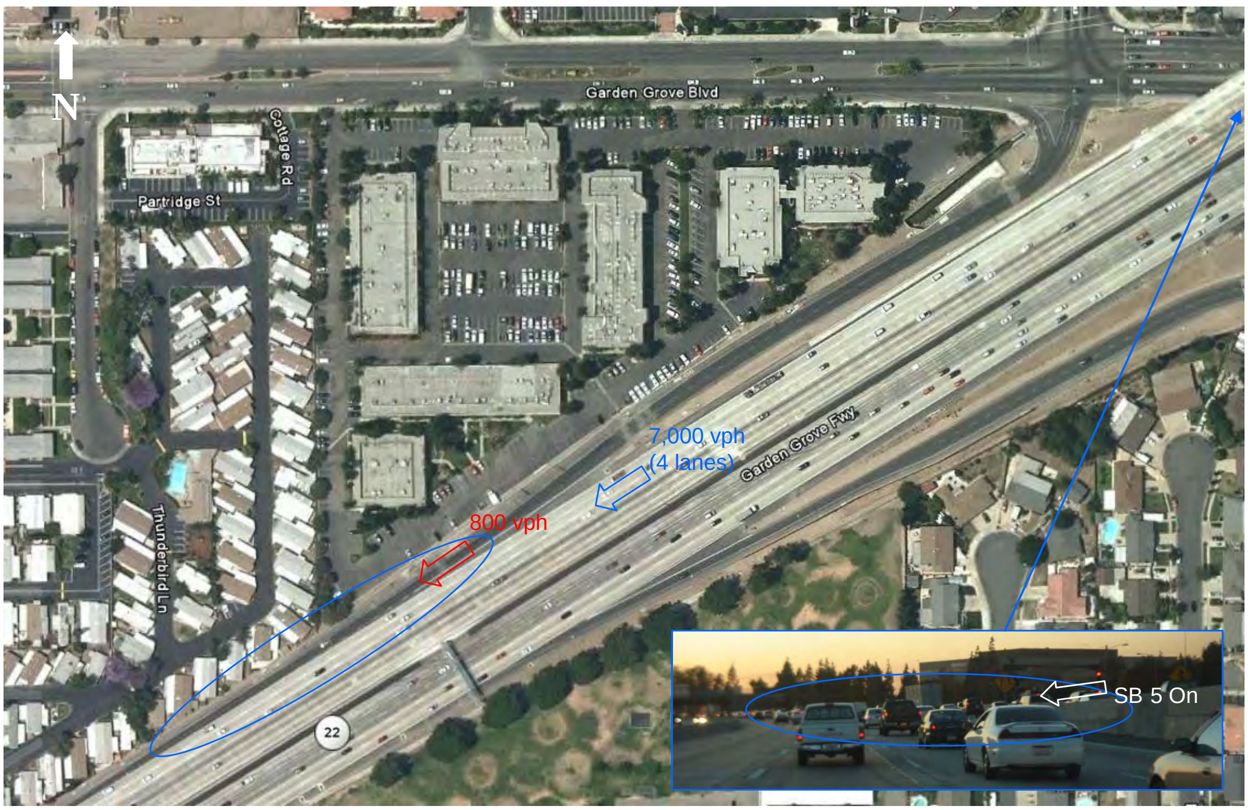
Exhibit 5-5 is an aerial photograph of the northbound I-5 mainline connector on-ramp to westbound SR-22. During the PM peak hours, the volume of traffic from SR-22 mainline is at about 4,500 vehicles per hour (vph) in 3 lanes or 1,500 vph per lane (vphpl). The northbound I-5 connector on-ramp adds typically about 500 vph during the peak hours, resulting in fairly heavy mainline traffic demand (nearly 1700 vphpl). Additionally, a downstream on-ramp from La Veta Avenue adds an additional 700 vph, resulting in a total of 5,700 vph on the mainline in 3 lanes or 1,900 vphpl, at the threshold level, often creating bottleneck conditions and traffic congestion.

Exhibit 5-5: Westbound SR-22 ML at Northbound I-5 On

Garden Grove Boulevard/Southbound I-5 On

Exhibit 5-6 is an aerial photograph of the Garden Grove Boulevard on-ramp to the westbound SR-22 mainline. As shown in the inset digital picture, significant congestion and queuing is evident from the southbound I-5 connector on-ramp. The mainline traffic cannot accommodate the additional demand from the two ramps. As indicated, with the I-5 connector ramp (over 1,300 vph) traffic the mainline currently carries over 7,000 vph during the PM peak hours. The on-ramp from Garden Grove Boulevard adds over 800 vph to this total, resulting in over 7,800 vph in four mainline lanes or over 1,900 vphpl at the threshold levels, often resulting in bottleneck conditions and traffic congestion.

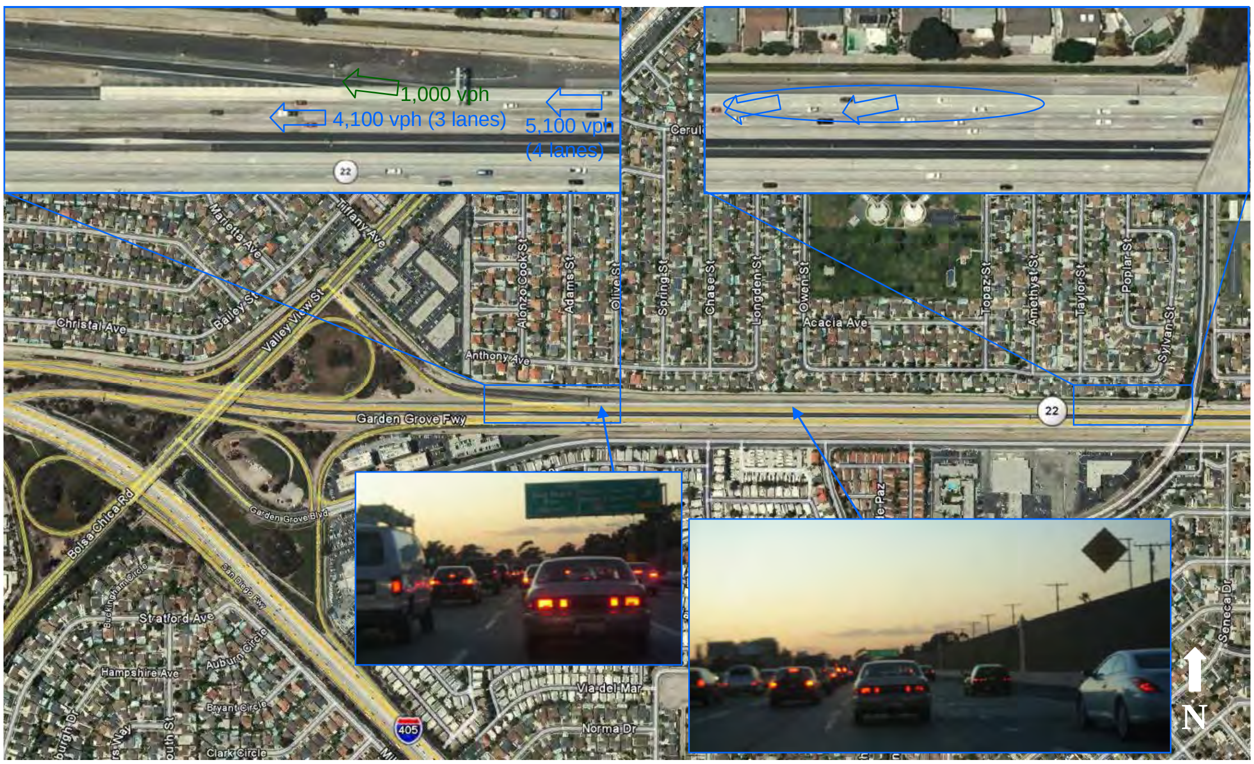
Exhibit 5-6: Westbound SR-22 ML at Garden Grove Blvd/Southbound I-5 On



<u>Valley View Street (access to Southbound I-405) Off</u>

Exhibit 5-7 is an aerial photograph of the Valley View Street off-ramp from westbound SR-22. Because of a missing freeway to freeway connector between westbound SR-22 and southbound I-405, traffic bound for southbound I-405 must exit at Valley View Street from westbound SR-22 freeway and re-enter the southbound I-405 freeway at the Bolsa Chica Road on-ramp. To accommodate this, the westbound SR-22 mainline dedicates the fourth lane to the Valley View Street exit, resulting in a lane drop from four lanes to three lanes. As a result, weaving occurs from the outer lanes to the inside lanes, creating the bottleneck condition and traffic congestion, as evident in the inset pictures.

Exhibit 5-7: Westbound SR-22 ML at Valley View Street Off



<u>Valley View Street On</u>

Exhibit 5-8 is an aerial photograph of the Valley View Street on-ramp to westbound SR-22. As illustrated traffic from two Valley View Street on-ramps merges into one before merging with the westbound SR-22 mainline. As indicated, combined, over 1,000 vph ramp traffic merges with the mainline. Also, the combined ramp lane and the loop ramp are not metered, often resulting in platoon merging at the mainline, creating the bottleneck condition and resulting in traffic congestion.

Total, the mainline traffic with the ramp traffic is over 5,000 vph in 3 lanes or nearly 1,700 vphpl, approaching the threshold level. Platoon merging at this level is likely to result in a breakdown of the mainline traffic flow.

Since the Valley View on- and off-ramps are located so closely in proximity to each other with detectors that are less than 0.2 miles apart, the previous bottleneck analysis did not analyze the bottleneck area between the Valley View off-ramp and on-ramp.

Exhibit 5-8: Westbound SR-22 ML at Valley View Street On

Northbound I-405 On

Exhibit 5-9 is an aerial photograph of the westbound SR-22 mainline merge with the northbound I-405 mainline. As indicated the westbound SR-22 mainline carries approximately 5,000 vph in three lanes while the northbound I-405 mainline carries approximately 8,000 vph in five lanes typically on most heavy weekdays.

The westbound SR-22, however, drops a lane from three lanes to two. Two lanes cannot accommodate 5,000 vph, resulting in the bottleneck condition and traffic congestion. Moreover, the traffic from the westbound SR-22 begins actively weaving into the northbound I-405 lanes, also impacting the I-405 traffic and thereby also creating congestion there. Just past the lane drop, the combined freeways reach a total traffic flow of over 13,000 vph across seven lanes. This is nearly 1,900 vphpl, which is near the threshold level.

Exhibit 5-9: Westbound SR-22 ML at Northbound I-405

Northbound I-405 ML Bottlenecks and Causes

Major northbound bottlenecks and congestion often occurs during both AM and PM peak hours. The following is a summary of the northbound bottlenecks and the identified causes.

Sand Canyon Off

Exhibit 5-10 is an aerial photograph of the northbound I-405 mainline at the Sand Canyon Avenue interchange. During the AM peak hours, the mainline traffic can reach 9,000 vph in five lanes. Immediately past the off-ramp to Sand Canyon Avenue (with about 400 vph), a lane drop occurs, from five to four lanes for the mainline traffic of over 8,600 vph. Four lanes cannot accommodate this amount of traffic. As a result, bottleneck and congestion occurs at this location, as evident in the inset pictures.

Exhibit 5-10: Northbound I-405 ML at Sand Canyon Avenue

Jeffrey Road On

Exhibit 5-11 is an aerial photograph of the northbound I-405 mainline at the Jeffrey Road interchange. As shown, there are back-to-back on-ramp merges with a combined flow of over 1,500 vph during the AM peak hours. While both ramps are metered, the westbound ramp allows over 1,200 vph (via two metered lanes), resulting in a platoon of vehicles merging onto the mainline, causing the bottleneck condition and traffic congestion, as evident in the inset picture. The mainline flow is near 7,700 vph in four lanes. The mainline cannot accommodate the additional 1,500 vph of traffic.

Exhibit 5-11: Northbound I-405 ML at Jeffrey Road On

SR-73/Fairview Road On

Exhibit 5-12 is an aerial photograph of the northbound I-405 mainline at the SR-73 connector on-ramp and Fairview Road on-ramp. As illustrated, the SR-73 connector ramp adds to the mainline approximately 3,300 vph in three lanes that reduces into two lanes further downstream. In addition, the Fairview Road on-ramp near the crest of the uphill grade adds another 500 vph to the mainline, bringing the total to 11,000 vph in six lanes or over 1,800 vphpl on an uphill grade, often resulting in the bottleneck condition and traffic congestion, as evident in the inset picture.

Exhibit 5-12: Northbound I-405 ML at SR-73/Fairview Road On

Euclid Street On/Brookhurst Street Off

Exhibit 5-13 is an aerial photograph of the northbound I-405 at Euclid Street and Brookhurst Street interchanges. At the Euclid Street off-ramp, one of the lane additions from the SR-73 connector is dropped at the exit, going from six lanes to five, with heavy off-ramp traffic often exceeding 1,400 vph. Between the Euclid Street on-ramp and the Brookhurst Street off-ramp, another lane is dropped from five lanes to four, forcing about 6,500 cars to be squeezed in. Although the mainline flow has not reached the threshold level (existing level is 8,000 vph in five lanes or 1,600 vphpl), the weaving results in the bottleneck condition and traffic congestion, as evident in the inset pictures. This condition is more pronounced when the mainline demand is higher.

Exhibit 5-13: Northbound I-405 ML at Euclid Street On/Brookhurst Street Off

Brookhurst Street On

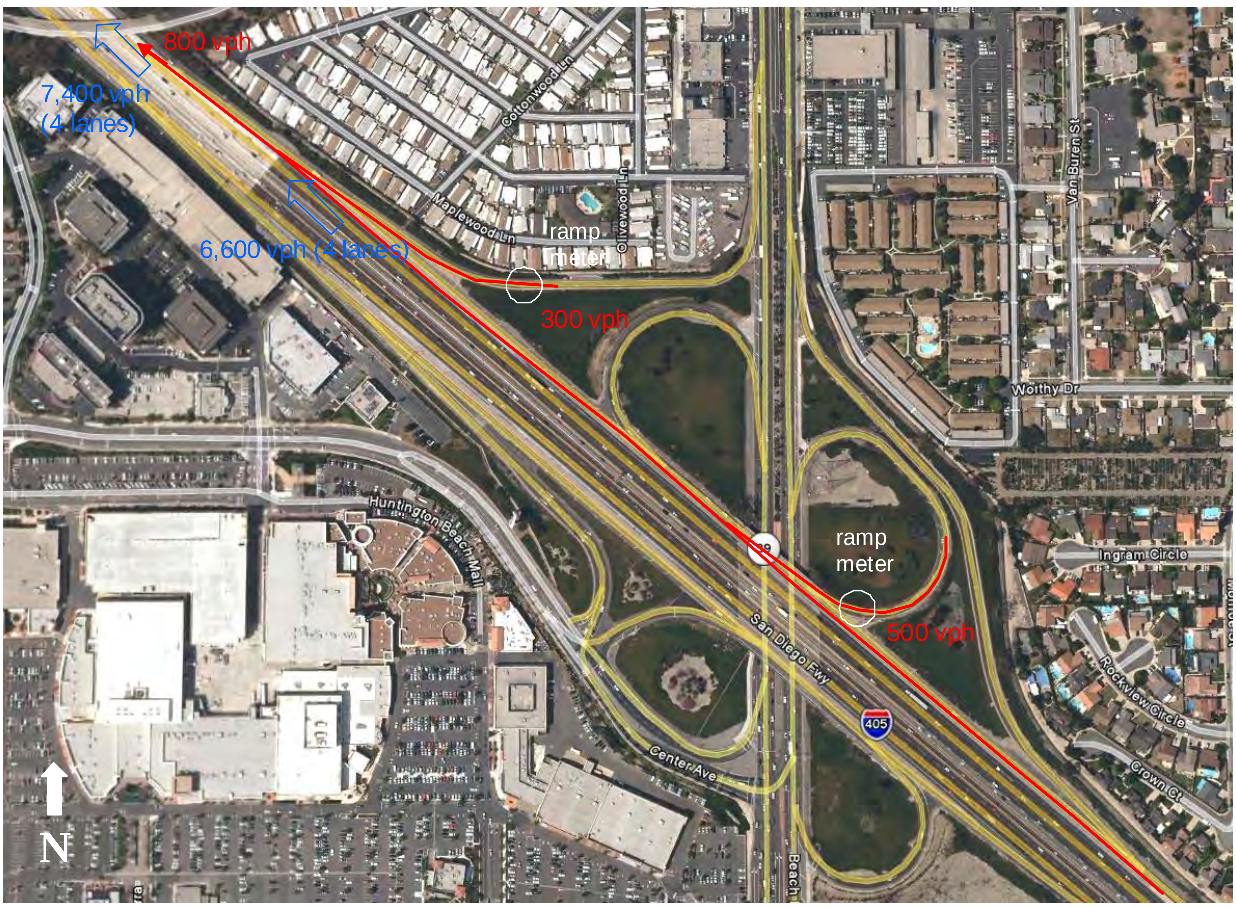
Exhibit 5-14 is an aerial photograph of the northbound I-405 at the Brookhurst Street on-ramp. As illustrated, this interchange includes a collector/distributor. While both on-ramps from Brookhurst Street are metered, the collector/distributor is not. As a result, platoons of vehicles merge onto the freeway mainline, causing mainline traffic flow to breakdown. This creates bottleneck conditions and traffic congestion. For much of the time during the PM peak hours, the steady stream of vehicles (platoons) merges onto the freeway, as shown on the inset pictures. With the added ramp traffic, the mainline facility cannot accommodate a total demand of over 7,800 vph or 1,950.

Exhibit 5-14: Northbound I-405 ML at Brookhurst Street On

Beach Boulevard (SR-39) On

Exhibit 5-15 is an aerial photograph of the northbound I-405 at the Beach Boulevard interchange. Although the operational issues are not as significant, the condition at this interchange is similar to the Brookhurst Street interchange with the collector/distributor. The flow from the ramps is less at about 800 vph combined. The extent and magnitude of the bottleneck condition and congestion are also less at this location than at Brookhurst Street, mainly because the bottleneck at Brookhurst Street reduces the traffic demand at Beach Boulevard. If the bottleneck at Brookhurst Street were eliminated, the Beach Boulevard bottleneck would be exacerbated.

Exhibit 5-15: Northbound I-405 ML at Beach Boulevard (SR-39) On



SR-22 On

Exhibit 5-16 is an aerial photograph of the northbound I-405 at the SR-22 on-ramp. As the exhibit illustrates, the SR-22 ramp drops a lane, just as it merges, from three lanes to two for 5,000 vph of traffic. Since the two lanes cannot accommodate the 5,000 vph of traffic, congestion builds quickly and traffic moves over onto the I-405 mainline, causing the I-405 to breakdown also. After the lane drop, the total flow on the freeway is over 13,000 vph in seven lanes or over 1,850 vphpl. This is near the breaking point or threshold level. With the merging and weaving, the bottleneck condition is created and congestion results.

