Interstate 680 Contra Costa Corridor System Management Plan

FINAL

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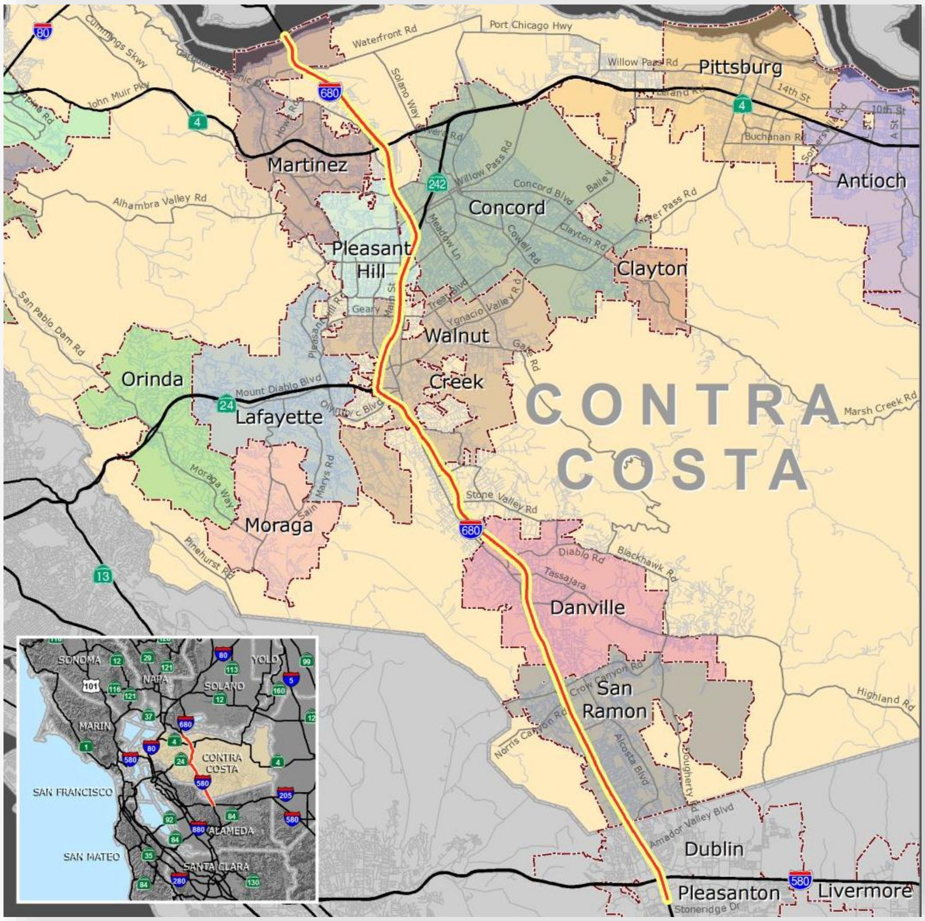

CSMP Corridor Limits

The limits of the Interstate 680 Corridor in Contra Costa County are from the Benicia-Martinez Bridge at the Solano-Contra Costa County line to the Interstate 580/Interstate 680 interchange near the Contra Costa-Alameda County line.

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Interstate 680 Contra Costa Corridor System Management Plan

APPROVED BY:

6/18/15

BIJAN SARTIPI   Date
District 4 Director
California Department of Transportation

I accept this Corridor System Management Plan for the Interstate 680 Corridor in Contra Costa County as a document informing the regional transportation planning process.

ACCEPTED BY:

June 16, 2015

RANDELL H. IWASAKI   Date
Executive Director
Contra Costa Transportation Authority

Interstate 680 Contra Costa
Corridor System Management Plan

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Stakeholder Acknowledgement

This Corridor System Management Plan represents a cooperative planning effort for the I-680 corridor in Contra Costa County. District 4 is pleased to acknowledge the time and contributions of stakeholders and partner agencies to this CSMP. Development of System Planning documents such as this one is dependent upon the participation and cooperation of its stakeholders. The following stakeholders provided essential information, advice and feedback for the preparation of this document:

- Contra Costa Transportation Authority
- Metropolitan Transportation Commission
- Transportation Partnership and Cooperation Committee (TRANSPAC)
- Southwest Area Transportation Committee (SWAT)
- Alameda County Transportation Commission
- Solano Transportation Authority
- City of Martinez
- City of Concord
- City of Pleasant Hill
- City of Walnut Creek
- City of Lafayette
- Town of Danville
- City of San Ramon
- City of Dublin
- Contra Costa County
- Bay Area Rapid Transit
- County Connection

This CSMP will be posted on the Caltrans Corridor Mobility website at:
http://www.dot.ca.gov/hq/tpp/corridor-mobility/

Caltrans

Contra Costa County I-680
Corridor System Management Plan (CSMP)
Final Report

System Metrics Group, Inc.

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1. INTRODUCTION

The Final Report for the *Contra Costa County I-680 (I-680) Corridor System Management Plan (CSMP) and Tools for Operational Planning (TOPL) Demonstration* project was developed by the California Department of Transportation (Caltrans) District 4 San Francisco Bay Area office in coordination with the Contra Costa County Transportation Authority (CCTA) and the Metropolitan Transportation Commission (MTC).

The goal of the Contra Costa County I-680 CSMP is to measure how the corridor is performing, understand why it is performing that way, and recommend system management strategies that dovetail into a long-range planning vision. This CSMP is unique from previous CSMP efforts in that it also incorporates three new and evolving planning elements into corridor system management:

- Smart Mobility Framework (SMF)
- Complete Streets
- Tools for Operational Planning (TOPL).

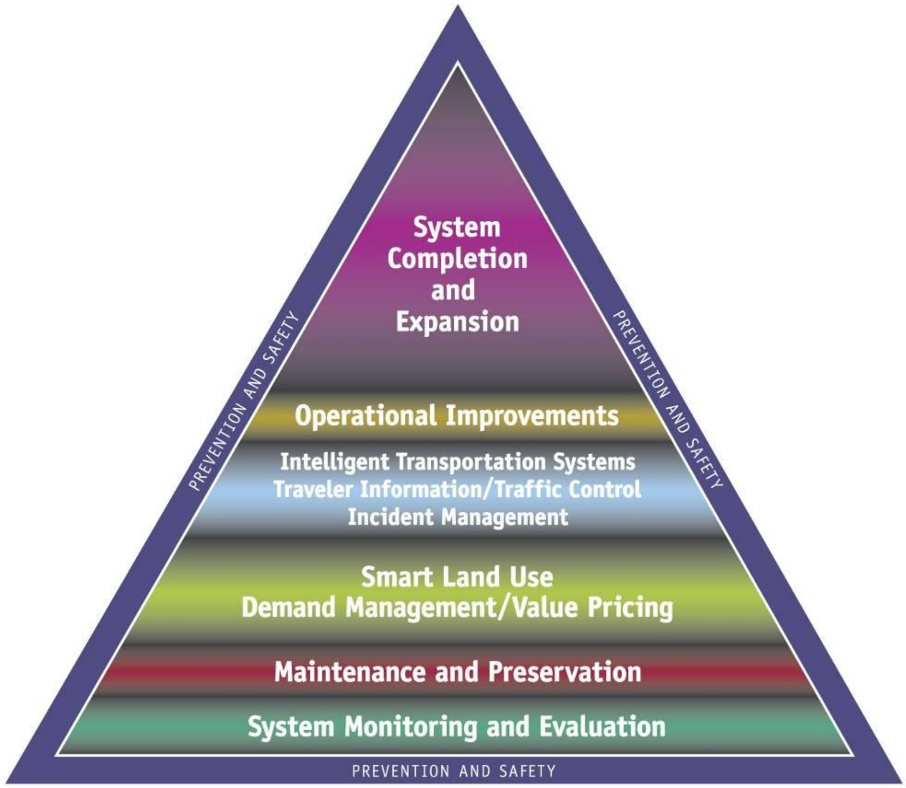
The Contra Costa County I-680 corridor CSMP was one of the two pilot areas identified for study as part of the implementation of the Caltrans Smart Mobility Framework. The purpose of the SMF study was to develop strategies and methodologies for integrating SMF principles, concepts, and performance measures into on-going transportation planning efforts, in this case, a CSMP. The SMF study is being conducted under a State Planning and Research grant through the Office of Community Planning.