Exhibit 5-16: Northbound I-405 ML at SR-22 On

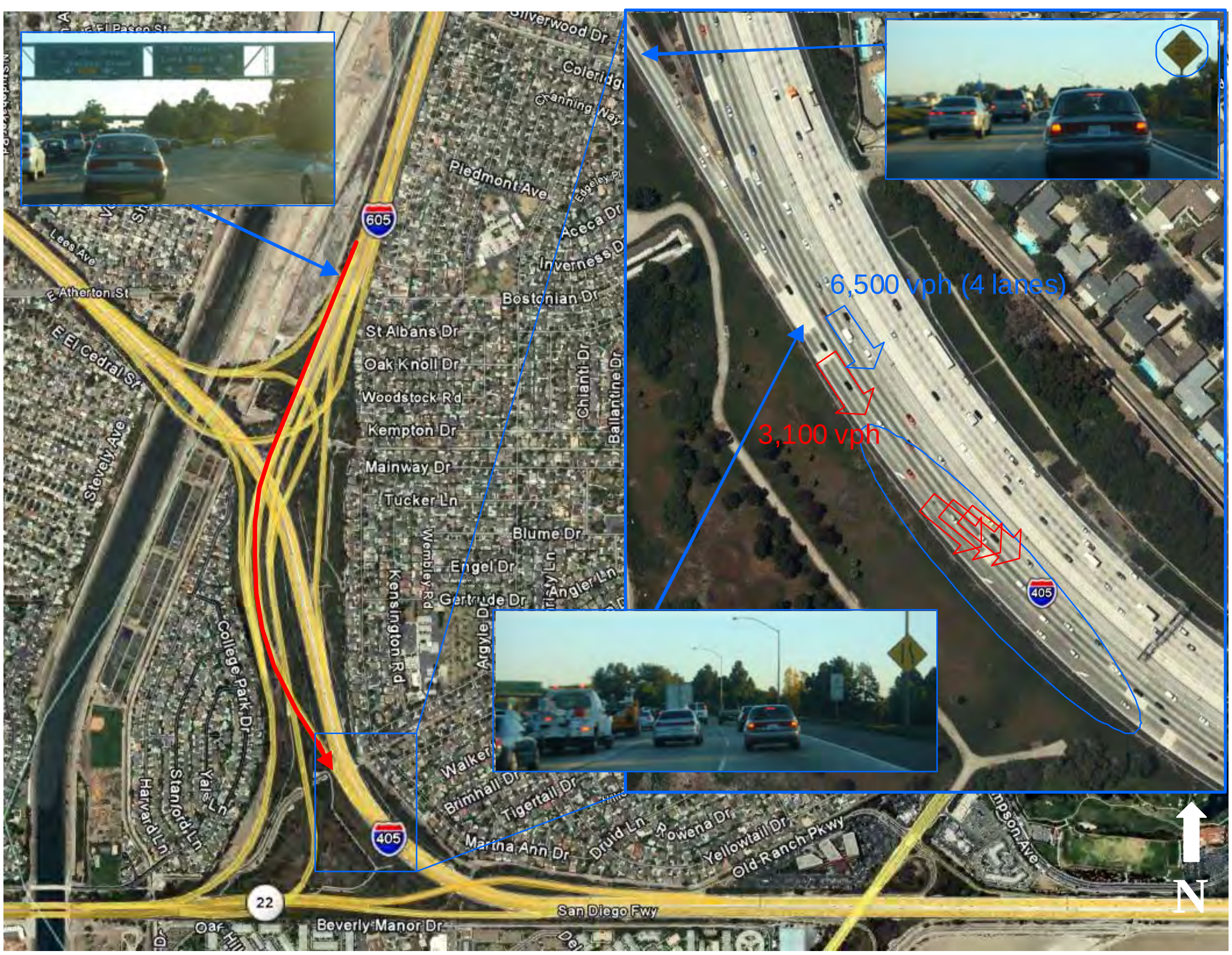
Southbound I-405 ML Bottlenecks and Causes

Major southbound bottlenecks and accompanying congestion often occur during both the AM and PM peak hours. The following is a summary of the southbound bottlenecks and the identified causes.

<u>I-605 On</u>

Exhibit 5-17 is an aerial photograph of the southbound I-405 mainline at the I-605 connector on-ramp. As shown in the inset photos, significant congestion is evident on both the I-605 connector and the I-405 mainline at the merge. The main cause of this bottleneck is the lane drop that occurs at the merge reducing the total lanes from six lanes to five. As the ramp traffic merges over to the left, the mainline flow breaks down and results in the bottleneck condition at this location.

Exhibit 5-17: Southbound I-405 ML at I-605 On



<u>Seal Beach On</u>

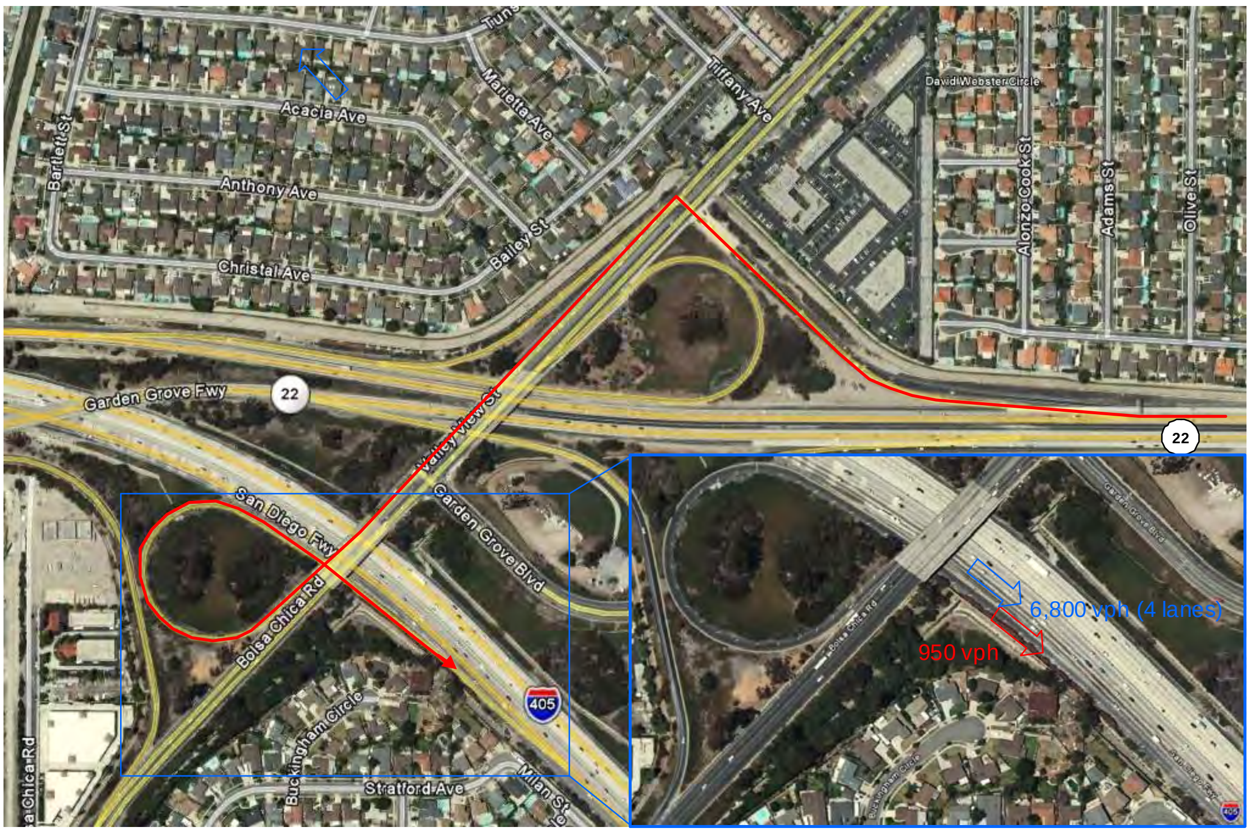
Exhibit 5-18 is an aerial photograph of the southbound I-405 mainline at the Seal Beach Boulevard interchange and SR-22 interchange. Although this is not a major bottleneck location and congestion was not observed on any of the field visits, data analysis indicates existing bottleneck conditions and traffic congestion. It is likely that the main cause of this bottleneck is due to the cross-weaving of the Seal Beach Boulevard on-ramp traffic and SR-22 off-ramp traffic.

Exhibit 5-18: Southbound I-405 ML at Seal Beach On

Bolsa Chica/Valley View Road (SR-22) On

Exhibit 5-19 is an aerial photograph of the southbound I-405 mainline at the Bolsa Chica Road interchange. Traffic from the westbound SR-22 typically exits at Valley View Street and re-enters the I-405 freeway at Bolsa Chica Road interchange. Nearly 1,000 vph enters the freeway at this location. This is also not a major bottleneck location and congestion was not observed on any of the field visits, but data analysis indicates existing bottleneck conditions and traffic congestion. Depending on the mainline demand, it is likely that the bottleneck condition occurs when the mainline demand is high (near or above 7,000 vph).

Exhibit 5-19: Southbound I-405 ML at Bolsa Chica Road (SR-22) On



Beach Boulevard (SR-39)/Edinger Avenue On

Exhibit 5-20 is an aerial photograph of the southbound I-405 at the Beach Boulevard (SR-39) on-ramp and Edinger Avenue on-ramp. As shown, the Beach Boulevard interchange has a collector/distributor. Although the westbound (southbound) Beach Boulevard loop on-ramp is metered, the collector/distributor is not. Over 900 vph are added to the mainline from this ramp. Shortly past this merge point, is another on-ramp merge from Edinger Avenue. Additional 900 vph metered traffic are also added to the freeway mainline, resulting in nearly 7,900 vph in four lanes. This is very close to threshold traffic and results a bottleneck condition.

Exhibit 5-20: Southbound I-405 ML at Beach Boulevard (SR-39)/ Edinger Avenue On

<u>Warner Avenue On</u>

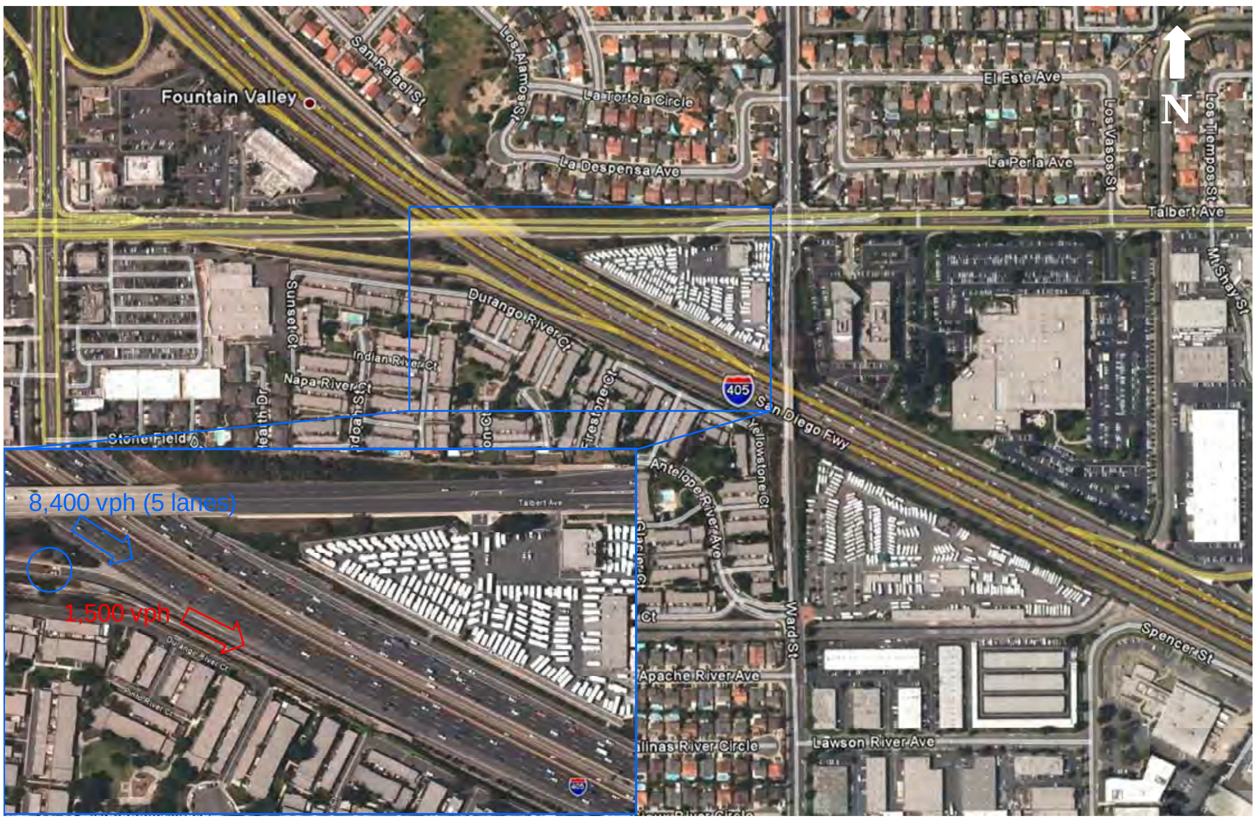
Exhibit 5-21 is an aerial photograph of the southbound I-405 mainline at the Warner Avenue on-ramp. As shown in the inset picture, there is a surge of demand (over 1,000 vph) from the on-ramp, which enters the freeway as platoons. This location is the most significant bottleneck on this corridor, with queues extending for many miles. Also indicated in the inset picture are higher speeds and separation of vehicles just past the on-ramp merge point. With mainline flow exceeding 7,400 vph in four lanes, the mainline cannot accommodate additional 1,000 vehicles of traffic.

Exhibit 5-21: Southbound I-405 ML at Warner Avenue On

Talbert Avenue On

Exhibit 5-22 is an aerial photograph of the southbound I-405 mainline at the Talbert Avenue on-ramp. With two lanes metered, the on-ramp flow merging onto the freeway often reaches 1,500 vph during the peak hours. With the mainline already at 8,400 vph approaching the ramp, the five freeway lanes cannot accommodate the total combined flow of nearly 10,000 vph. A bottleneck condition results.

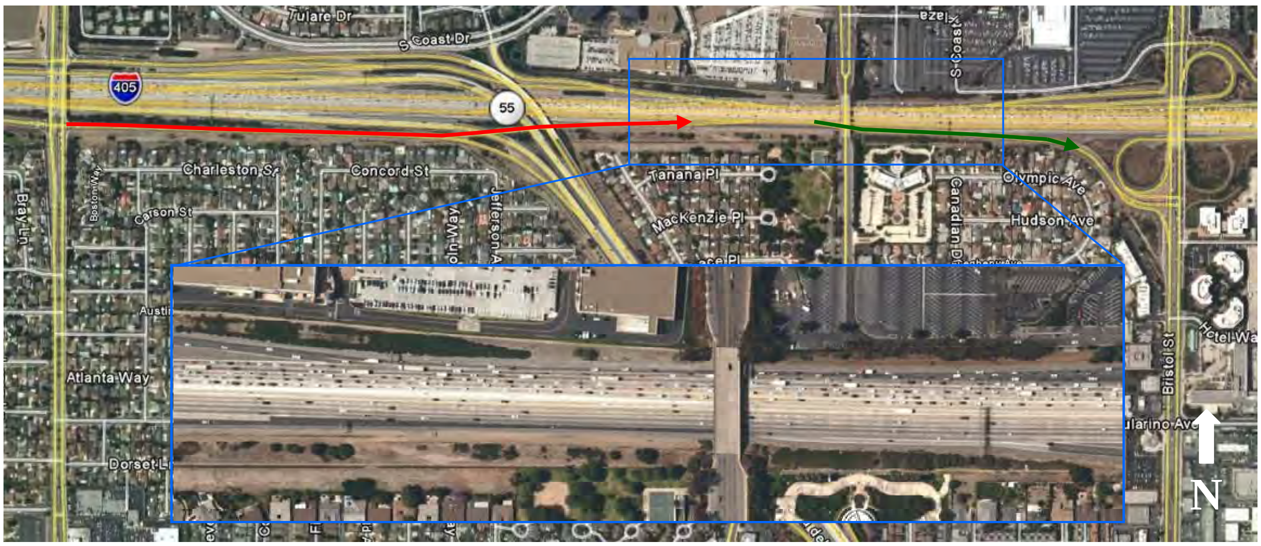
Exhibit 5-22: Southbound I-405 ML at Talbert Avenue On



Fairview Road On/Bristol Street Off

Exhibit 5-23 is an aerial photograph of the southbound I-405 mainline between the Fairview Road on-ramp and Bristol Street off-ramp. As indicated, over 2,500 vph cross-weaves along the 1,000-foot stretch of freeway segment between the two ramps. This condition often results in a bottleneck and ensuing traffic congestion.

Exhibit 5-23: Southbound I-405 ML at Fairview Road On/Bristol Street Off



SR-55 On/MacArthur Boulevard Off

Exhibit 5-24 is an aerial photograph of the southbound I-405 mainline between the SR-55 connector on-ramps and MacArthur Boulevard off-ramp. As indicated in the picture, a sequence of consecutive SR-55 connector ramps add over 2,300 vph. The MacArthur Boulevard off-ramp carries as much as 2,500 vph during the AM peak hours. As a result, significant cross-weaving occurs at this location and often causes a bottleneck condition to occur resulting in traffic congestion.

Exhibit 5-24: Southbound I-405 ML at SR-55 On/MacArthur Boulevard Off

<u>Culver Drive On</u>

Exhibit 5-25 is an aerial photograph of the southbound I-405 mainline at the Culver Drive interchange. With back-to-back on-ramp merges for a combined flow of over 1,100 vph, the mainline cannot accommodate the nearly 8,000 vph in four lanes, creating the bottleneck condition at this location and resulting in traffic congestion.

Exhibit 5-25: Southbound I-405 ML at Culver Drive On

Jeffrey Road/University Drive On

Exhibit 5-26 is an aerial photograph of the southbound I-405 mainline at the University Drive interchange. A series of on-ramp merges produce a combined flow of over 1,300 vph. The mainline cannot accommodate the over 8,200 vph in four lanes, creating the bottleneck condition at this location and resulting in traffic congestion. The two metered lanes that allow over 1,100 vph to merge onto the freeway results in a platoon of vehicles merging and traffic congestion on the mainline, as evident in the inset picture.

Exhibit 5-26: Southbound I-405 ML at University Drive On

Sand Canyon/Shady Canyon Avenue On

Exhibit 5-27 is an aerial photograph of the southbound I-405 mainline at the Shady Canyon Avenue interchange. When the mainline demand is heavy at over 7,500 vph in four lanes, the mainline cannot accommodate the additional demand of over 500 vph from the Shady Canyon Avenue on-ramp, resulting in the bottleneck condition.

Exhibit 5-27: Southbound I-405 ML at Culver Drive On

Southbound I-605 ML Bottleneck and Cause

Congestion and bottleneck conditions occur on the I-605 study corridor during the PM peak only. Although northbound congestion also exists on I-605, it is beyond the limits of the study.

<u>Southbound I-405 On</u>

Exhibit 5-28 is an aerial photograph of the southbound I-605 mainline connector on-ramp to the southbound I-405 freeway. During the PM peak hours, the traffic from the I-605 at about 3,100 vph merges with the southbound I-405 traffic carrying about 6,500 vph in 4 lanes, for a total of over 9,600 vph in five lanes, as the outer lane is dropped. This lane drop results in the mainline traffic over the threshold level creating the bottleneck condition and resulting traffic congestion, as evident in the inset pictures.

Exhibit 5-28: Southbound I-605 ML at Southbound I-405

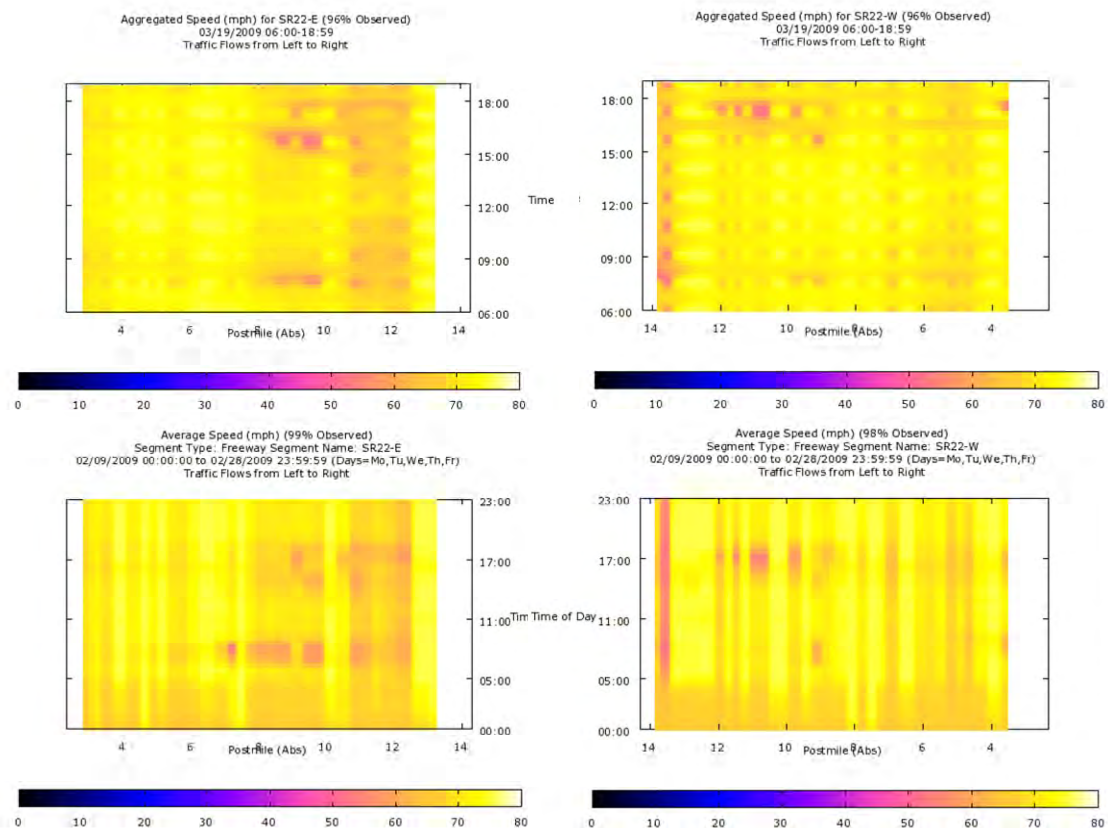
HIGH-OCCUPANCY VEHICLE (HOV) FACILITY

Bottleneck and causality analyses were also conducted for the HOV facilities on SR-22 and I-405. The bottleneck locations on the HOV facility were initially determined based on PeMS data analysis and later verified by multiple field reviews that confirmed the actual bottleneck locations and identified the causes. The HOV facility along the SR-22 Corridor is contiguous and operates on a full-time basis with a vehicle occupancy requirement of two plus (2+) in both directions. Similarly, the HOV facility along the I-405 operates on a full-time basis with a vehicle occupancy requirement of two plus (2+) in both directions, but is buffer-separated from the mainline facility in varying widths. The I-605 Corridor in Orange County does not comprise an HOV facility. The proceeding section describes the bottleneck locations and the causes for the bottlenecks that were verified on the SR-22 and I-405 HOV facilities.

SR-22 HOV Facility Bottlenecks and Causes

PeMS data analysis and multiple field reviews conducted in February and March 2009 during the weekday peak period confirm that there are no bottlenecks or traffic congestion on SR-22 in either direction of the HOV facility. Exhibit 5-29 shows the PeMS speed contours of the HOV lanes in both directions. These speed contours indicate speeds well above 50 miles per hour during all hours of the day for the sample day in March 2009 and the average of multiple weekdays in the last three weeks of February 2009. This sample period is based on excellent data quality.

Exhibit 5-29: Eastbound and Westbound SR-22 HOVL PeMS Speed Contours



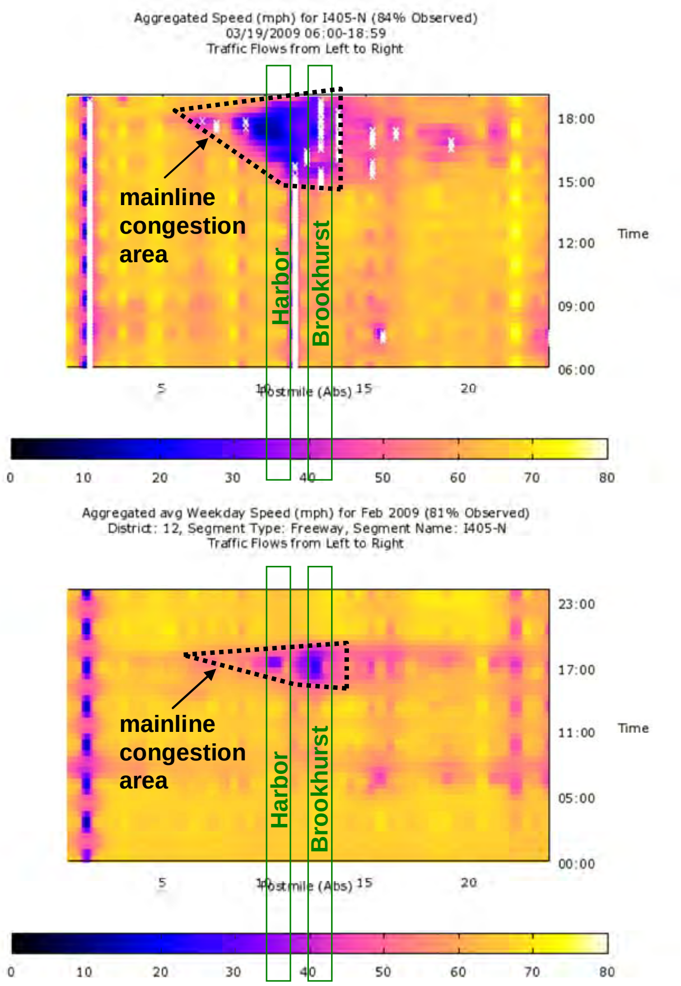
Northbound I-405 HOV Facility Bottlenecks and Causes

PeMS data analysis and multiple field reviews conducted in February and March 2009 during the weekday peak period confirm two major bottlenecks in the northbound direction at the following locations:

- Brookhurst Street ingress/egress (Caltrans postmile 13.5)
- Harbor Boulevard ingress/egress (Caltrans postmile 11.0)

These two bottleneck locations are caused by weaving traffic entering and exiting at the HOV lane ingress/egress areas during the peak hours. Exhibit 5-30 presents the PeMS speed contour diagram of the northbound I-405 HOV lane for a sample day in March 2009 and for an average of all weekdays in the month of February 2009. As indicated in the exhibit, the two bottleneck locations at the Brookhurst Street ingress/egress and at the Harbor Boulevard ingress/egress coincide within the mainline congestion area. As a result, the vehicles on the HOV lane that intend to exit the corridor must stop to squeeze into the mainline congested traffic stream. Similarly, the vehicles on the mainline which intend to enter the HOV lane must do so from a very low speed, disrupting the HOV lane flow. The HOV volume at these two locations exceeds 1,600 vehicles per hour (vph) during the PM peak hours, which is near the threshold or capacity level of 1,800 vph.

Exhibit 5-30: Northbound I-405 HOVL PeMS Speed Contours, 2009



Exhibits 5-31 and 5-32 are aerial photographs of the HOV lane ingress/egress areas of the Brookhurst Street and Harbor Boulevard bottleneck locations. When the mainline freeway is congested, vehicles have a difficult time entering and exiting the HOV lane. As a result, a bottleneck condition occurs and vehicles queue behind this location, as far back as 5 miles.

Exhibit 5-31: Northbound I-405 HOVL Ingress/Egress at Brookhurst Street

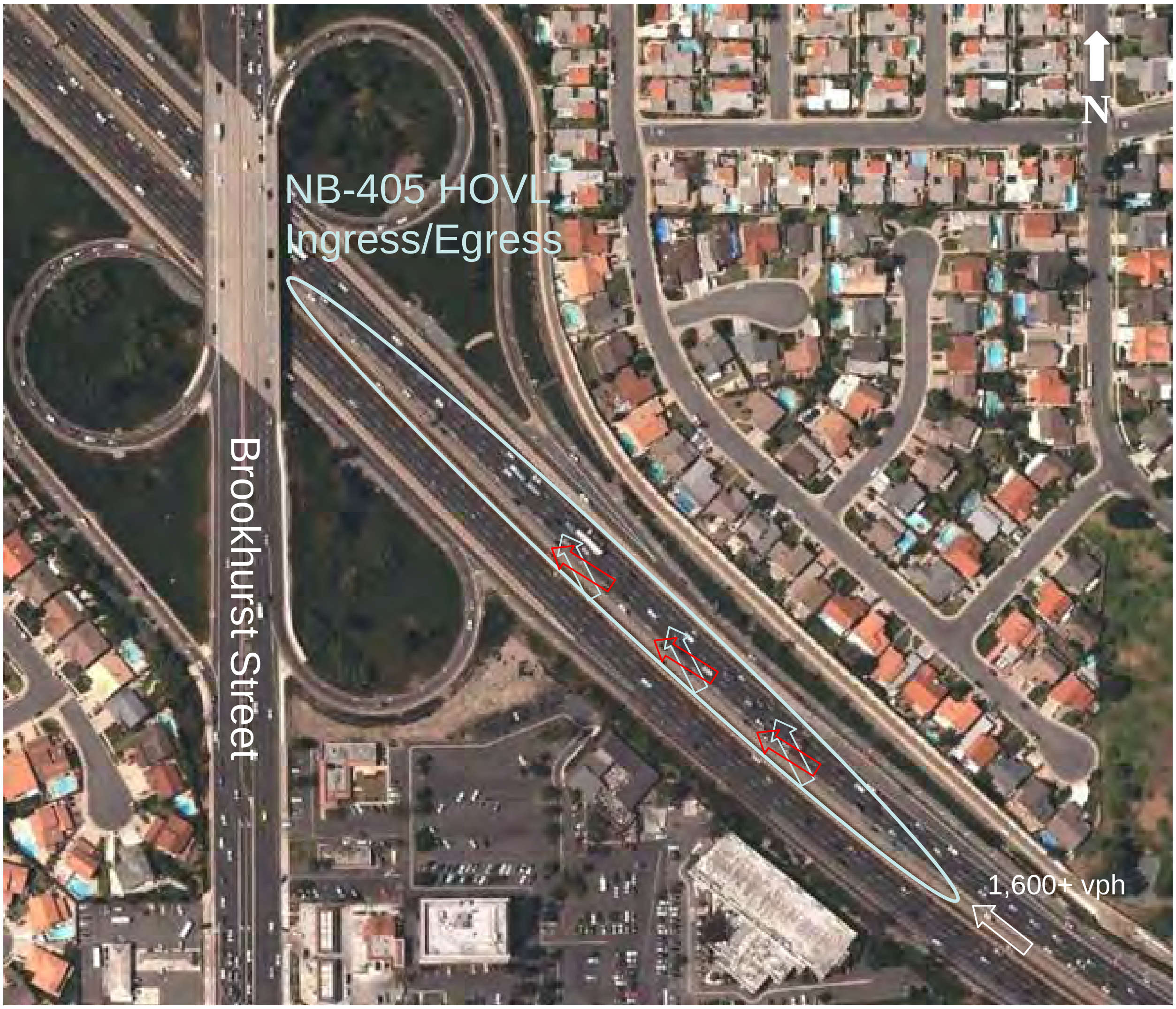


Exhibit 5-32: Northbound I-405 HOVL Ingress/Egress at Harbor Blvd

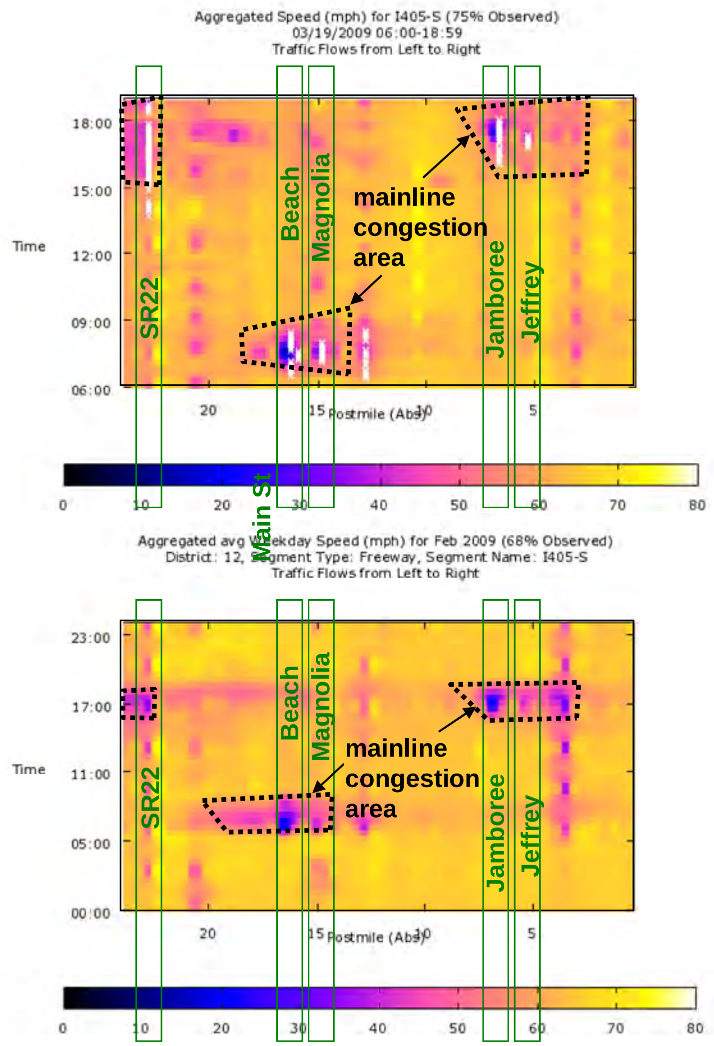
Southbound I-405 HOV Facility Bottlenecks and Causes

PeMS data analysis and multiple field reviews conducted in February and March 2009 during the weekday peak period confirm five major bottlenecks in the southbound direction at the following locations:

- Seal Beach Boulevard ingress/egress (Caltrans postmile 22.0)
- North of Beach Boulevard ingress/egress (Caltrans postmile 17.0)
- Magnolia Street ingress/egress (Caltrans postmile 15.0)
- South of Jamboree Road ingress/egress (Caltrans postmile 6.0)
- South of Culver Drive ingress/egress (Caltrans postmile 5.0)

These five bottleneck locations are caused by weaving traffic entering and exiting at the HOV lane ingress/egress areas during the peak hours. Exhibit 5-33 presents the PeMS speed contour diagram of the southbound I-405 HOV lane for a sample day in March 2009 and for an average of all weekdays in the month of February 2009. As indicated in the exhibit, all five bottleneck locations are within the mainline congestion area. As a result, the vehicles on the HOV lane that intend to exit the corridor must stop to squeeze into the mainline congested traffic stream. Similarly, the vehicles on the mainline which intend to enter the HOV lane must do so from a very low speed, disrupting the HOV lane flow. The HOV volumes at these locations vary from 1,500 vph to 2,100 vph during the peak hours, near or over the threshold capacity level of 1,800 vph. Also as indicated, the bottlenecks at Beach Boulevard and Magnolia Street occur during the AM peak hours, whereas the other three bottlenecks occur during the PM peak hours.

Exhibit 5-33: Southbound I-405 HOVL PeMS Speed Contours (2009)



Exhibits 5-34 to 5-38 are the aerial photographs of the bottleneck locations of the HOV lane ingress/egress areas at: Seal Beach Boulevard; north of Beach Boulevard; Magnolia Avenue; south of Jamboree Road; and south of Culver Drive. When the mainline freeway is congested, vehicles have a difficult time entering and exiting the HOV lane. As a result, bottleneck conditions occur and vehicles queue behind these locations. Peak hour volumes are near or exceed threshold capacity levels at all of these locations.