This effort also included a Complete Streets evaluation to apply preliminary District 4 Complete Streets guidance to an urban freeway corridor to make Complete Streets a routine part of Caltrans system planning. Caltrans adopted Deputy Directive-64-R1, *Complete Streets- Integrating the Transportation System (DD64-R1)* in 2008. DD64-R1 sets a "course of action" for Caltrans to provide for the needs of travelers of all ages and abilities on the State Highway System for all transportation modes. This policy is supported by Federal law requiring safe accommodation for all users and State law that Caltrans provide an integrated multimodal system. It also helps local governments meet their requirement under State law (AB 1358) to include Complete Streets in their General Plans.

Finally, this CSMP effort is the first large-scale demonstration of TOPL currently under development by Partners for Advanced Transportation Technology (PATH) at the University of California at Berkeley. In collaboration with the Caltrans District 4 Division of Traffic Operations, the TOPL analytical package is designed to provide quick, quantitative assessments of congestion relief strategies for freeways and urban arterials. This will allow planners and engineers to test system operational improvements that benefit travelers without relying on major infrastructure expansion projects.

Guided by the system management pyramid shown in Exhibit 1-1, this CSMP seeks to incorporate operational analysis, Caltrans SMF, and a Complete Streets assessment into the traditional transportation planning processes.

Exhibit 1-1: System Management Pyramid



Source: Caltrans Office of System Management Planning.

A critical goal of system management is to get the most out of the existing system by maximizing system productivity for people and freight, while aiming to achieve speeds that are safe for the facility and that meet other regional goals. When travel demand is at its highest, particularly during peak travel periods, the available capacity of the roadway at bottleneck locations is exceeded and traffic flow breaks down. The freeway cannot accommodate any more vehicles at bottlenecks, and vehicular throughput in the congested segments upstream of the bottleneck location is reduced significantly.

This CSMP aims to recommend how the corridor should be managed in the short to medium term, focusing on operational strategies in addition to already funded expansion projects. This report presents performance measurement findings, identifies bottlenecks that lead to less than optimal performance, and diagnoses the causes for these bottlenecks. Project scenarios are then developed and evaluated to quantify the congestion relief benefits of those scenarios.

Other Elements of the CSMP

This CSMP effort is unique from other CSMP efforts in that it also incorporates three new and evolving planning elements described above.

Smart Mobility Framework

A major component of the Contra Costa County I-680 CSMP is to advance Caltrans Smart Mobility Framework (SMF) by serving as a pilot for applying SMF principles and performance measures to corridor planning. Smart mobility moves people and freight while enhancing California's economic, environmental, and human resources by emphasizing: convenient and safe multimodal travel, speed suitability, accessibility, management of the circulation network, and efficient use of land. The following six principles express the priorities and values of Smart Mobility:

- *Location Efficiency* - Integrate transportation and land use in order to achieve high levels of non-motorized travel and transit use, reduced vehicle trip making, and shorter average trip lengths while providing a high level of accessibility.
- *Reliable Mobility* - Manage, reduce, and avoid congestion by emphasizing multimodal options and network management through operational improvements and other strategies. Provide predictability and capacity increases focused on travel that supports economic productivity.
- *Health and Safety* - Design, operate, and manage the transportation system to reduce serious injuries and fatalities, promote active living, and lessen exposure to pollution.
- *Environmental Stewardship* - Protect and enhance the State's transportation system and its built and natural environment. Act to reduce the transportation system's emission of greenhouse gasses (GHGs) that contribute to global climate change.
- *Social Equity* - Provide mobility for people who are economically, socially, or physically disadvantaged in order to support their full participation in society. Design and manage the transportation system in order to equitably distribute its benefits and burdens.
- *Robust Economy* - Invest in transportation improvements, including operational improvements—that support the economic health of the State and local governments, the competitiveness of California's businesses, and the welfare of California residents.

The primary goal of this SMF pilot effort was to supplement and complement the Contra Costa County I-680 CSMP, to compile the findings of SMF testing and evaluation, and to present the results that can be used to guide Caltrans' future system planning and facility development. The Contra Costa County I-680 CSMP incorporates SMF principles when defining goals and objectives of the CSMP and when recommending performance measures, SMF Place Types when defining and describing the corridor (in Section 2), and SMF performance measures as the basis for evaluating corridor existing conditions performance.

Complete Streets[1]

The second component of this CSMP was to perform an assessment of Complete Streets opportunities and prepare a Complete Streets Evaluation report focused on the I-680 CSMP corridor in Contra Costa County. The Caltrans District 4 Office of System Planning drafted the *Preliminary Guidance on Incorporation of Complete Streets Issues in Caltrans System Planning Documents* (under separate cover at Appendix B of this CSMP) and wanted to improve upon this guidance in a freeway-based, congested urban corridor.

The California Complete Streets Act of 2008[2] requires that cities and counties address the needs of all roadway users including bicyclists, pedestrians, and transit users in general plan updates. Caltrans has adopted a Complete Streets policy through *Deputy Directive-64-R1, Complete Streets- Integrating the Transportation System (2008)*. Complete Streets provide for the safe mobility of all users, including bicyclists, pedestrians, transit riders, truckers, and motorists appropriate to the function and context of the facility. It provides safe travel for people using any legal mode of travel, including bicycling, walking, riding transit, and driving, resulting in benefits to communities, regions, and the State, including:

- Supporting increased physical activity and improving public health and safety
- Providing options and access for non-drivers
- Decreasing vehicle trips and associated air pollutant and greenhouse gas emissions
- Improving livability, revitalizing communities, and decreasing transportation costs.

Tools for Operational Planning (TOPL)[3]

Currently under development by the PATH program at the University of California at Berkeley (UCB), TOPL is a package of software and analytics that will allow planners and engineers the ability to design and test major traffic corridor operational improvements that go beyond major infrastructure expansion such as:

- Incident management
- Traveler routing and diversion
- Toll and commuter lane (HOT) management
- Arterial signaling control
- Demand management
- Pricing
- Ramp metering.

TOPL is designed to provide quick, quantitative assessments of congestion relief strategies for freeways and urban arterials. The Caltrans District 4 (San Francisco Bay Area) Division of Traffic Operations has been working with the UCB PATH research team over the past several years to design and test TOPL. The Contra Costa County I-680 CSMP is the first larger-scale demonstration of TOPL being applied to a corridor.

[1] Complete Streets, Caltrans Division of Transportation Planning Office of Community Planning: www.dot.ca.gov/hq/tpp/offices/ocp/complete_streets.html
[2] Assembly Bill 1358, requires cities and counties to ensure that traffic elements of local general plans account for the needs of all roadway users. http://www.leginfo.ca.gov/pub/07-08/bill/asm/ab_1351-1400/ab_1358_bill_20080930_chaptered.pdf
[3] UC Berkeley PATH TOPL: http://gateway.path.berkeley.edu/topl/index.html.

TOPL is based on macro-simulation freeway and arterial models that are readily assembled, self-calibrated, and self-diagnosed. A successful TOPL will have real-time tools to predict traffic conditions and performance in short-term (e.g., 1-5-years), sound alarms for potential trouble or stress conditions, allow real-time testing and evaluation of counter measures (e.g., "play-book" strategies for addressing congestion).

The Contra Costa County I-680 CSMP was used to assess the feasibility of applying TOPL to CSMP development that takes into account the performance measures developed for the Contra Costa County I-680 CSMP calibration criteria defined by generally accepted best practices.

This report discusses the base year conditions that were used to determine if TOPL was calibrated, including the identification of the locations and causality of major bottlenecks on the corridor (Section 5 of this report). For this study, traffic conditions for spring 2013 non-holiday weekdays were used as the base conditions against which TOPL was evaluated.