Exhibit 5-34: Southbound I-405 HOVL Ingress/Egress at Seal Beach Blvd

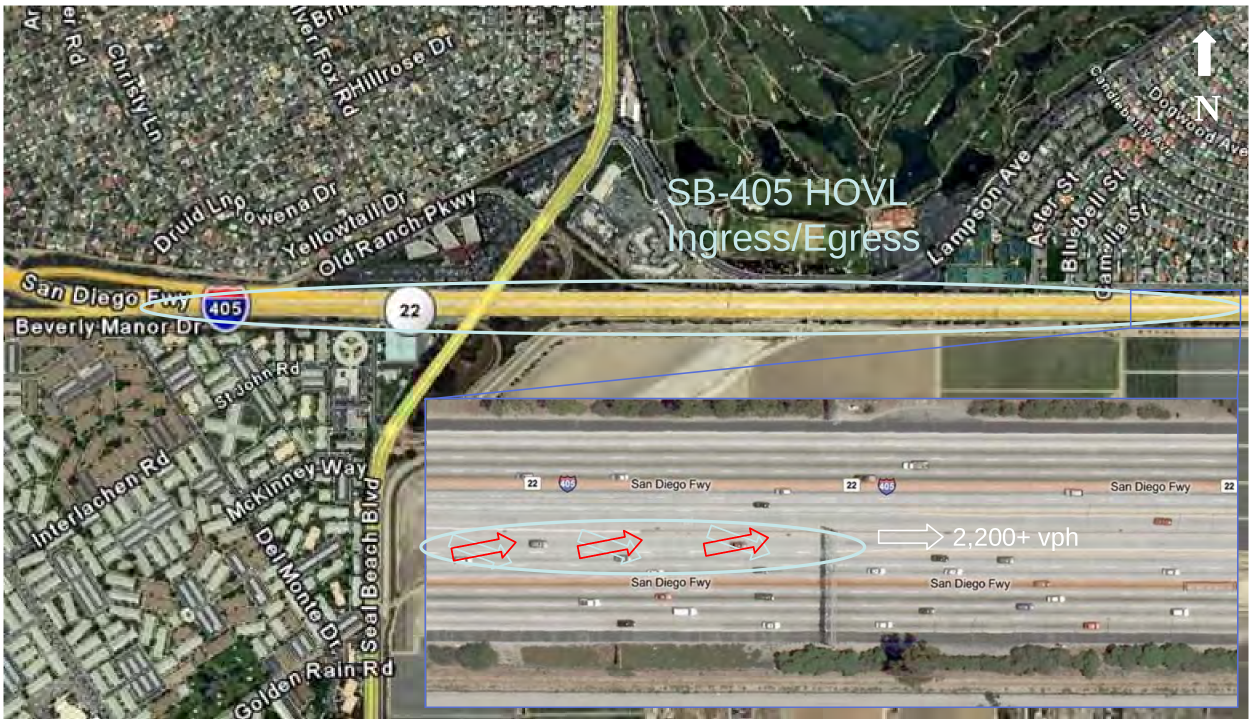


Exhibit 5-35: Southbound I-405 HOVL Ingress/Egress at Beach Blvd

Exhibit 5-36: Southbound I-405 HOVL Ingress/Egress at Magnolia Street

Exhibit 5-37: Southbound I-405 HOVL Ingress/Egress at South of Jamboree Road

Exhibit 5-38: Southbound I-405 HOVL Ingress/Egress at South of Culver Drive

I-605 HOV Lane Bottleneck and Cause

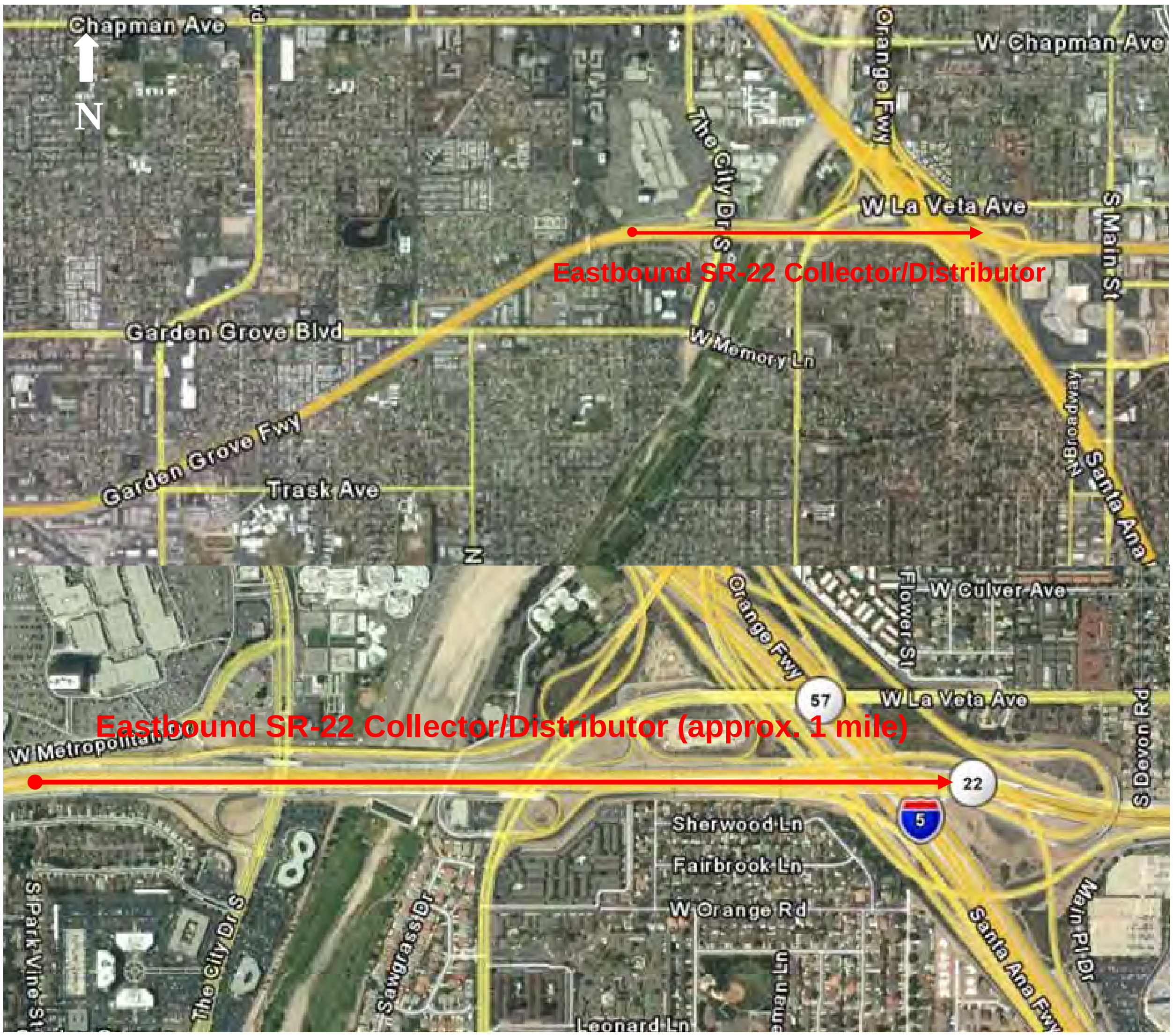
The I-605 Corridor in Orange County does not include an HOV facility as of 2009.

COLLECTOR/DISTRIBUTOR (C/D) FACILITY

Eastbound SR-22 C/D Facility Bottlenecks and Causes

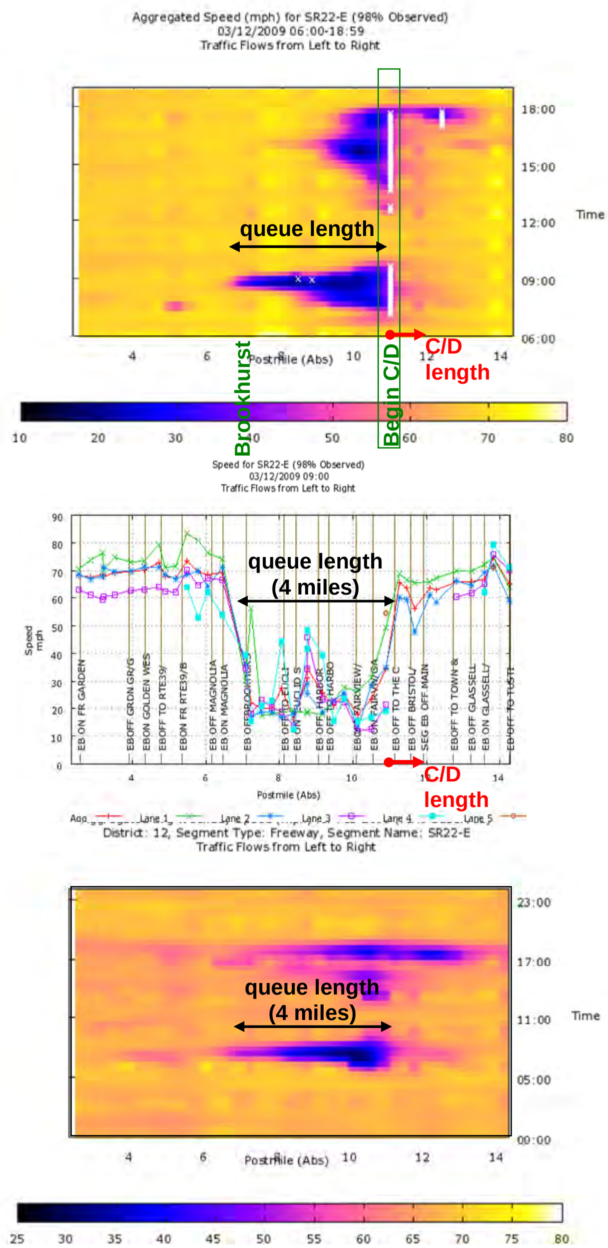
Bottleneck and causality analyses were also conducted for the collector/distributor (C/D) facility of SR-22 in the eastbound direction from City Drive to the SR-57 connector ramp. Exhibit 5-39 is an aerial photograph of the SR-22 C/D facility. The two-lane C/D is approximately one mile in length and runs from slightly west of the City Drive off-ramp to slightly east of the SR-57 connector off-ramp. Within the C/D, there are two interchanges – City Drive and Bristol Street – which interact with the C/D.

Exhibit 5-39: Eastbound SR-22 Collector/Distributor Section



During the AM and PM peak hours, the demand for the C/D is extremely heavy such that the entrance of the C/D does not have enough capacity to accommodate the demand. As a result, bottleneck conditions occur and significant congestion and queuing forms. Exhibit 5-40 presents the PeMS speed contour diagram and speed profile of the eastbound SR-22 mainline (not including C/D) for a sample day in March 2009 and for an average of all weekdays in the month of February 2009. As indicated the bottleneck causes over 4 miles of queuing to Brookhurst Street that lasts 3 hours, from 7AM to 10AM, in the AM peak and 4 hours, from 2PM to 6PM, in the PM peak, with speeds below 20 miles per hour.

Exhibit 5-40: Eastbound SR-22 PeMS Speed Contours, 2009



Exhibits 5-41 and 5-42 are aerial photographs of the C/D facility. The bottleneck section is from the C/D entrance to the southbound I-5 connector off-ramp. As shown, the bottleneck volume is around 3,900 vehicles per hour (vph) in 2 lanes and the output (C/D capacity) volume is over 4,100 vph in 2 lanes. The key bottleneck segment is the Bristol Street auxiliary lane that runs from the on-ramp to the southbound I-5 off-ramp. As indicated in Exhibit 5-42, the auxiliary lane is extremely short at 500 feet that services the Bristol Street on-ramp volume of over 1,500 vph and the I-5 off-ramp of over 1,500, during the AM peak hours. In addition to this 3,000 vehicles of cross-weaving, the I-5 connector off-ramp often queues back onto the C/D, in the AM peak. Traffic bound for the northbound I-5 and northbound SR-57, over 4,000 vph, must endure and pass through the congestion of the C/D, adding and contributing to the overall demand of the C/D. Without the C/D, this traffic could bypass the bottleneck stemming from the southbound I-5 connector off-ramp.

Exhibit 5-41: Eastbound SR-22 C/D

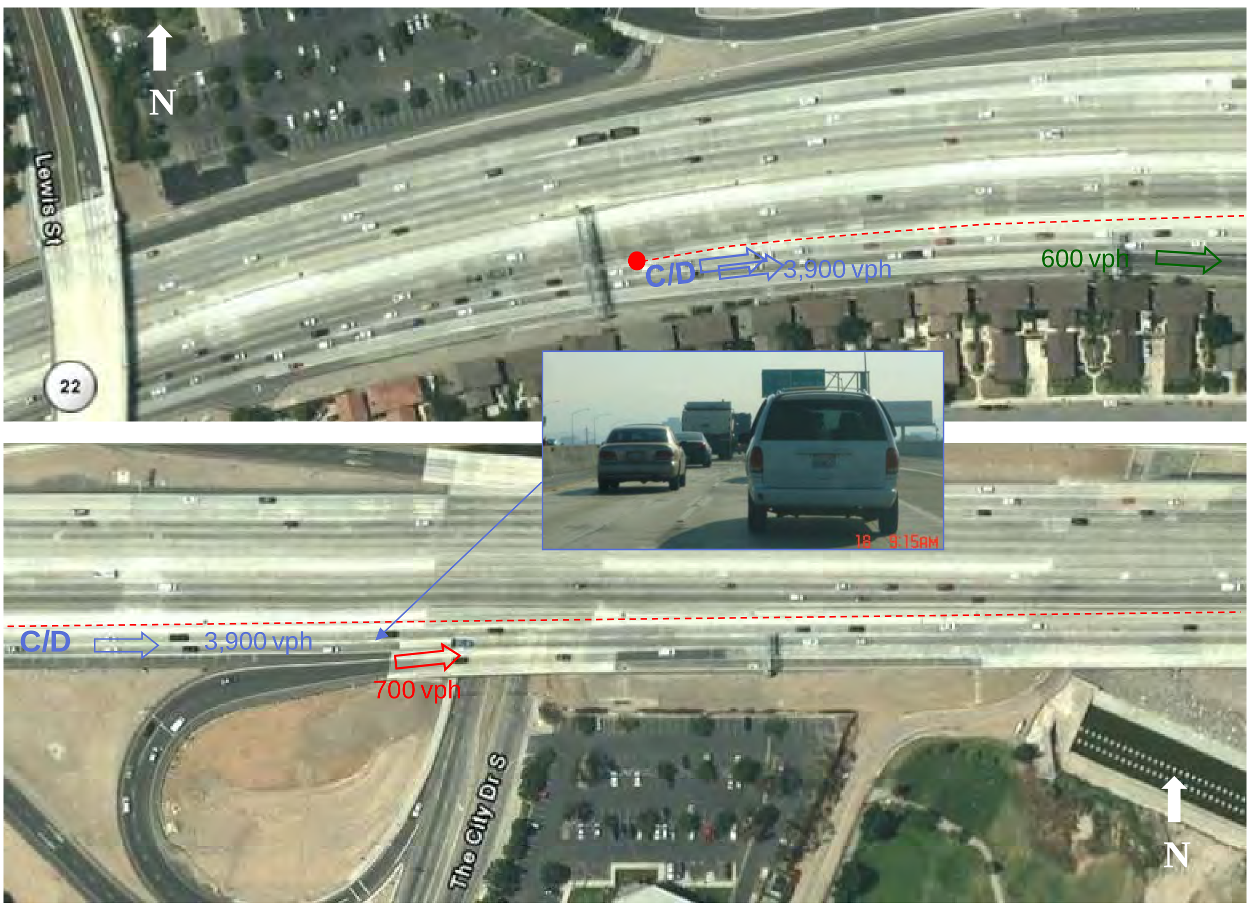
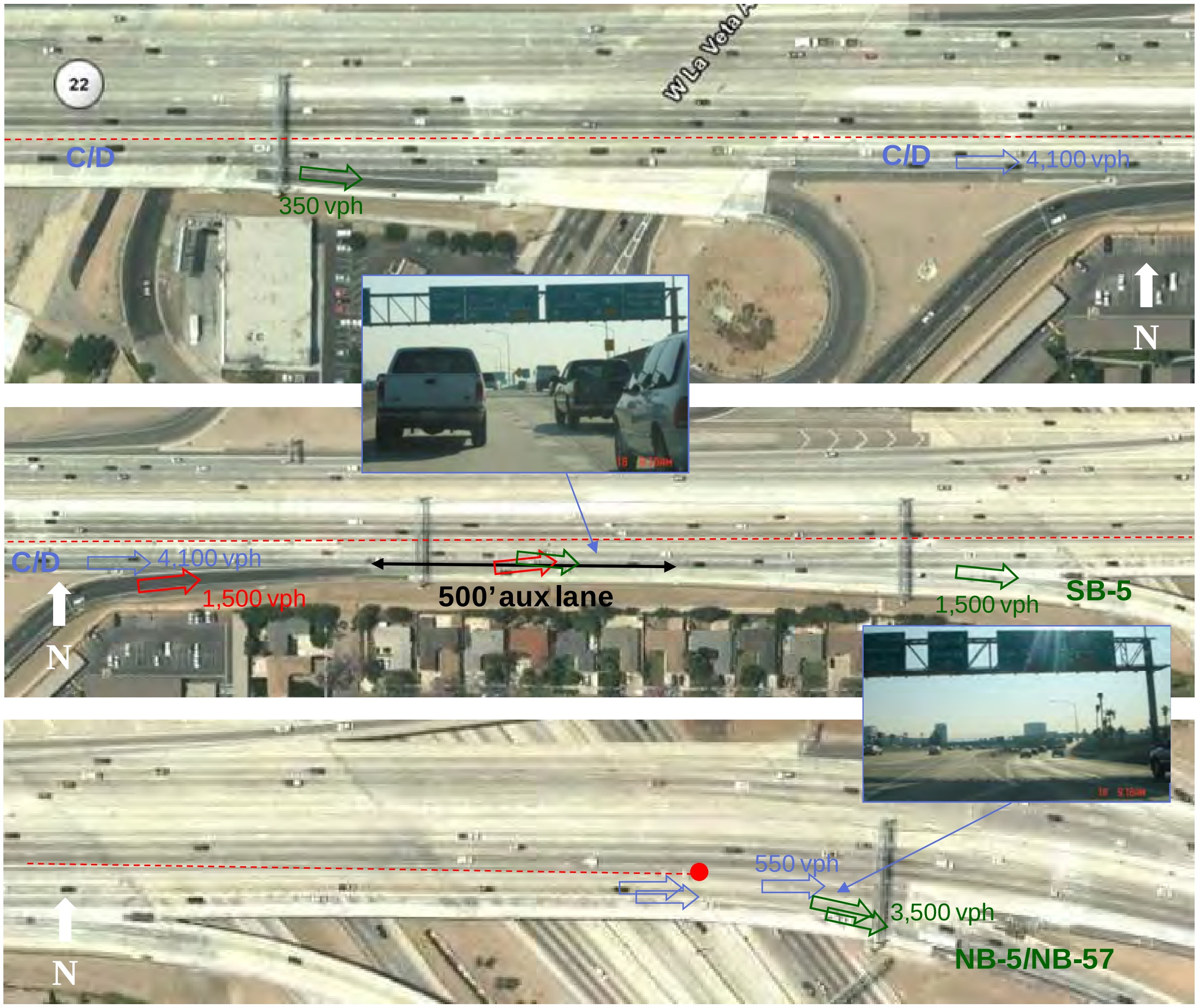


Exhibit 5-42: Eastbound SR-22 C/D



APPENDIX

Appendix A is an exact copy of Section 4 from the Preliminary Performance Assessment document submitted to Caltrans in May 2008 (with the exception that an "A" has been added to the exhibit numbers). It is included for reference purposes and also to allow future updates to this analysis. The analysis identified potential bottlenecks based on a number of data sources and very limited field observations. However, it represented the foundation for the conclusions in Section 4 of this Comprehensive Performance Assessment report, which built on the original findings and then revised and/or confirmed these conclusions with significant field observations and additional data analysis.

Appendix A: BOTTLENECK ANALYSIS

In this section, 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.

A variety of sources were used to identify bottlenecks. They include the following:

- Highway Congestion Monitoring Program (HICOMP) 2006 report;
- Probe vehicle (electronic tachograph) runs
  - *Caltrans District 12 tach runs*
- Freeway Performance Measurement System (PeMS)
  - *Speed contour plots*
  - *Flow data; and*
- Aerial photos.

HICOMP

In review of the Caltrans Highway Congestion Monitoring Program (HICOMP) Report, potential problem areas were initially identified. As illustrated in Exhibit A4-1 and A4-2, the downstream end of congested segments could potentially be bottleneck areas in the northbound direction, as outlined in red circles, and in the southbound direction, as outlined in blue circles.

- As indicated, northbound I-405 has potentially one major bottleneck location in the AM peak period, at Jamboree. In the southbound direction, there is potentially one major bottleneck in the AM peak period, at University Drive, and two in the PM peak period, at Newland Street and Laguna Canyon Road.
- The I-605 has a potential bottleneck location at the I-405 Interchange in both peak periods.
- For SR-22, no congestion or bottleneck was indicated in the 2006 HICOMP report.

Further analysis would be needed, however, to determine their actual locations and possibly any other bottlenecks along the corridor not identified in the HICOMP. The review of the HICOMP provides a good starting point to keep in mind of the congested areas and possible bottleneck locations as more detailed analysis is conducted.

Exhibit A4-1: 2006 HICOMP AM Congestion Map with Potential Bottlenecks

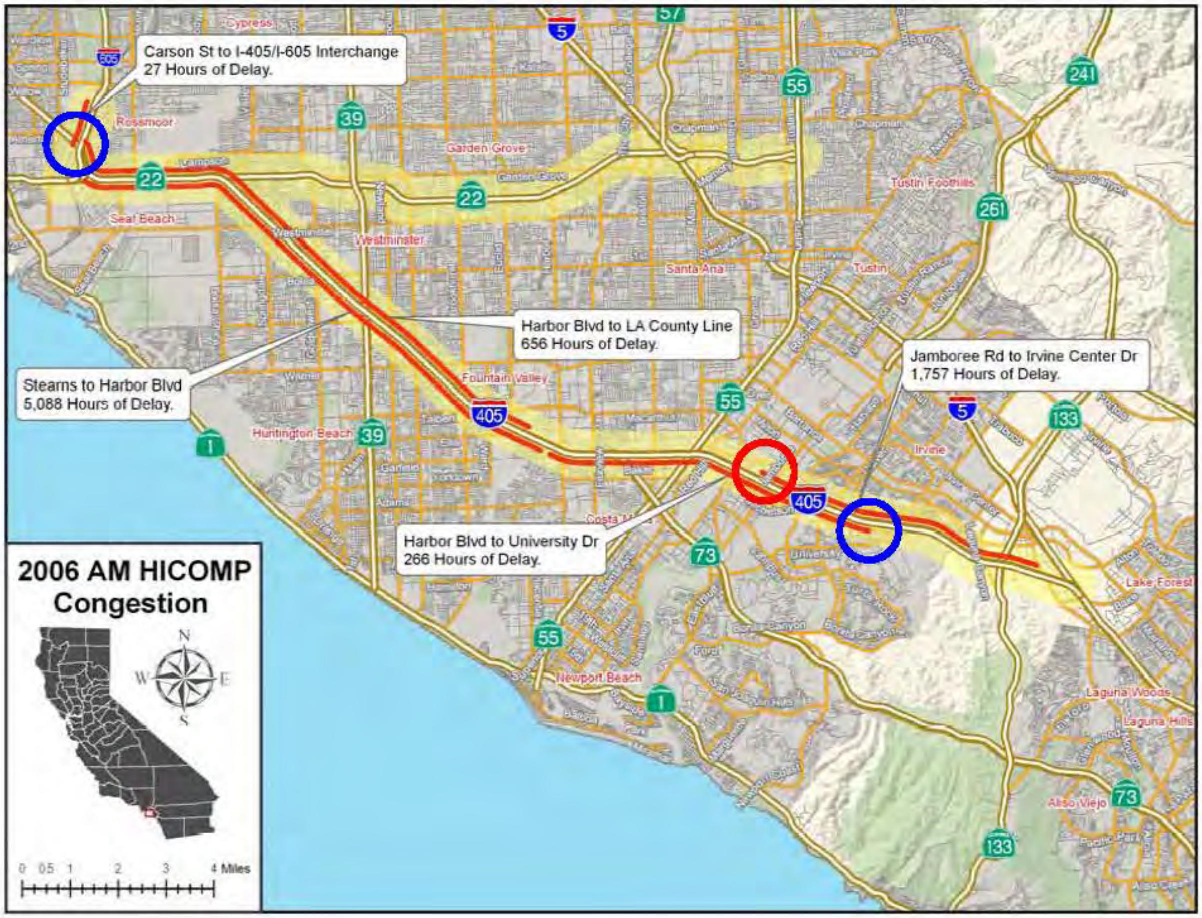
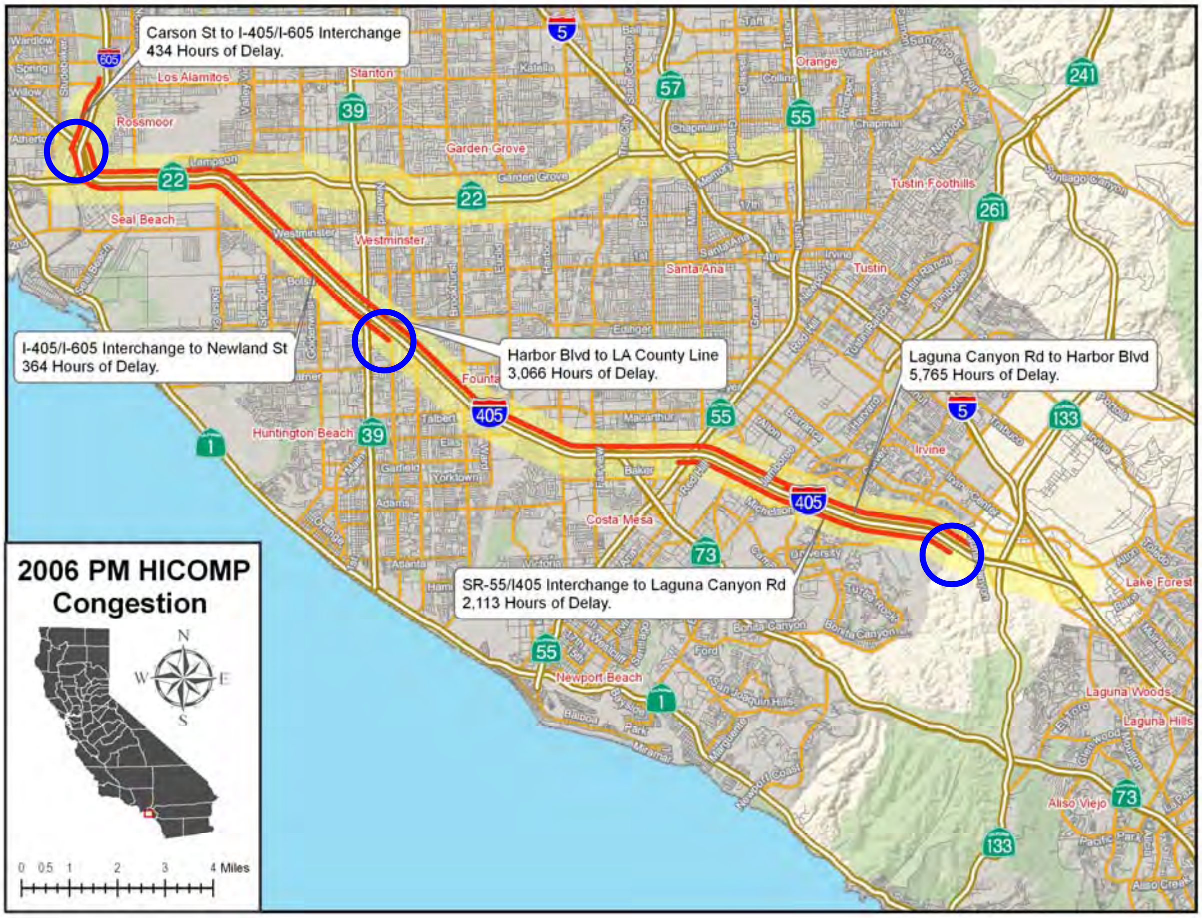


Exhibit A4-2: 2006 HICOMP PM Congestion Map with Potential Bottlenecks



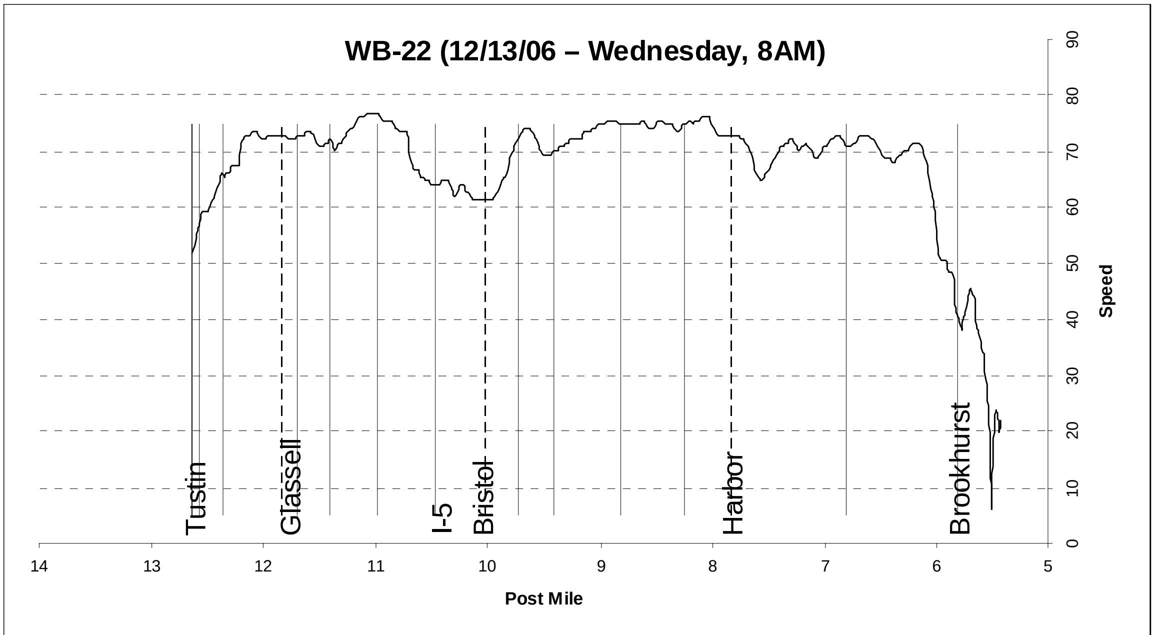
Probe Vehicle Runs

The electronic tachograph (tach), or probe vehicle, runs provide speed plots across the corridor at various departure times. A vehicle equipped with an electronic tachograph (GPS) device is driven along the corridor at various departure times, typically in a middle lane, during the peak period, or at regular, 20 to 30 minute intervals. Actual speeds are recorded as the vehicle traverses the corridor length. Bottlenecks can be found at the end of a congested speed location where speeds pick up to 30 miles per hour to 50 miles per hour in a very short distance.

Caltrans collected probe vehicle run data in December 13, 2006 for the SR-22 Corridor from Tustin to Brookhurst. No data was available for the I-405 or I-605.

Exhibit A4-3 illustrates the SR-22 westbound probe vehicle run at 8AM and 5:20PM conducted on December 13, 2006. As indicated, there is no congestion or bottleneck evident in the AM peak hours; however, there is some slowing in the PM peak hours from Euclid to west of Brookhurst. The likely bottleneck would be west of Brookhurst, beyond the limit of the probe vehicle runs. No data is available west of Brookhurst. As such, potential bottleneck cannot be determined from these runs.

Exhibit A4-3: WB-22 Sample Probe Vehicle Runs – 2006



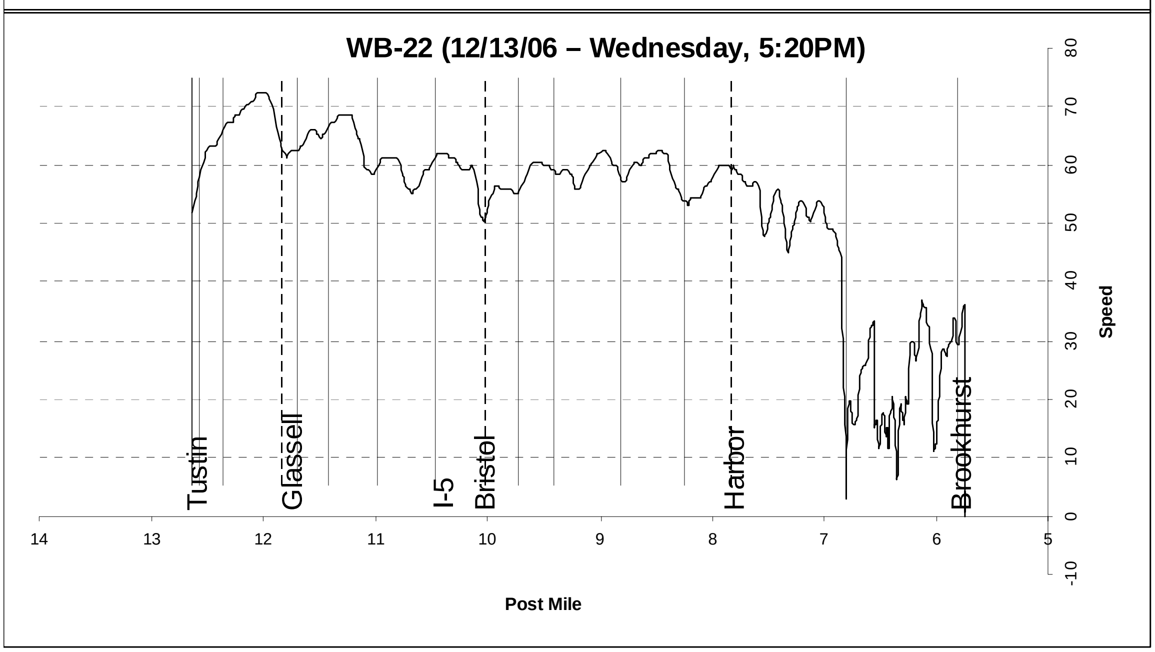
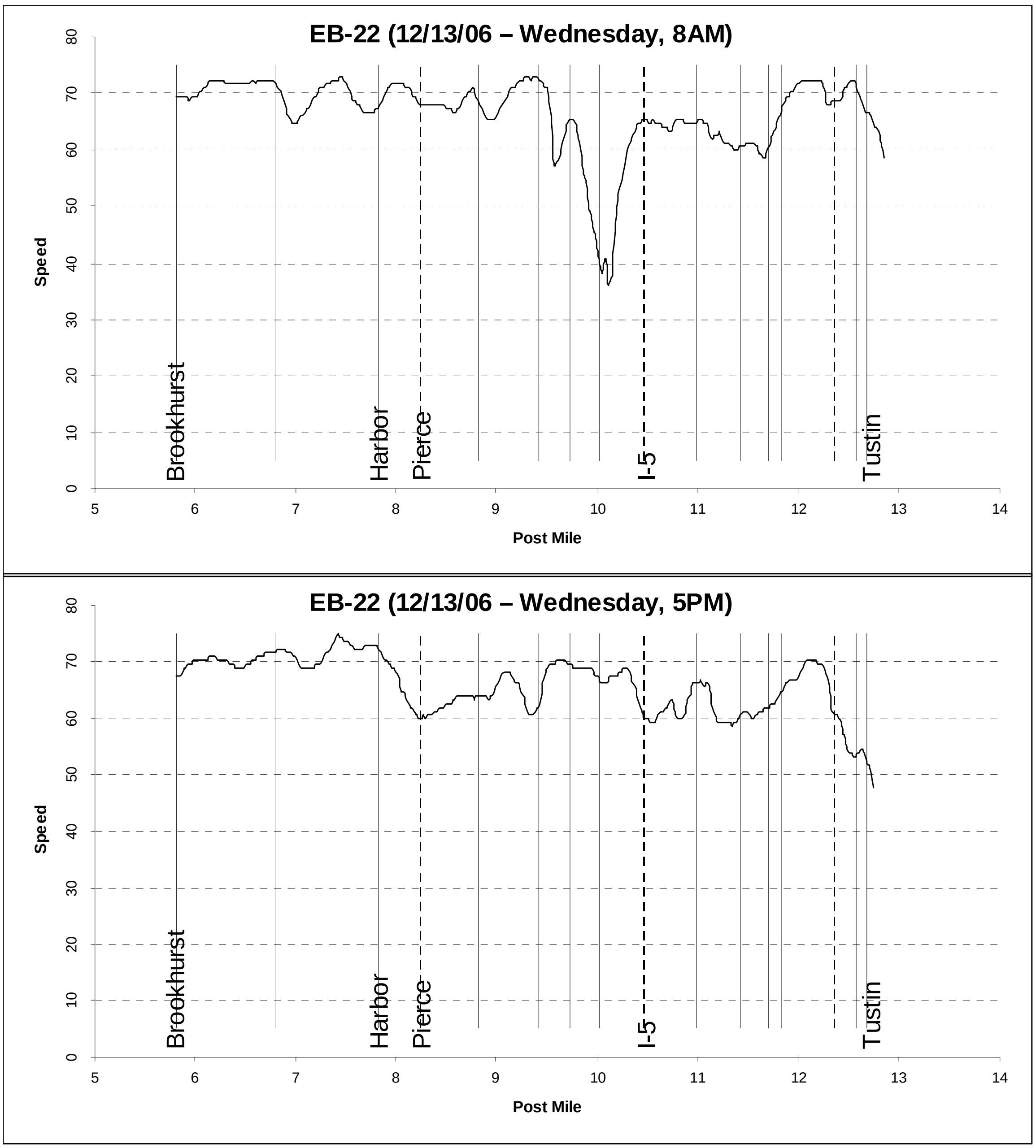


Exhibit A4-4 illustrates the SR-22 eastbound probe vehicle run at 8AM and 5PM conducted on December 13, 2006. As indicated, there is very little congestion or slowing evident in the AM or PM peak hours; however, there is some slowing in the AM peak hours approaching the I-5 junction.

The potential bottleneck location based on the 8AM run is from Bristol On-ramp to I-5 Off-ramp. The amount of congestion and queuing would vary from day to day. With only one day sample run, the level of impact or extent of this potential bottleneck cannot be determined.

Exhibit A4-4: EB-22 Sample Probe Vehicle Runs – 2006



Freeway Performance Measurement System (PeMS)

In PeMS, 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, 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.

- Due to construction and inoperable vehicle detection on SR-22, PeMS data is not available beyond 2004. With the recent widening, results from the 2004 data cannot be applied, as conditions have significantly changed.
- Recent 2006 and 2007 PeMS data is available for I-405. The results of the data analysis are presented.
- Only two vehicle detection stations are available for the I-605 and as such provide very limited results, which are presented.

Exhibit A4-5 and A4-6 illustrate the PeMS speed plots at 8AM for a typical weekday, April 19, 2007. In contrast to the 2006 HICOMP report, there is very little congestion in the northbound direction in the AM peak hours with potential bottleneck at University. In the southbound direction, there is congestion throughout with multiple potential bottlenecks.