For forecast year conditions, the CCTA travel demand model was used to develop growth rates for horizon year simulation. The CCTA model was used to identify general impacts on the corridor and estimate diversion impacts for major transit service, land use, and arterial improvements.[4] Section 6 of this report discusses the CCTA model in more detail.

Stakeholder Outreach

To help guide the CSMP effort, Caltrans convened a Staff Working Group (SWG) composed of Caltrans District 4 and headquarters engineering and planning staff, CCTA planning staff, MTC planning staff, as well as UCB PATH researchers involved in the development of TOPL and SMF pilot study consultant team members. The purpose of the SWG was to carry out the work for the study and to guide consultant efforts. The SWG met monthly over the lifespan of the project with few exceptions. In conjunction with forming the SWG, Caltrans invited the following corridor stakeholders to join a Technical Advisory Committee (TAC):

- Alameda County Transportation Commission (ACTC)
- Bay Area Rapid Transit District (BART)
- City of Concord
- Town of Danville
- City of Dublin
- City of Lafayette
- City of Martinez
- City of Pleasant Hill
- City of San Ramon
- City of Walnut Creek
- Contra Costa County
- CCTA
- County Connection
- Contra Costa County Transportation Authority Countywide Bicycle and Pedestrian Advisory Committee (CBPAC)
- MTC
- Regional Transportation Planning Committees (RTPCs)
  - Transportation Partnership and Cooperation (TRANSPAC)-Central County
  - Southwest Area Transportation (SWAT)-Southern County
  - TRANSPLAN Committee-Eastern County
- Solano Transportation Authority (STA).

The TAC was convened at major decision points in the study or when significant milestones had been reached:

[4] CCTA Travel Demand Model: http://www.ccta.net/planning/view/162/2.

May 18, 2012 – To provide an overview of the project and milestones, summarize previous studies, and introduce TOPL and SMF efforts.

September 21, 2012 – To discuss the proposed TOPL model network, Complete Streets analysis network, and performance measures. Initial corridor wide performance results were presented as well as a summary of SMF place types.

June 18, 2013 – To present the findings from the corridor performance assessment, the Complete Streets analysis, and the findings from the bottleneck and causality assessment. A TOPL update was presented in addition to a facilitated discussion of future scenarios to be evaluated using TOPL.

November 18, 2013 – To present the final freeway performance assessment, Complete Streets analysis, SMF multimodal service quality analysis, and the freeway bottlenecks and causality analysis. A TOPL modeling update was also presented as were the draft scenarios to be evaluated.

February 27, 2014 – To present the findings from the scenario testing using the CCTA travel demand model. A TOPL modeling update was also presented.

In addition to the TAC meetings, presentations were made to the CCTA RTPCs - TRANSPAC, SWAT, and TRANSPLAN - as well as to the Countywide Bicycle and Pedestrian Advisory Committee.

Report Organization

This report is organized into the following sections:

1. *Introduction* is this current section.
2. *Corridor Description* describes the corridor, including the roadway facility, recent improvements, major interchanges, transit services serving freeway travelers, major intermodal facilities around the corridor, special event facilities/trip generators, and corridor socio-economic characteristics.
3. *Corridor Environmental Considerations* provides a high-level review of environmental resources and issues known to exist near the corridor. The provided information is relative to the route or route segment and is not to be considered project specific.
4. *Corridor Performance and Trends* presents results for and trends for the mobility, reliability, safety, and productivity performance measures.
5. *Bottleneck Identification and Causality* describes how bottlenecks on the freeway facility were identified and pinpoints the causes of congestion created at the bottleneck location.
6. *Modeling Approach* presents the overall approach to modeling baseline and forecast conditions on the corridor.
7. *Future Conditions* presents base year and forecast year baseline model conditions
8. *Scenario Testing Approach* discusses the evaluation scenarios and the method used to evaluate scenarios.
9. *Scenario Evaluation and Conclusions* presents the results of the modeling analysis and summarizes key findings and conclusions from the study.

2. CORRIDOR DESCRIPTION

Interstate 680 is the primary north-south route traversing the entire length of Contra Costa County. As shown in Exhibit 2-1, the Contra Costa County I-680 CSMP Corridor covers the length of the county limits from the Alameda County line (postmile R0.000) to the Solano County line (postmile R25.461). To capture the impacts of the regionally significant I-580/I-680 interchange, the modeled corridor for freeway traffic analysis was extended south into Alameda County, extending from Stoneridge Drive in the City of Pleasanton, approximately one mile south of the I-580/I-680 interchange.

I-680 is part of the State Scenic Highway System from SR-238 in Fremont north to SR-24 in Walnut Creek. Between the I-580 interchange in Alameda County and Alcosta Boulevard in San Ramon, I-680 is officially designated the "Officer John Paul Monego Memorial Freeway," between the Alcosta Boulevard and Livorna Road interchanges, it is designated the “Donald D. Doyle Highway,” and north of SR-24 is designated as the “Senator Daniel E. Boatwright Highway.”

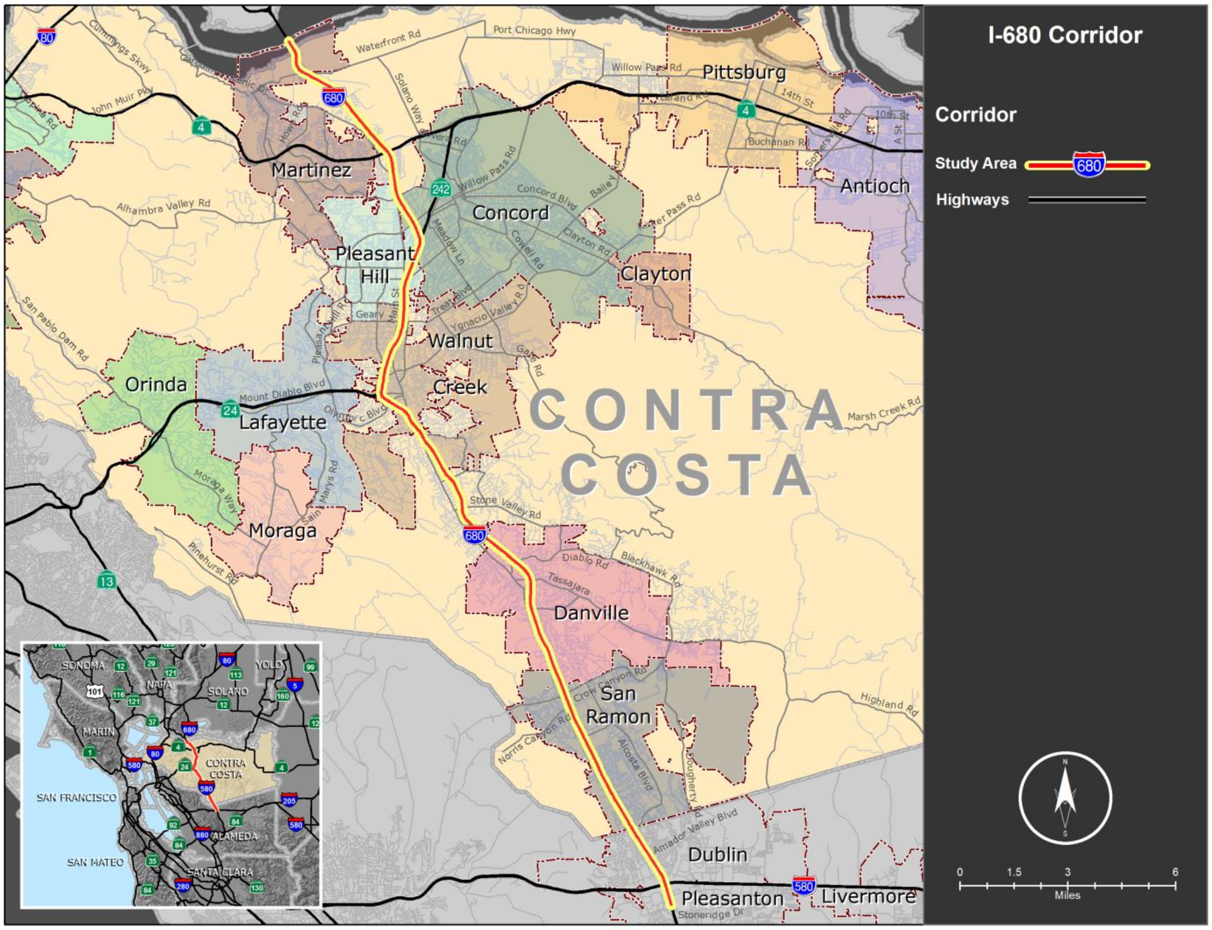
There are four freeway-to-freeway interchanges along the corridor:

- SR-24 is an east–west freeway located on the eastern side of the San Francisco Bay Area that runs from the I-580/I-980 interchange in Oakland to the I-680 junction in Walnut Creek.
- SR-242 is a 3-mile north-south connector linking I-680 north of Pleasant Hill to SR-4 in Concord.
- SR-4 is an east-west State highway route that runs from I-80 in western Contra Costa County to San Joaquin County, continuing through the City of Stockton, and ending at SR-89 in Alpine County in the Sierra Nevada Mountains.
- I-580 is an 80-mile east-west interstate between San Rafael in Marin County and the I-5 near Tracy in the Central Valley. It intersects I-680 at the southern end of the corridor in Alameda County.

The study corridor passes through eight cities and unincorporated communities in Contra Costa and Alameda Counties including:

- City of Concord
- Town of Danville
- City of Dublin (Alameda County)
- City of Lafayette
- City of Martinez
- City of Pleasant Hill
- City of Pleasanton (Alameda County)
- City of San Ramon
- City of Walnut Creek
- Unincorporated communities of Alamo and Pacheco.

Exhibit 2-1: Contra Costa County I-680 CSMP Corridor



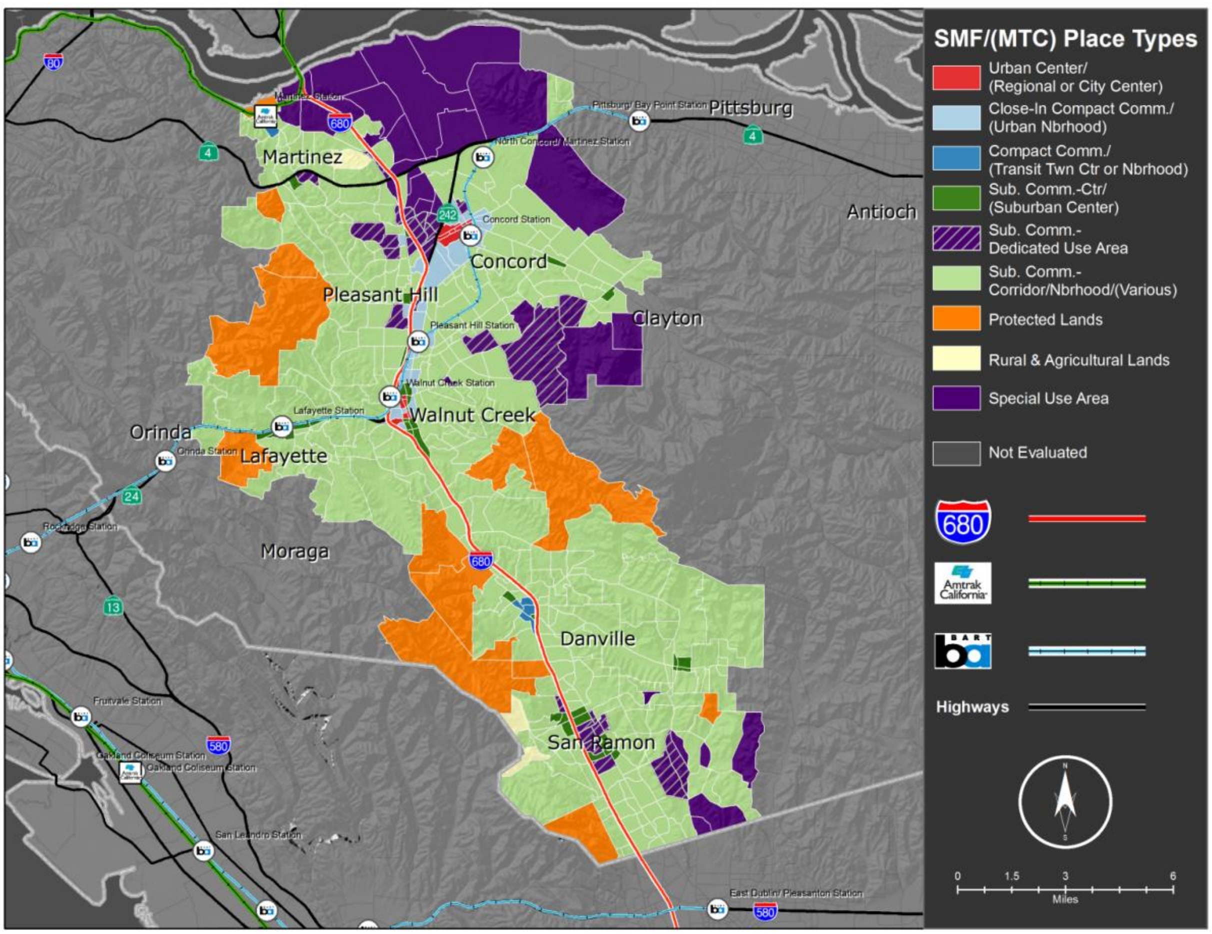
Source: System Metrics Group, Inc.

SMF Place Types

The CSMP study included a "Place Types" analysis for the corridor focusing on Contra Costa County (due to the availability of parcel data for the county) using the SMF place type categories shown in Exhibit 2-2. Most of the Contra Costa County I-680 CSMP corridor may be best described as being a "Suburban Community" place type shown by the light green color. Other predominant types include "Special Use Areas" such as the Tesoro Golden Eagle Refinery in Pacheco and the Concord Naval Weapons Station. A third major type is the "Protected Lands" open spaces such as Mount Diablo State Park (in orange).

Areas near the Walnut Creek and Concord BART stations were labeled as "Urban Centers" (dark red) surrounded by a mix of "Suburban Centers" and "Close-In Compact Communities" all lying adjacent to I-680 and SR-242. Some "Suburban Community Dedicated Use Areas' along the corridor include Bishop Ranch in San Ramon, the California State University East Bay campus and the Waterworld Theme Park, both in Concord.

Exhibit 2-2: Contra Costa County Place Types



Source: System Metrics Group, Inc.

The place types were labeled based on general SMF criteria that include:

- Completeness in relation to land use and activities
- Connectivity of transportation networks
- Accessibility to a range of destinations throughout the area
- Local transit service
- Safe and convenient bicycling and walking.[5]

The process for developing the place types was iterative, using both quantitative and qualitative analysis. More details can be found in Appendix D of this final report (*I-680 Corridor System Management Plan Smart Mobility Framework (SMF) Place Type Analysis Methodology*).