Northbound

- Jeffery/University to Culver

Southbound

- Warner to Brookhurst
- Fairview to Bristol
- Jeffrey/University to Sand Canyon

Exhibit A4-5: PeMS NB-405 Speed Plot – 4/19/07 (Thursday) at 8AM

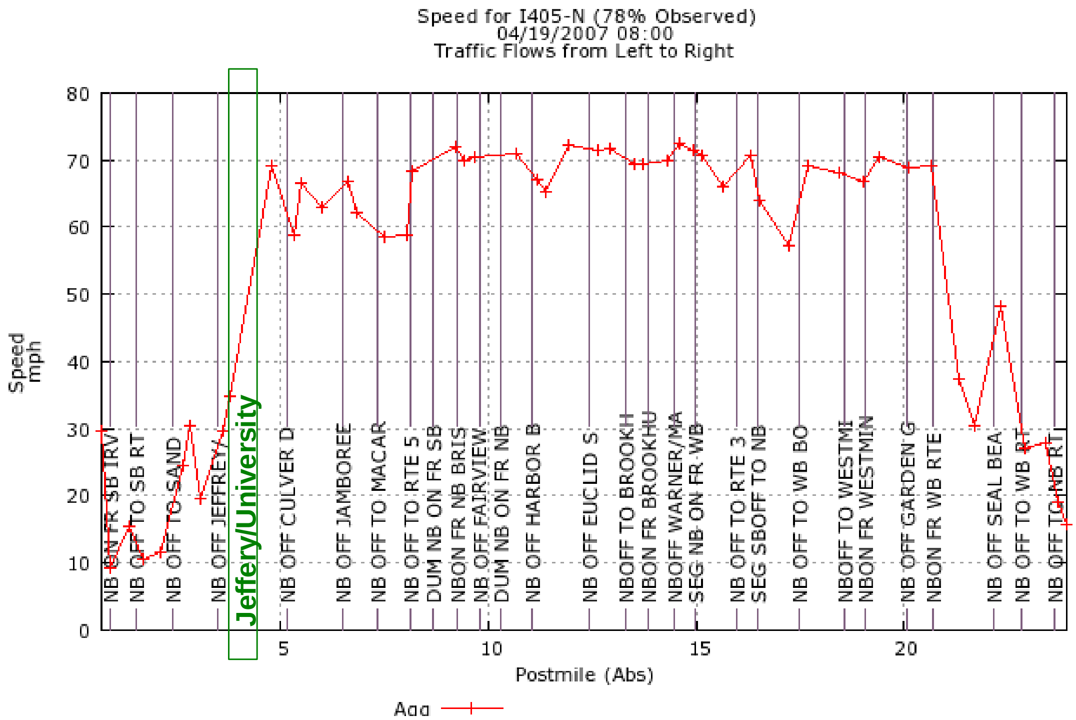


Exhibit A4-6: PeMS SB-405 Speed Plot – 4/19/07 (Thursday) at 8AM

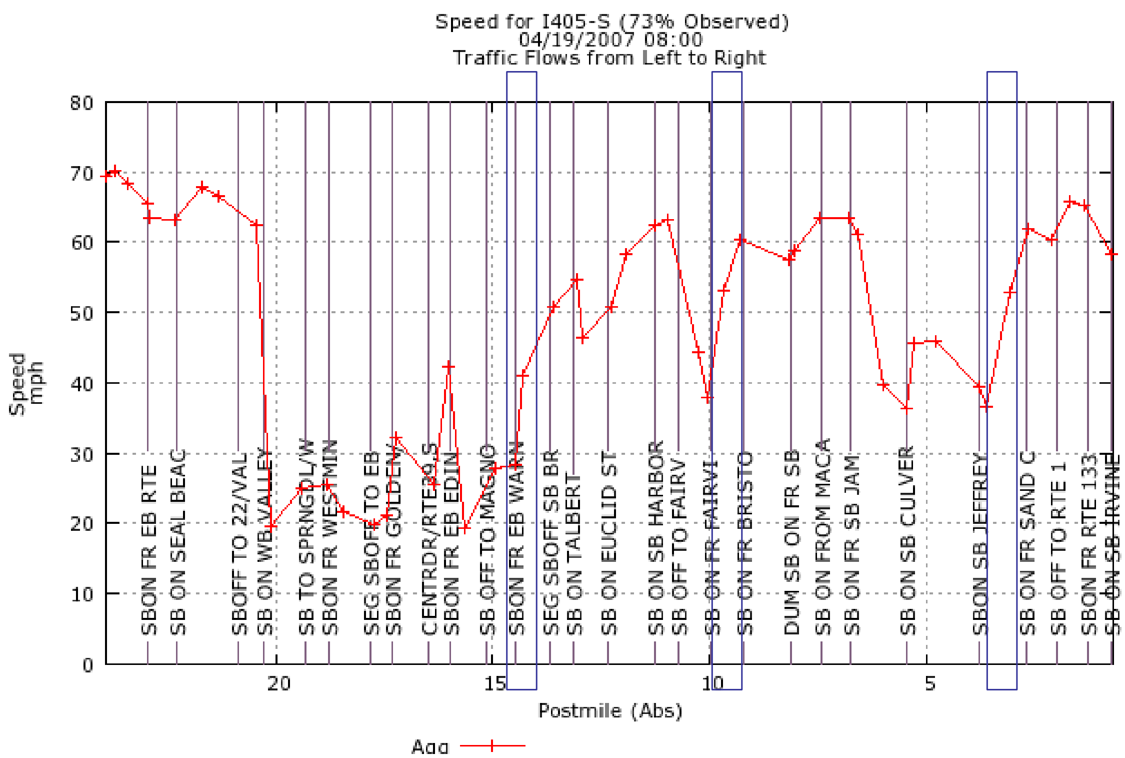


Exhibit A4-7 and A4-8 illustrate the PeMS speed plots at 5PM for a typical weekday, April 19, 2007. Based on these speed plots, potential bottlenecks are located:

<u>Northbound</u>

- SR73/Fairview to Harbor
- Brookhurst to Warner
- SR39 to Bolsa
- SR22 to Seal Beach

<u>Southbound</u>

- I-605/SR22 to Seal Beach
- Westminster to Bolsa
- Bolsa to SR39
- Edinger to Magnolia
- Jamboree to Culver
- Jeffrey/University to Sand Canyon
- Sand Canyon to SR133

Exhibit A4-7: PeMS NB-405 Speed Plot – 4/19/07 (Thursday) at 5PM

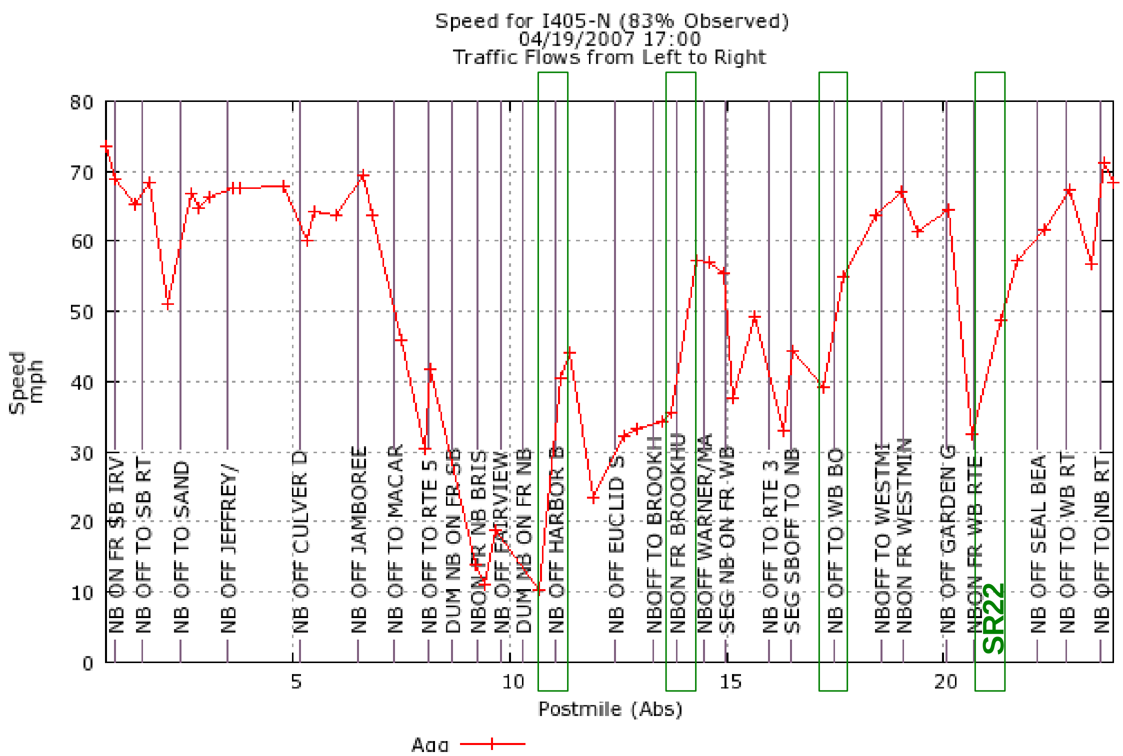
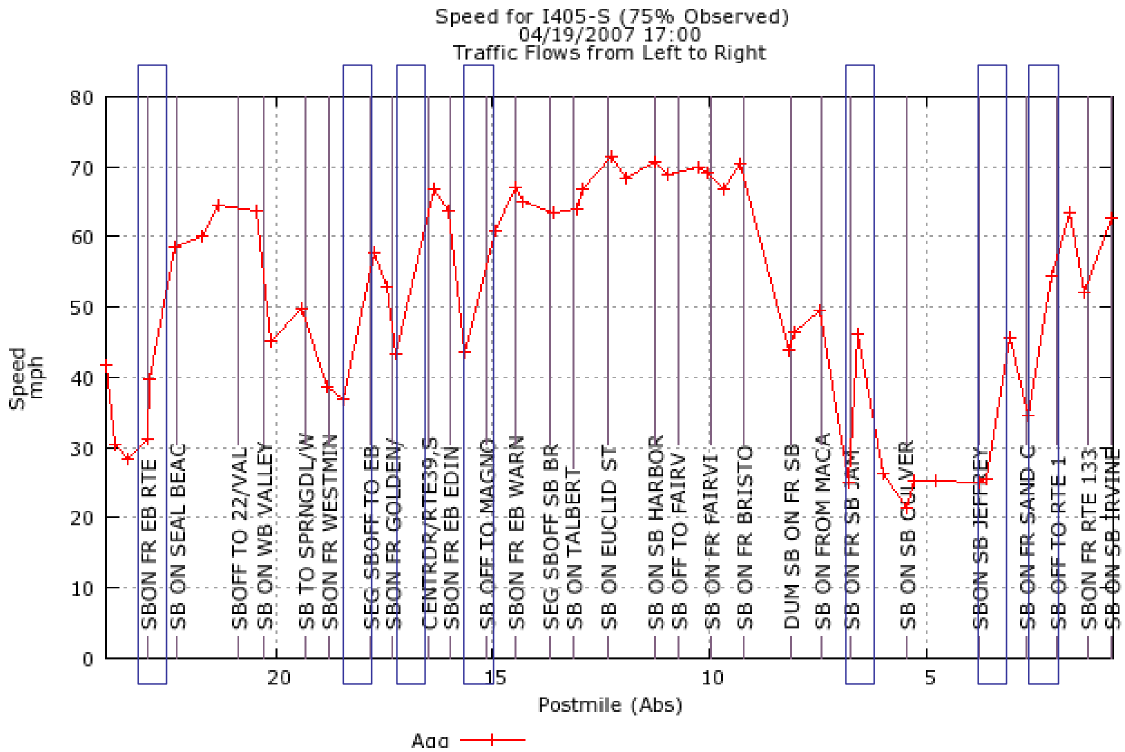


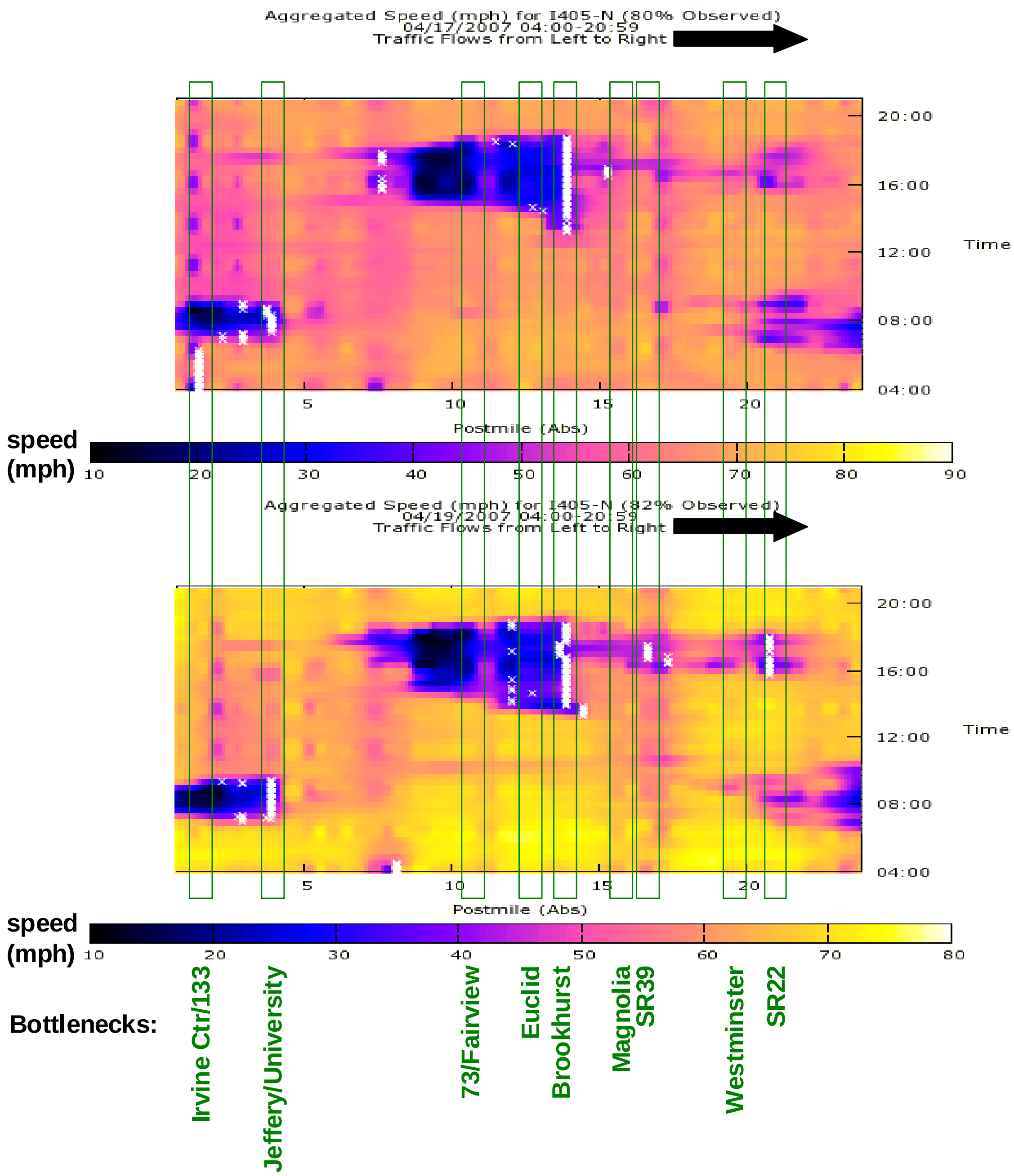
Exhibit A4-8: PeMS SB-405 Speed Plot – 4/19/07 (Thursday) at 5PM



PeMS Speed Contour Plots

In PeMS, speed contour plots are also used to identify potential bottleneck locations. Speed contour plots are essentially the compilation of speed plots across the corridor at every 5 minutes. Exhibit A4-9 illustrates a typical speed contour plot generated by PeMS.

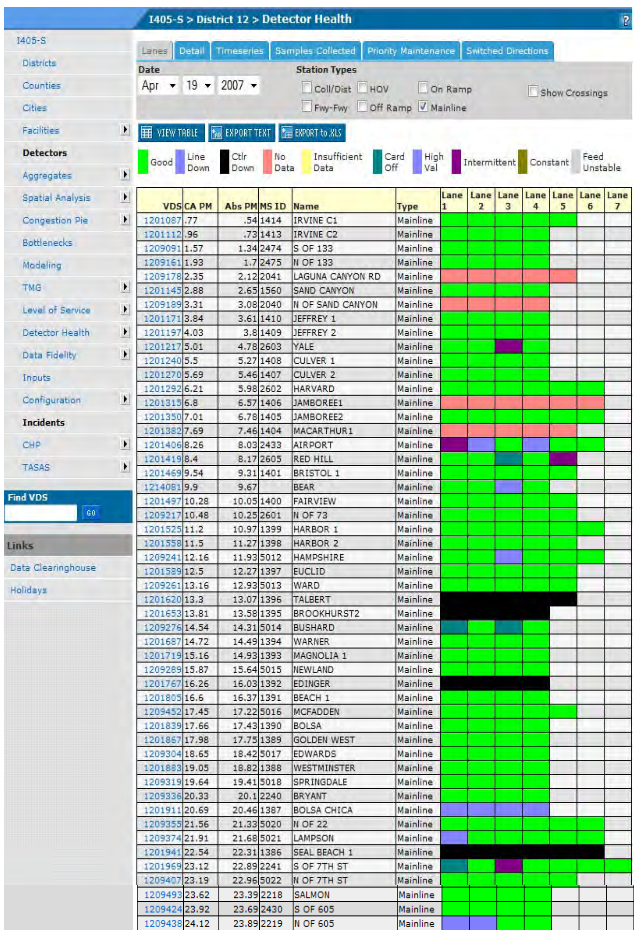
Exhibit A4-9: PeMS NB-405 Speed Contour Plot – 4/17/07 (Tue) & 4/19/07 (Thu)



These speed contour plots illustrate the typical speed contour diagram for the I-405 freeway in the northbound direction (traffic moving left to right on the plot) on two typical weekdays in the month of April 2007 (17th Tuesday and 19th Thursday). Along the vertical axis is the time period from 4AM to 8PM. Along the horizontal axis is the corridor segment from I-5 junction to the Los Angeles/Orange County Line. 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 the dark blotches represent bottleneck areas, where speeds pickup after congestion, typically 30 to 50 miles per hour in a very short stretch. The horizontal length of each plot is the congested segment, queue lengths. The vertical length is the congested time period.

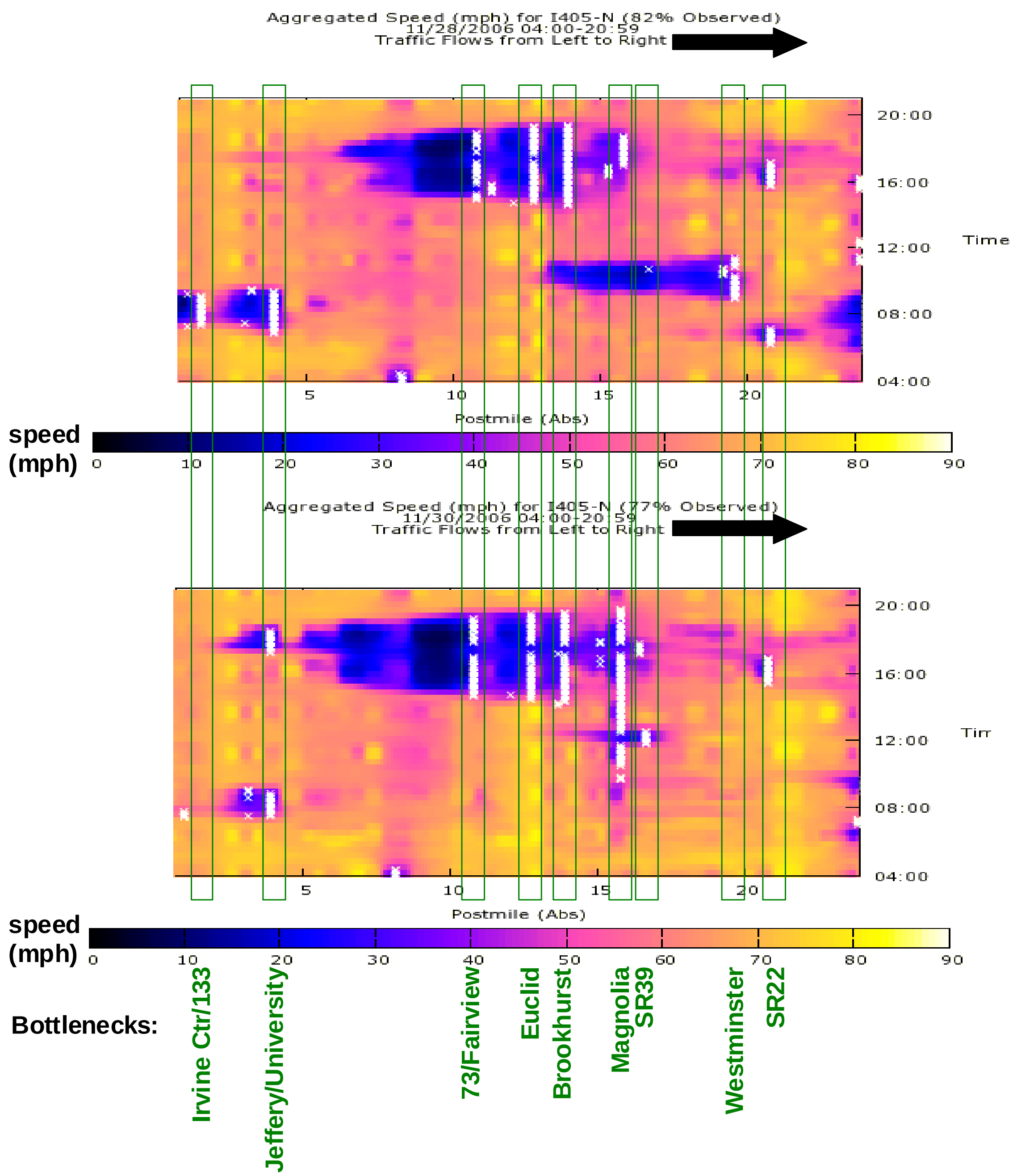
As indicated on the plots, 80% to 82% of the detector data was observed (actual data collected from good detectors), and 18% to 20% were imputed (calculated due to defective detection data). Exhibit A4-10 illustrates where the 20% of the detector stations along this corridor were defective on April 19, 2007. With the spacing of the defective detector stations among good, working ones, PeMS imputed algorithm is expected to be effective, in this case, providing reasonably accurate results.