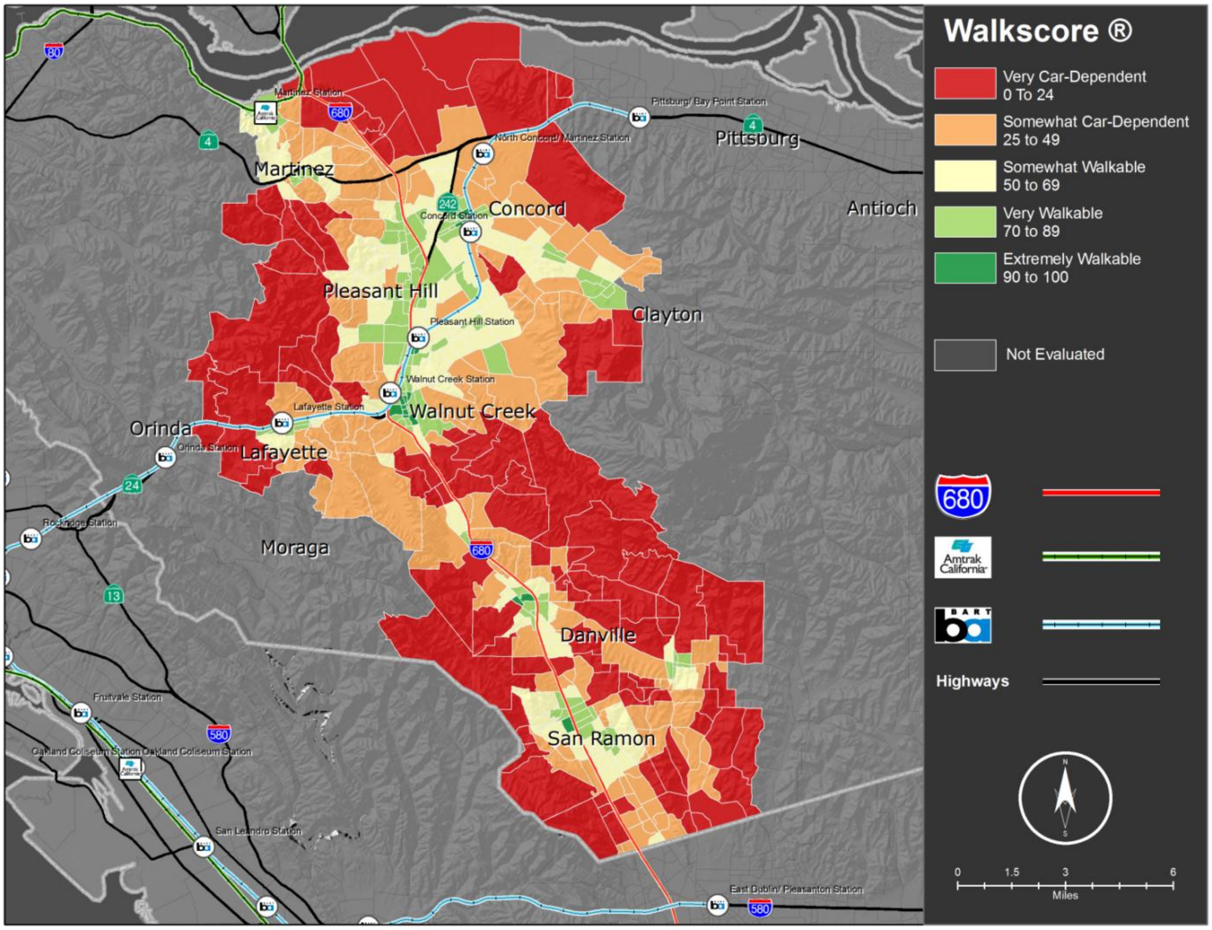
The process was largely based on 2010 land use and socio-economic data at the traffic analysis zone (TAZ) level from the CCTA countywide model master land use data. The TAZ data are linked to Geographic Information System (GIS) spatial coverages for visualization. Key information from this dataset included household and employment data.

These data were supplemented by other data from Walk Score®, an internet-based site that rates street addresses based on the walkability to nearby utilitarian amenities (e.g., grocery, restaurants, entertainment)[6]. Exhibit 2-3 is a map showing the results of the Walk Score analysis. Other data sets used included parcel maps obtained from CCTA, transit route maps and schedules, and MTC Place Types maps.

Labeling TAZs with SMF Place Types was an iterative process using all of the data sources and tools described above. There were also challenges caused by a lack of firm guidelines to apply quantitative measures to place types. For example, one of the key features of a "Highly Compact" place is residential density, but there are no distinctions between what constitutes a "Close-In Compact Neighborhood" versus a "Suburban Neighborhood."

[5] California Department of Transportation. *(2010). Smart Mobility 2010: A Call to Action for the New Decade*.
http://www.dot.ca.gov/hq/tpp/offices/ocp/documents/smf_files/SMF_handbook_062210.pdf
[6] www.walkscore.com

Exhibit 2-3: I-680 Corridor Walk Score



Source: SMG analysis of Walk Score. 2012

The I-680 CSMP corridor has been divided into ten segments as listed in the table in Exhibit 2-4 and shown in the map in Exhibit 2-5. The major characteristics of the existing corridor are summarized in the table in Exhibit 2-6. The study corridor is a six to 10 lane freeway with intermittent auxiliary lanes. The high majority of the corridor has concrete median barriers. Part-time High Occupancy Vehicle (HOV) lane segments are available along most of the corridor. Three northbound HOV segments include: Alcosta Boulevard to Livorna Road, SR-242 to Marina Vista Boulevard, and at the Benicia-Martinez Bridge toll plaza. The two sections of southbound HOV lanes run from Marina Vista Boulevard south to Treat Boulevard and from Rudgear Road to Alcosta Boulevard. Finally, 19 segments were identified for the Complete Streets evaluation that contained parallel arterials, interchanges, and non-interchange crossings to the freeway.

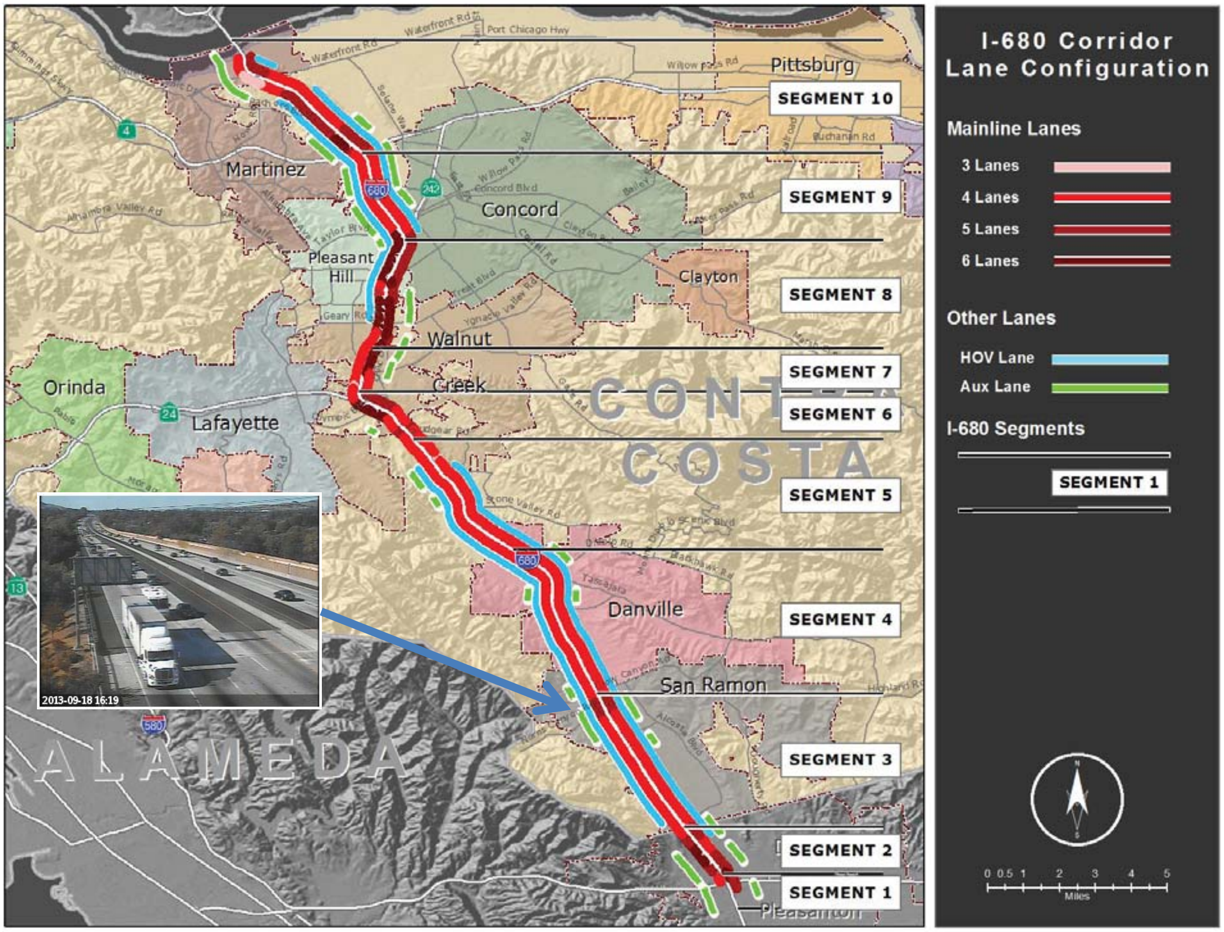
Exhibit 2-7 is a table summarizing the HOV facilities on the Contra Costa County I-680 CSMP corridor. In November 2011, the southbound HOV lane was extended north from Livorna Road to Rudgear Road, which now makes the southbound facility a 12.9 mile lane from Rudgear Road south to Alcosta Boulevard. Exhibit 2-8 is a table summarizing the auxiliary facilities on the Contra Costa County I-680 CSMP corridor.