Exhibit A4-10: PeMS NB and SB-405 Detector Station Health – 4/19/07 (Thurs)



Results are very similar across multiple days during the year. Exhibit A4-11 illustrates the speed contour plots on Tuesday, November 28, 2006, and Thursday, November 30, 2006. The same bottleneck locations are identified in these plots as well. This indicates that the recurrent congestion and bottleneck occurs on most commute days.

Exhibit A4-11: PeMS NB-405 Speed Contour Plots – 11/28/06 (Tue) & 11/30/06 (Thu)



Based on these contour plots of typical weekday samples in April 2007 and November 2006, the following potential bottlenecks are identified:

<u>Northbound</u>

- Irvine Center to SR133
- Jeffery/University to Culver
- SR73/Fairview to Harbor
- Harbor to Euclid
- Brookhurst to Warner
- Magnolia to SR39
- SR39 to Bolsa
- Westminster to SR22
- SR22 to Seal Beach

In addition to multiple days, larger averages were also analyzed. Exhibits A4-12 and A4-13 illustrate weekday averages by each quarter of each year from 2006 to 2007. The same bottleneck locations are identified. From the long contours, we see the same bottlenecks.

Exhibit A4-12: PeMS NB-405 Long (Speed) Contours – 2006 By Quarter

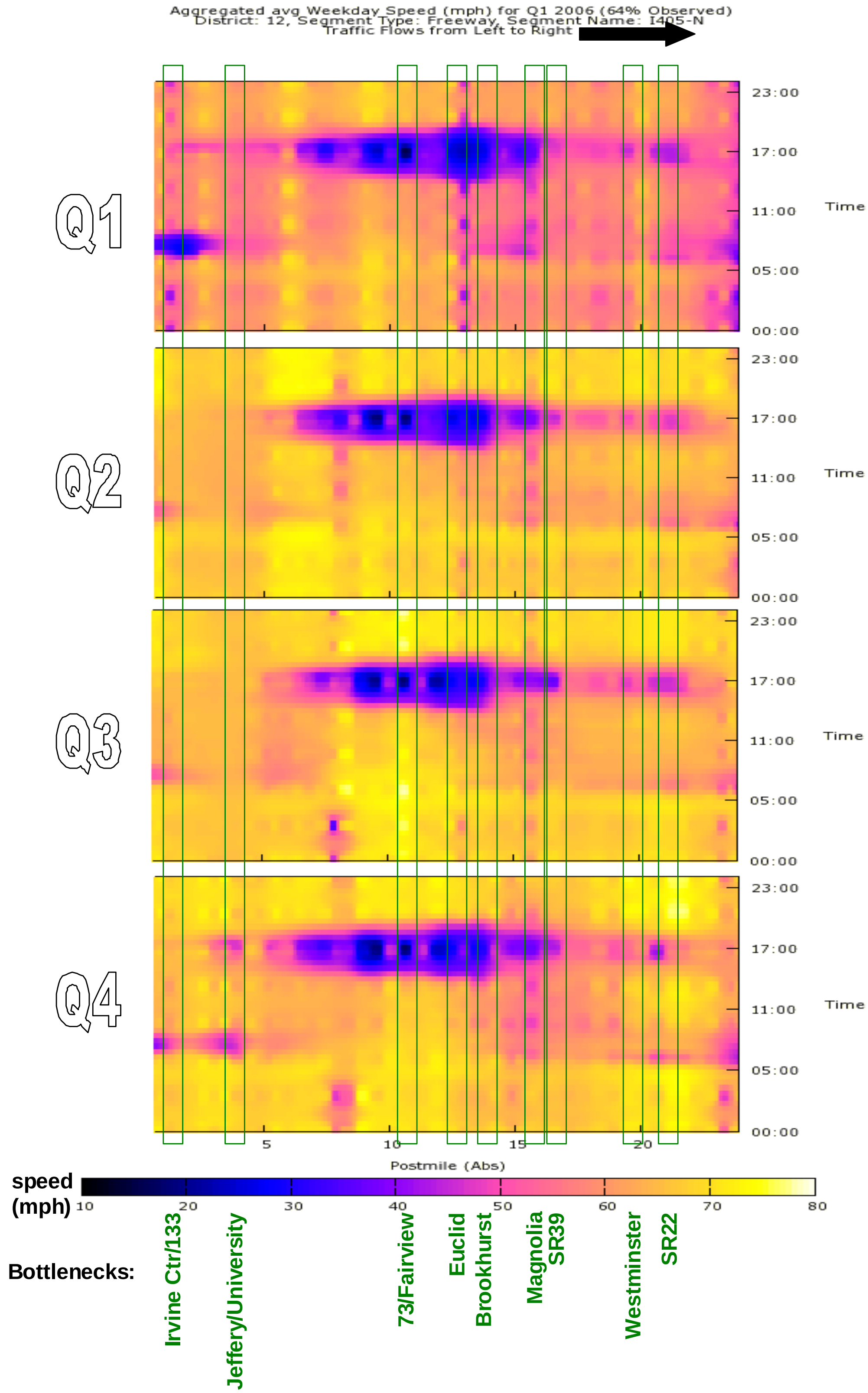
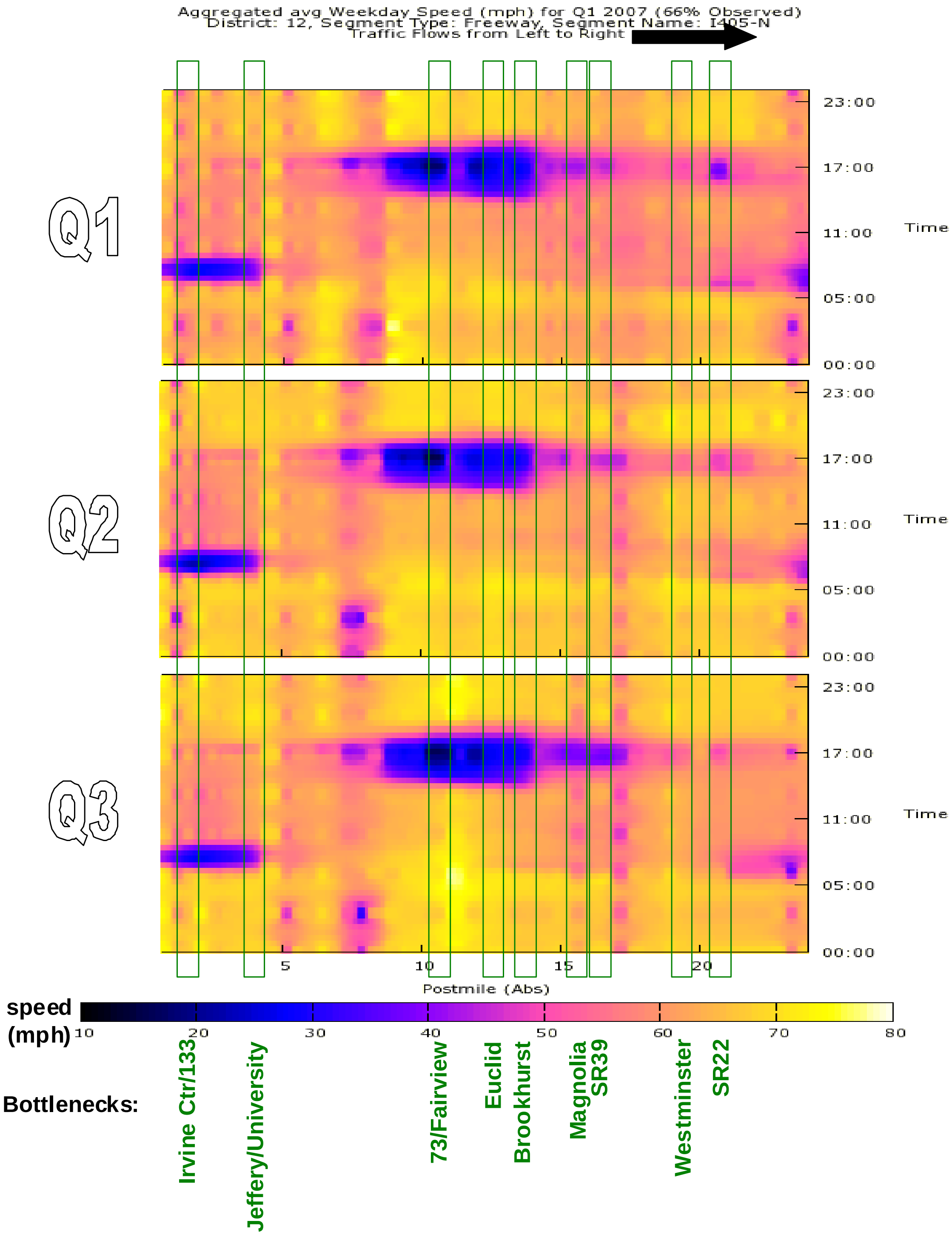


Exhibit A4-13: PeMS NB-405 Long (Speed) Contours – 2007 By Quarter



Similarly, speed contour plots for the same sample days and 2006/2007 quarterly weekday average long contours were analyzed for the southbound direction. Exhibit A4-14 to Exhibit A4-17 illustrate the speed contour plots for the I-405 freeway corridor in the southbound direction (traffic moving left to right on the plot) on two typical weekdays in the month of April 2007 and November 2006 and 2006/2007 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 I-5 junction to Orange/Los Angeles County Line.

Exhibit A4-14: PeMS SB-405 Speed Contour Plot – 4/18/07 (Wed) & 4/19/06 (Thu)

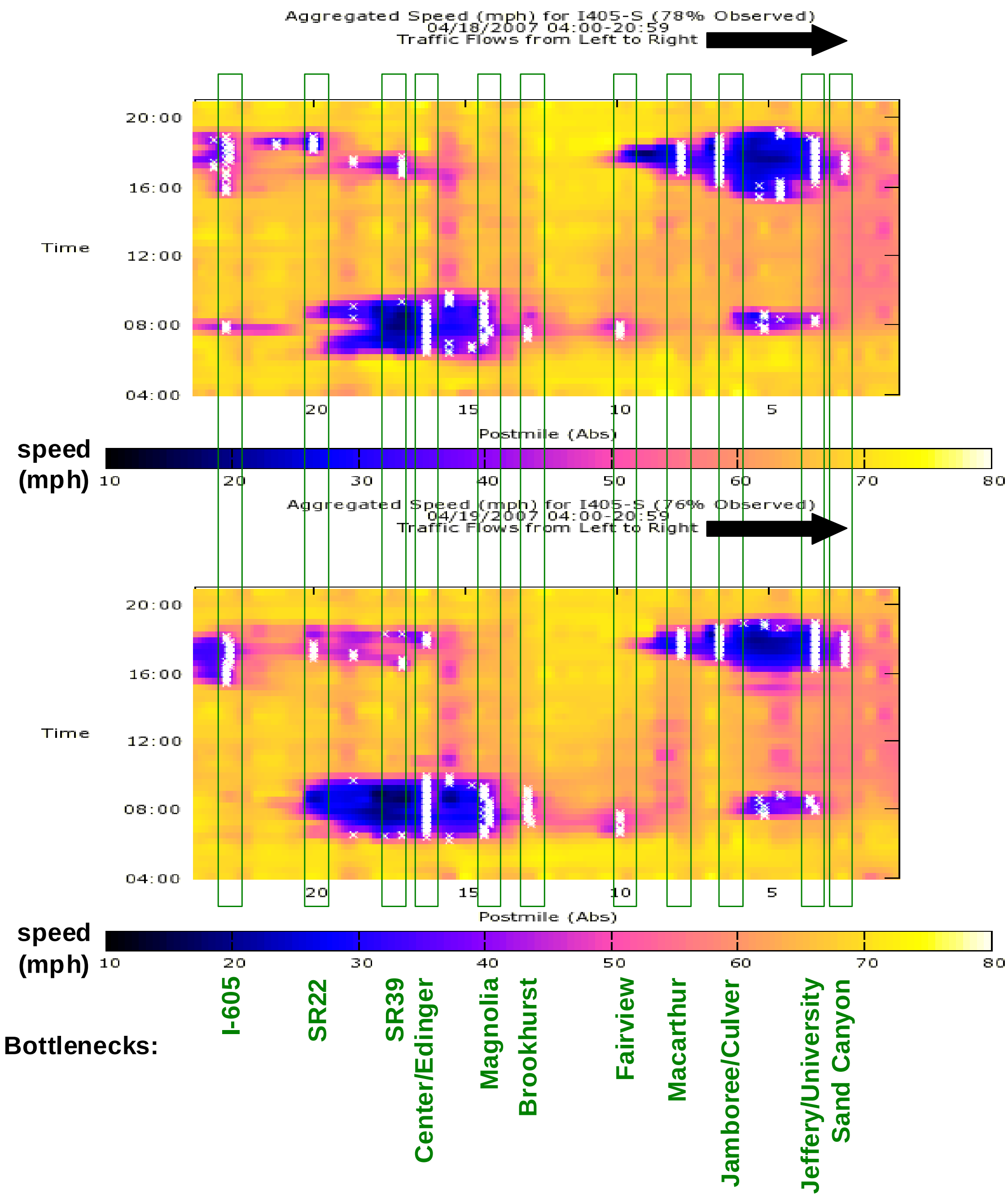
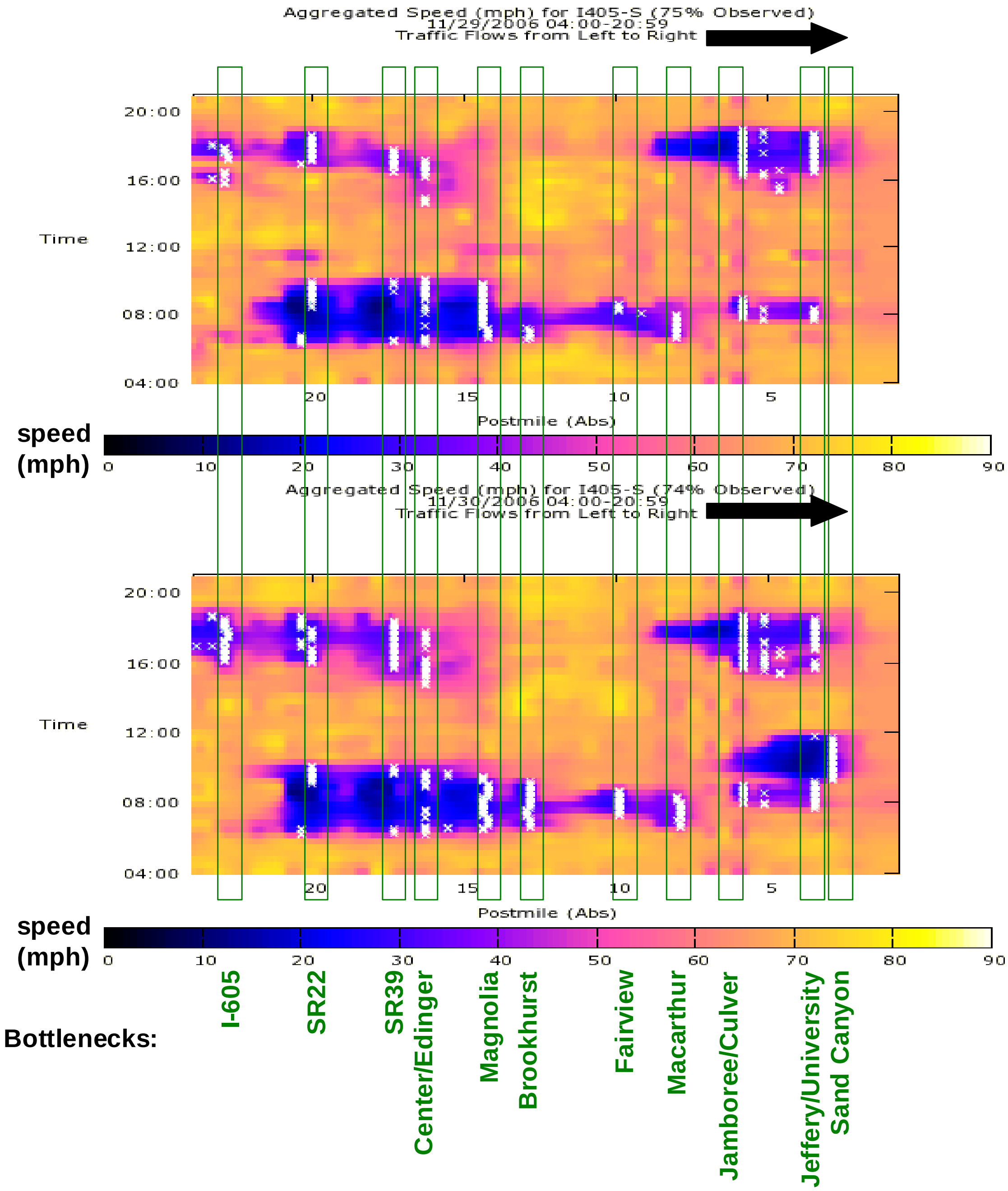


Exhibit A4-15: PeMS SB-405 Speed Contour Plots – 11/29/06 (Wed) & 11/30/06 (Thu)



As indicated on the plots, 74% to 78% of the detector data was observed (actual data collected from good detectors), and 26% to 22% were imputed (calculated due to defective detection data). Exhibit A4-10 illustrates where the 24% of the detector stations along this corridor were defective on April 19, 2007. With the spacing of the defective detector stations among good, working ones, PeMS imputed algorithm is expected to be effective, in this case, providing reasonably accurate results.