Finally, 19 different segments were evaluated as part of a Complete Streets evaluation of parallel arterials, interchanges, and non-interchange crossings of the I-680 CSMP corridor. Exhibit 2-9 shows the freeway crossings evaluated as part of this evaluation. More details and findings from the evaluation can be found in Appendix C of this report.

Exhibit 2-4: I-680 Corridor Segments

Segment	Location Description	County_Route_ Beg. PM	County_Route_ End PM
1	Stoneridge Drive to I-580 East Interchange	ALA_680_R19.301	ALA_680_R20.324
2	I-580 East Interchange to Alcosta Blvd (Contra Costa county line)	ALA_680_R20.324	CC_680_R0.005
3	Alcosta Blvd (Contra Costa county line) to Crow Canyon Rd	CC_680_R0.005	CC_680_R4.181
4	Crow Canyon Rd to El Pintado Rd	CC_680_R4.181	ALA_680_R8.761
5	El Pintado Rd to Rudgear Rd	ALA_680_R8.761	CC_680_R12.611
6	Rudgear Rd to SR 24	CC_680_R12.611	CC_680_14.38
7	SR 24 to North Main St	CC_680_14.38	CC_680_15.61
8	North Main St to SR 242	CC_680_15.61	CC_680_R18.71
9	SR 242 To SR 4	CC_680_R18.71	CC_680_21.19
10	SR 4 to Contra Costa/Solano county line/Benicia-Martinez Bridge	CC_680_21.19	CC_680_R25.518R

Exhibit 2-5: I-680 Corridor Lane Configuration



Source: System Metrics Group, Inc.

Exhibit 2-6: I-680 Corridor Existing Facilities

Segment #		1	2	3	4	5	6	7	8	9	10
Existing Facility											
Facility Type		F	F	F	F	F	F	F	F	F	F
General Purpose Lanes		7 - 10	6 - 11	8 - 10	8 - 10	7 - 8	8 - 11	7 - 10	9 - 12	8 - 11	7 - 11
Lane Miles		8.0	15.6	37.9	31.9	33.4	17.2	9.4	35.4	23.2	38.0
Centerline Miles		0.9	1.7	4.6	3.9	4.2	1.7	1.1	3.2	2.7	4.3
Median Width		10	10	10	10	10	10	10	10	10	10
Median Characteristics		Paved	Paved	Paved	Paved	Paved	Paved	Paved	Paved	Paved	Paved
HOV Lanes		0	1	2	2	2	0	0	1	2	2
HOV Characteristics		N/A	2 or more persons per vehicle	2 or more persons per vehicle	2 or more persons per vehicle	2 or more persons per vehicle	N/A	N/A	2 or more persons per vehicle	2 or more persons per vehicle	2 or more persons per vehicle / 3 or more persons per vehicle at toll plaza
HOT/Express Lanes		0	0	0	0	0	0	0	0	0	0
HOT/ Express Lanes Characteristics		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Toll Lanes		0	0	0	0	0	0	0	0	0	10
Toll Lane Characteristics		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	HOV: 3 or more persons per vehicle
BRT Lanes		0	0	0	0	0	0	0	0	0	0
Auxiliary Lanes		65%	61%	24%	17%	9%	24%	26%	23%	63%	28%
Passing Lanes		0	0	0	0	0	0	0	0	0	0
Truck Climbing Lanes		0	0	0	0	0	0	0	0	0	0
Distressed Pavement		66%	56%	0%	26%	29%	0%	0%	12%	0%	0%
Current ROW		67 - 95 Ft.	85 - 110 Ft.	73 - 75 Ft.	82 - 90 Ft.	81 - 86 Ft.	91 - 91 Ft.	81 - 150 Ft.	92 - 117 Ft.	92 - 150 Ft.	67 - 95 Ft.

Exhibit 2-7: I-680 HOV Lane Summary

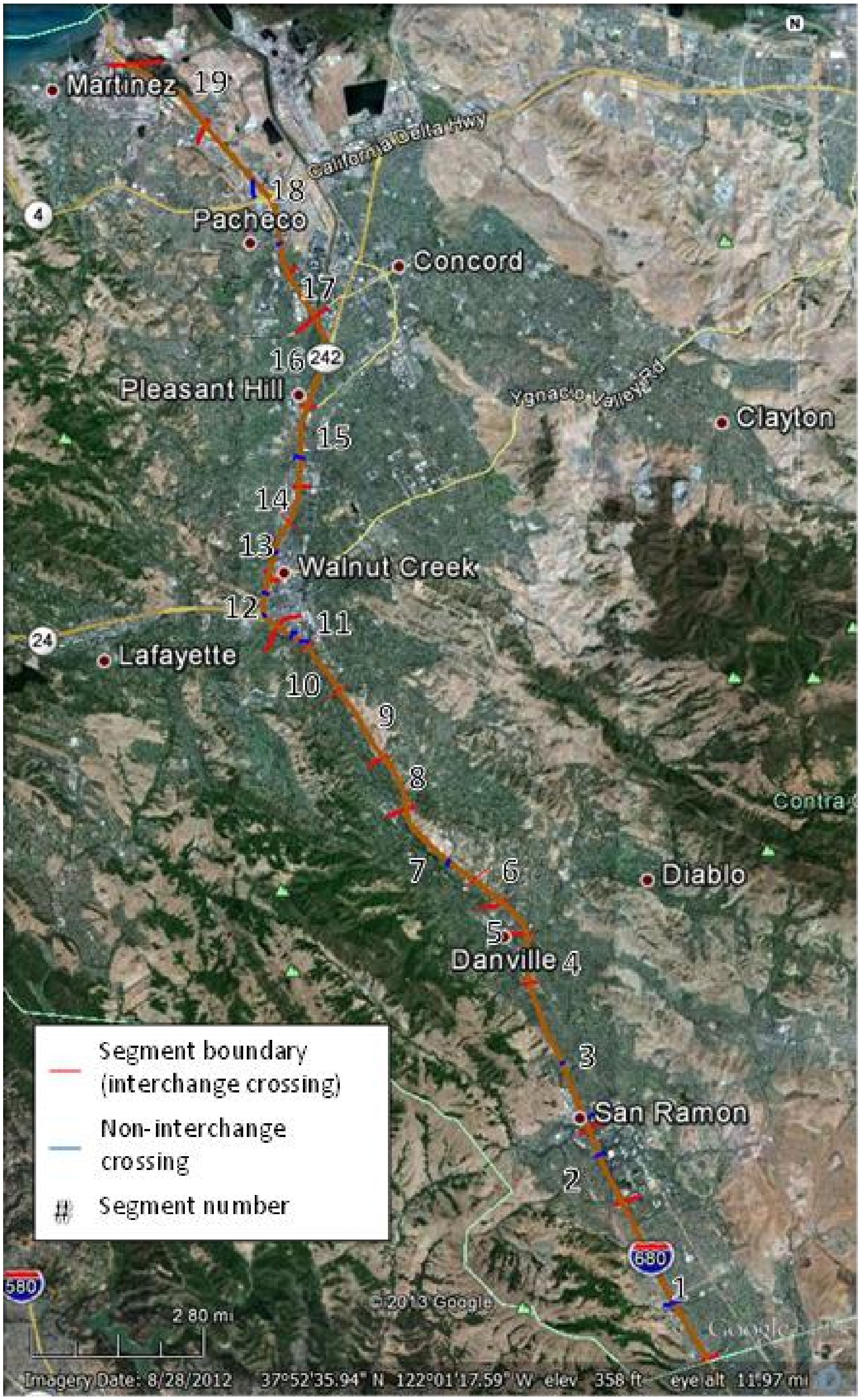
Segment	Dir	Location	Lane-Miles	Minimum Occupancy Requirement	Hours of Operation
10	NB	Benicia-Martinez Bridge Toll Plaza	1	3+	5-10 AM, 3-7 PM
8-10	SB	Marina Vista to N/O N. Main St.	7.8	2+	5-9 AM, 3-7 PM
9-10	NB	Route 242 to Marina Vista I/C	4.4	2+	5-9 AM, 3-7 PM
2-5	SB	Rudgear Rd to Alcosta Blvd	12.9	2+	5-9 AM, 3-7 PM
3-5	NB	Alcosta Blvd to Livorna Rd	11.9	2+	5-9 AM, 3-7 PM

Source: Caltrans. 2011 Bay Area HOV Lanes: Volumes, Occupancies and Violation Rates. 2011.
, http://www.dot.ca.gov/dist4/highwayops/docs/2011%20Revised%20HOV%20Report.pdf

Exhibit 2-8: I-680 Auxiliary Lanes Summary

Route	Direction	County	Segment	PM1	PM2	Length (miles)	Approximate Start	Approximate End
680	NB	ALA	1	R19.43	R19.83	0.4	STONERIDGE DR ON	EB I-580 ON
680	NB	ALA	1-2	R20.274	R20.829	0.5	NB I-580 OFF	JNO AMADOR VALLEY BLVD
680	NB	ALA	2	R21.152	R21.749	0.6	JNO AMADOR VALLEY BLVD	NB OFF TO ALCOSTA BLVD
680	NB	CC	3	R2.223	R2.524	0.3	ASCOT DR	NB OFF TO BOLLINGER CANYON RD
680	NB	CC	3	R3.039	R3.798	0.8	NB ON FROM BOLLINGER CANYON RD	NB OFF TO CROW CANYON RD
680	NB	CC	4	R6.904	R7.263	0.4	NB ON FROM SYCAMORE VALLEY RD	NB OFF TO DIABLO RD
680	NB	CC	4	R7.66	R8.013	0.3	NB ON FROM DIABLO RD	NB OFF TO EL CERRO BLVD
680	NB	CC	6	14.091	14.459	0.4	NB ON FROM OLYMPIC BLVD	NB OFF TO YGNACIO VALLEY BLVD
680	NB	CC	7	14.893	15.451	0.6	YGNACIO VALLEY RD	NB OFF TO N MAIN ST
680	NB	CC	8	15.737	16.176	0.4	NB ON FROM N MAIN ST	NB OFF TREAT BLVD
680	NB	CC	8	16.454	R17.452	1.0	TREAT BLVD	NB OFF TO MONUMENT BLVD
680	NB	CC	9	19.186	19.693	0.5	NB ON FROM WILLOW PASS RD	NB OFF TO BURNETT AVE/CONCORD AVE
680	NB	CC	9	20.066	21.041	1.0	NB ON FROM CONCORD AVE	NB OFF TO EB SR-4
680	NB	CC	10	21.397	21.905	0.5	NB ON FROM WB SR-4	NB OFF TO PACHECO BLVD
680	SB	ALA	1	R20.142	R19.442	0.7	SB OFF TO STONERIDGE DR	JNO I-580 IC
680	SB	ALA	2	R21.476	R20.528	0.9	SB OFF TO I-580 WB	SB ON FROM ALCOSTA BLVD
680	SB	CC	3	R3.922	R3.108	0.8	SB OFF TO BOLLINGER CANYON BLVD	SB ON FROM CROW CANYON RD
680	SB	CC	3	R4.716	R4.406	0.3	SB OFF TO CROW CANYON RD	HOOPER DR
680	SB	CC	4	R7.271	R6.96	0.3	SB OFF TO SYCAMORE VALLEY DR	SB ON FROM DIABLO RD
680	SB	CC	4	R7.953	R7.686	0.3	SB ON FROM EL CERRO BLVD	SB OFF TO DIABLO RD
680	SB	CC	5	R11.097	R10.779	0.3	SB ON FROM LIVORNA RD	SB OFF TO STONE VALLEY RD
680	SB	CC	5	R11.917	R11.46	0.5	SB ON FROM RUDGEAR RD	SB OFF TO LIVORNA RD
680	SB	CC	6	13.663	13.192	0.5	SB OFF FROM OLYMPIC BLVD	SB OFF TO S MAIN ST
680	SB	CC	9	R19.06	R18.707	0.3	SB ON FROM SUNVALLEY BLVD	I-680/SR-242 IC
680	SB	CC	9	19.897	19.161	0.7	SB ON FROM CONTRA COSTA BLVD	SB OFF TO SUNVALLEY BLVD
680	SB	CC	9	21.01	20.113	0.9	SB ON FROM EB SR-4	SB OFF TO CONTRA COSTA BLVD
680	SB	CC	10	22.336	21.595	0.8	SB ON FROM PACHECO BLVD	SB OFF TO WB SR-4
680	SB	CC	10	0.115L	24.42	1.2	SOLANO COUNTY LINE	SB OFF TO MARINA VISTA