Exhibit A4-16: PeMS SB-405 Long (Speed) Contours – 2006 By Quarter

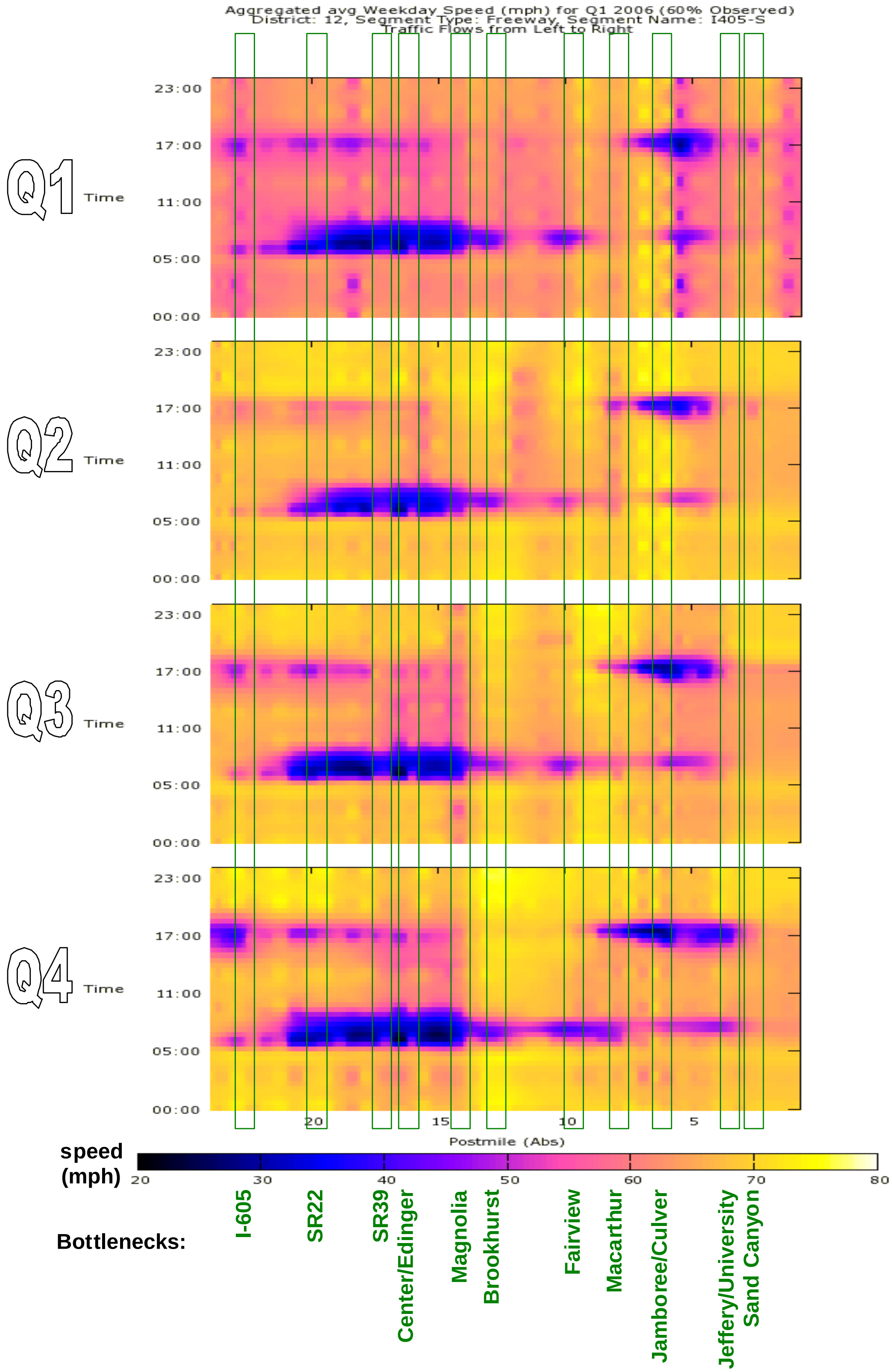
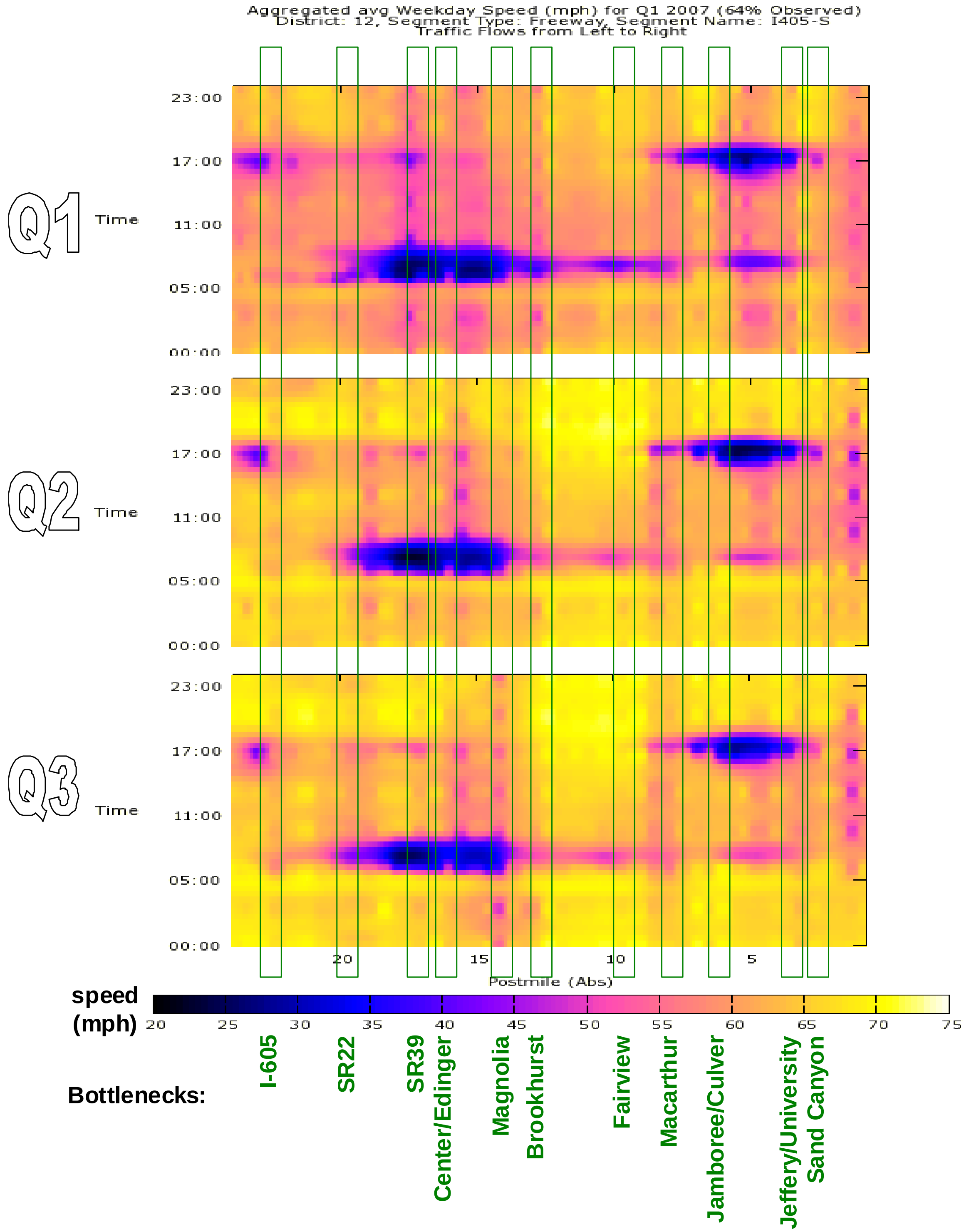


Exhibit A4-17: PeMS SB-405 Long (Speed) Contours – 2007 By Quarter



Based on these contour plots of typical weekday samples in April 2007 and November 2006 and 2006/2007 quarterly weekday average long contours, the following potential bottlenecks are identified:

Southbound

- I-605/SR22 to Seal Beach
- Valley View/SR22 to Spring Dale/Westminster
- Bolsa to SR39
- Edinger to Magnolia
- SR39 to Magnolia
- Magnolia to Warner
- Brookhurst to Euclid
- Fairview to Bristol
- SR55 to MacArthur
- Jamboree to Culver
- Jeffrey/University to Sand Canyon
- Sand Canyon to SR133

I-605

Much like the analysis for I-405, PeMS data was also analyzed for the I-605 freeway section. Unlike I-405, I-605 only had two vehicle detector stations within the corridor, and as such, it provided limited results. Exhibits A4-18 to A4-20 illustrate the typical AM and PM speed profiles and typical weekday speed contour diagram. As indicated, the entire section is congested during the PM peak hours, with the bottleneck stemming from the I-405 junction.

Exhibit A4-18: PeMS SB-605 Speed Plot – 4/19/07 (Thursday) at 8AM

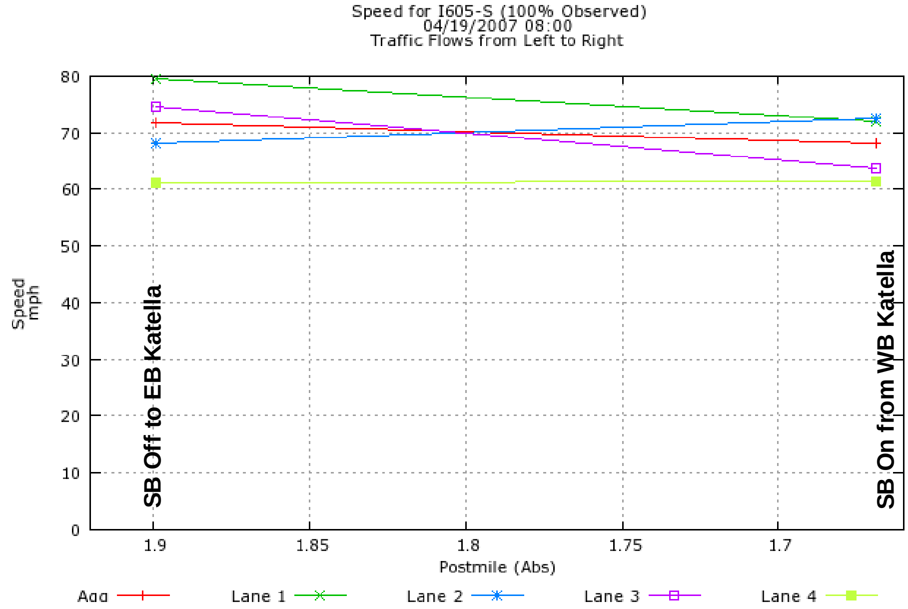


Exhibit A4-19: PeMS SB-605 Speed Plot – 4/19/07 (Thursday) at 5PM

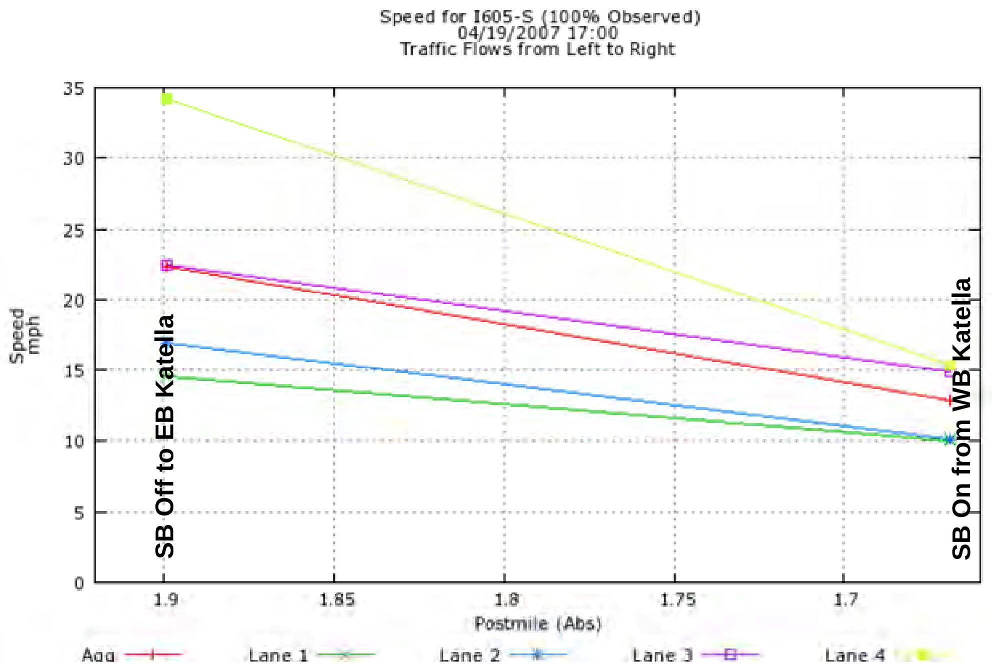
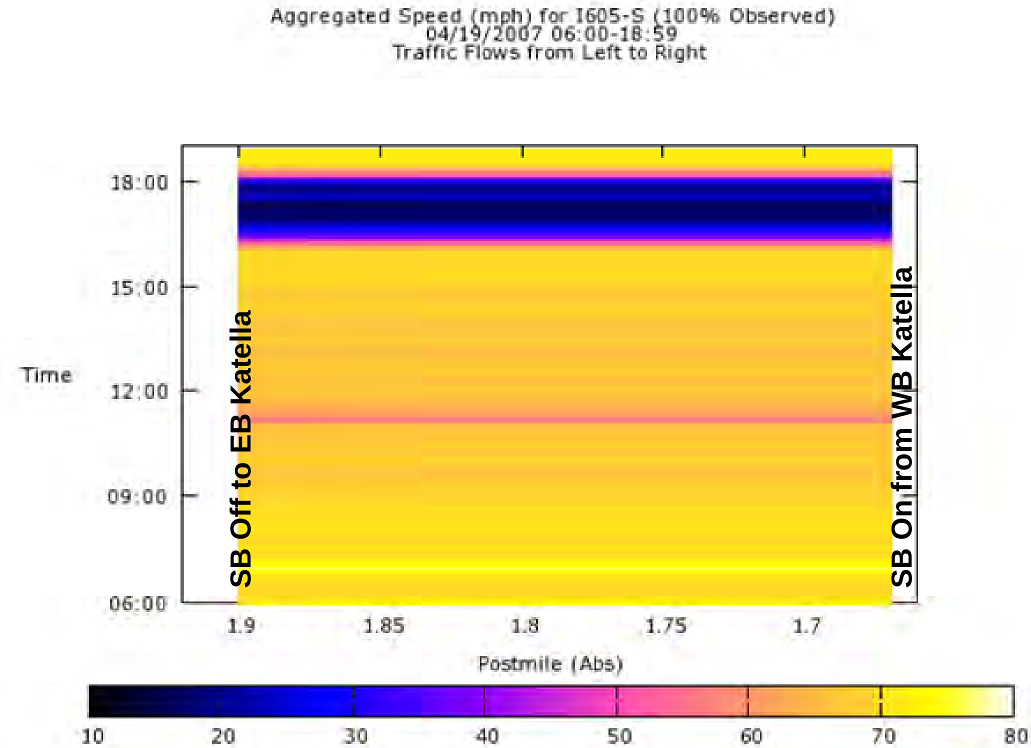


Exhibit A4-20: PeMS SB-605 Speed Contour Plot –4/19/06 (Thu)



Bottleneck Summary

Exhibits A4-21 to A4-23 provide a summary of the potential bottleneck locations based on the 2006 HICOMP report, Caltrans District 12 probe vehicle runs, and PeMS speed plots and speed contour plots. It should be noted that these locations has not been field verified. Additional data and/or extensive field reviews will be necessary to confirm their actual locations and identify causes of the bottlenecks.

Exhibit A4-21: SR-22 Bottleneck Summary

BOTTLENECK LOCATION	Bottleneck Area Post Mile Range		HICOMP [a] Report		Caltrans [b] Probe Veh. Runs		PeMS [a] Speed Contours	
	CT	ABS	AM	PM	AM	PM	AM	PM
WESTBOUND								
West of Brookhurst	na	na	-	-	✓	✓	na	na
EASTBOUND								
Bristol On to I-5 Off	R10.1/R10.4	11.7/11.9	-	-	✓	-	na	na

NOTES:
[a] Based on 2006 HICOMP report.
[b] Based on Caltrans District 12 sample probe vehicle runs, as part of highway congestion monitoring program (HICOMP), taken in December 2006.
[c] Based on Performance Measurement System (PeMS) sample daily speed contours taken from April 2007 & November 2006, and quarterly weekday averages from 2006 to 2007 data.
na Data not available
- No indication of bottleneck from this source.

Exhibit A4-22: I-605 Bottleneck Summary

BOTTLENECK LOCATION	Bottleneck Area Post Mile Range		HICOMP [a] Report		Caltrans [b] Probe Veh. Runs		PeMS [a] Speed Contours	
	CT	ABS	AM	PM	AM	PM	AM	PM
NORTHBOUND								
none								
SOUTHBOUND								
I-405 junction	3.5/R1.6	0.4/2.0	✓	✓	na	na	-	✓

NOTES:
[a] Based on 2006 HICOMP report.
[b] Based on Caltrans District 12 sample probe vehicle runs, as part of highway congestion monitoring program (HICOMP), taken in December 2006.
[c] Based on Performance Measurement System (PeMS) sample daily speed contours taken from April 2007 & November 2006, and quarterly weekday averages from 2006 to 2007 data.
na Data not available
- No indication of bottleneck from this source.

Exhibit A4-23: I-405 Bottleneck Summary

BOTTLENECK LOCATION	Bottleneck Area Post Mile Range		HICOMP [a] Report		Caltrans [b] Probe Veh. Runs		PeMS [a] Speed Contours	
	CT	ABS	AM	PM	AM	PM	AM	PM
NORTHBOUND	0.0	0.0						
Irvine Center to SR133	1.1/1.7	0.9/1.1	-	-	na	na	✓	-
Jeffery/University to Culver	4.1/5.4	3.9/5.2	-	-	na	na	✓	
Culver to Jamboree	5.7/6.7	5.5/6.5	✓	-	na	na	-	-
SR73/Fairview to Harbor	10.9/11.3	10.7/11.0	-	-	na	na	-	✓
Harbor to Euclid	11.6/12.6	11.4/12.4	-	-	na	na	-	✓
Brookhurst to Warner	14.1/14.7	13.8/14.5	-	-	na	na	-	✓
Magnolia to SR39	15.5/16.2	15.3/16.0	-	-	na	na	-	✓
SR39 to Bolsa	16.9/17.7	16.6/17.5	-	-	na	na	-	✓
Westminster to SR22	19.3/20.3	19.1/20.1	-	-	na	na	-	✓
SR22 to Seal Beach	20.9/22.4	20.7/22.2	-	-	na	na	-	✓
End (County Line)	24.2	24.0						
SOUTHBOUND	24.2	24.0						
I-605/SR22 to Seal Beach	23.2/22.7	23.0/22.5	-	-	na	na	-	✓
Valley View/SR22 to Westminster	20.5/19.5	20.3/19.3	-	-	na	na	-	✓
Westminster to Bolsa	19.0/18.1	18.8/17.9	-	-	na	na	-	✓
Bolsa to SR39	17.6/16.8	17.3/16.6	-	-	na	na	-	✓
Edinger/SR39 to Magnolia	16.4/15.4	16.2/15.1	-	-	na	na	-	✓
Magnolia to Warner	15.1/14.8	14.9/14.6	-	-	na	na	-	✓
Warner to Brookhurst	14.7/14.0	14.5/13.8	-	-	na	na	✓	✓
Brookhurst to Euclid	13.6/12.7	13.4/12.5	-	-	na	na	-	✓
Fairview to Bristol	10.2/9.7	10.0/9.5	-	-	na	na	✓	✓
Jamboree to Culver	7.0/5.8	6.8/5.6	-	-	na	na	-	✓
Jeffery/University to Sand Canyon	4.0/3.1	3.8/2.9	✓	✓	na	na	✓	✓
Sand Canyon to SR133	2.9/2.2	2.7/2.0	-	-	na	na	-	✓
End (I-5 Junction)	0.0	0.0						

NOTES:

[a] Based on 2006 HICOMP report.

[b] Based on Caltrans District 12 sample probe vehicle runs, as part of highway congestion monitoring program (HICOMP), taken in December 2006.

[c] Based on Performance Measurement System (PeMS) sample daily speed contours taken from April 2007 & November 2006, and quarterly

na Data not available

\- No indication of bottleneck from this source.