Exhibit 2-9: I-680 Complete Streets Interchange and Non-Interchange Crossings



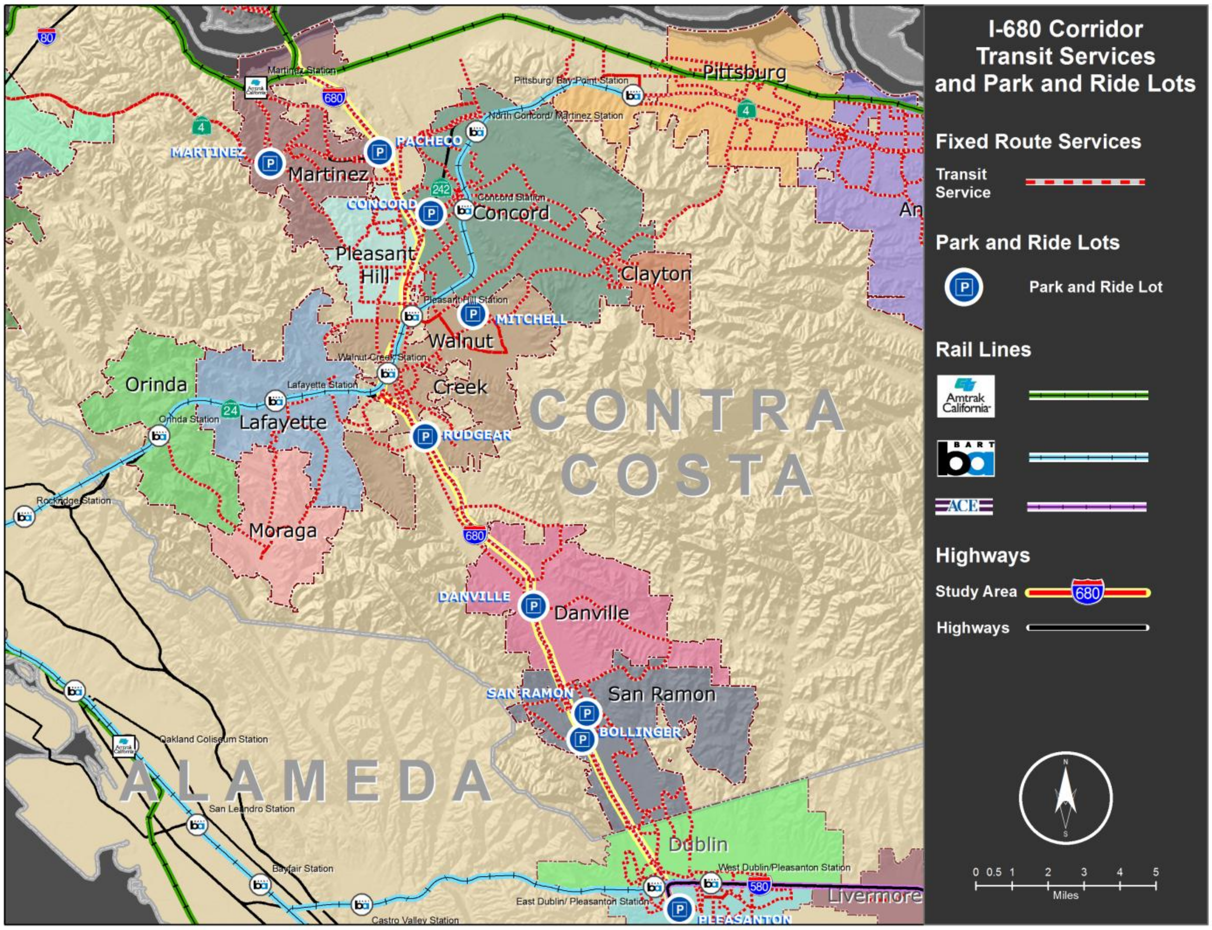
Corridor Transit Services

The major public transportation operators that provide service on or within five miles of the study corridor are:

- Heavy, Commuter, or Intercity Rail
    - Altamont Corridor Express (ACE)
    - Bay Area Rapid Transit District (BART)
    - Capitol Corridor (Amtrak California)
    - San Joaquin (Amtrak California).
- Bus Transit
    - County Connection
    - FAST (Fairfield & Suisun Transit)
    - Soltrans
    - Tri Delta Transit
    - WestCAT
    - Wheels.

Exhibit 2-10 shows the major rail corridors and stations, nearby park and ride lots, as well as fixed route bus transit services that serve the Contra Costa County I-680 CSMP corridor. The primary transit service providers serving the corridor are described in the sections below. Exhibit 2-11 is a table listing key features of nearby park and ride lots that do not serve BART stations.

Exhibit 2-10: I-680 CSMP Corridor Transit Services/Park and Ride Facilities



Source: System Metrics Group, Inc./GIS/Internet

Exhibit 2-11: I-680 Corridor Park and Ride Facilities

Park and Ride Name	Address	City	Number of Spaces	Highway
Bollinger	SW Quad I-680 / Bollinger Canyon Rd	San Ramon	108	680
Concord	E of SR-242 / S of Willow Pass Rd / W of Market St	Concord	45	242
Danville	Sycamore Valley Rd & Camino Ramon	Danville	230	680
Martinez	Alhambra Rd & Franklin Canyon	Martinez	24	680
Mitchell	Mitchell Dr btwn Oak Grove Rd & N Wiget Ln	Walnut Creek	92	680
Pacheco Transit Hub	Pacheco Blvd @ Blum Rd N of SR-4	Martinez	110	4
Pleasanton	Johnson Dr & Stoneridge Dr	Pleasanton	83	680
Rudgear	SE Quad I-680 / Rudgear Rd	Walnut Creek	64	680
San Ramon	Camino Ramon & Executive Pkwy	San Ramon	52	680

Sources: Caltrans District 4 Division of Traffic Operations. MTC 511.org.

ACE Train

ACE is a commuter rail system that operates between Stockton in San Joaquin County and San Jose in Santa Clara County. The Pleasanton Station lies approximately four miles from the southern terminus of the Contra Costa County I-680 CSMP corridor. The County Connection *Route 92x ACE Express* provides direct express bus service to Bishop Ranch in San Ramon and Shadelands Business Park in Walnut Creek.

ACE provides four AM peak period westbound trains and four PM peak period eastbound trains during non-holiday weekdays. Parking is free at all ACE stations.

BART

The BART heavy rail system connects the San Francisco and San Mateo Counties on the peninsula with East Bay cities in Alameda and Contra Costa Counties. In Contra Costa County, BART serves communities adjacent to or near the Contra Costa County I-680 CSMP corridor including Concord, Lafayette, Martinez, Pleasant Hill, and Walnut Creek. In Alameda County, BART directly serves Dublin and Pleasanton.

BART operates between the hours of 4:00 AM and 12:00 AM with reduced frequency of service on weekends and holidays. BART stations serving the I-680 corridor have parking, which are either free or paid.

Capitol Corridor

The Capitol Corridor is an intercity passenger rail system providing service along the I-80, I-680, and I-880 freeways between San Jose and Auburn. The system serves 16 stations, including a staffed station in the City of Martinez, which lies approximately 1.6 miles west of the I-680/Marina Vista interchange.

Since August 2012, the Capitol Corridor Joint Powers Authority (CCJPA) has operated 30 weekday and 22 weekend trains between Oakland and Sacramento, 14 weekday trains between Oakland and San Jose, with two weekday trains to Roseville and Auburn in Placer County.

The CCJPA is a partnership among the six local transit agencies in the eight county service areas which shares the administration and management of the Capitol Corridor. BART provides day-to-day management support to the CCJPA.

San Joaquin

The San Joaquin is an intercity passenger rail system providing service along the I-880, I-80, I-680, SR-4, and SR-99 freeways between Oakland and Bakersfield. The system serves 18 stations, including a staffed station in the City of Martinez, which lies approximately 1.6 miles west of the I-680/Marina Vista interchange.

The San Joaquin route operates seven weekday trains between Oakland and Bakersfield and seven weekday trains between Bakersfield and Oakland. Free transfers are provided to Tri-Delta Transit and Rio Vista Delta Breeze transit services.

County Connection -Central Contra Costa Transit Authority (CCCTA)

County Connection is the primary Contra Costa County I-680 CSMP corridor provider of fixed-route and paratransit bus service throughout the central Contra Costa County including the communities of Clayton, Concord, Martinez, Pleasant Hill, Walnut Creek, Danville, San Ramon, Lafayette, Orinda, and Moraga, as well as unincorporated communities. Express bus routes 92x, 95x, 96x, and 97x provide direct service along the I-680 corridor. Express bus route 98x connects Martinez to Walnut Creek and provides stops parallel to I-680 along Contra Costa Boulevard in Pleasant Hill.

FAST

FAST route 40 express intercity bus provides weekday service between Vacaville and Walnut Creek. Route 40 provides eastbound and westbound service in the AM & PM commute periods only. The eastbound route departs from Walnut Creek BART, to Pleasant Hill BART, to Benicia Park Road and Industrial Way, to Fairfield Transportation Center, and arrives at the Vacaville Transportation Center. The westbound route departs from the Vacaville Transportation Center, to the Fairfield Transportation Center, to Benicia Park Road and Industrial Way, to Pleasant Hill BART, and arrives at the Walnut Creek BART. There is no weekend service.

SolTrans

SolTrans provides transit services primarily in Vallejo and surrounding communities in Solano County. Route 76 provides one morning trip each weekday to Diablo Valley College in Pleasant Hill from Vallejo and Benicia, and one afternoon trip returning to Vallejo. Routes 78 and 80 provide weekday and Saturday service between Vallejo, Benicia, and the Walnut Creek BART station.

Tri Delta Transit

Tri-Delta Transit provides fixed-route and paratransit bus services in eastern Contra Costa County. Routes 200 and 201 provide service to Martinez and the Concord BART station, respectively.

WestCAT

WestCAT serves West Contra Costa County, including the cities of Pinole and Hercules and the unincorporated areas of Montalvin Manor, Bayview, Tara Hills, Rodeo, Crockett, and Port Costa. WestCAT also operates regional service between Martinez and the El Cerrito del Norte BART station. It also provides transbay service between the Hercules Transit Center and the San Francisco Transbay Terminal.

Wheels

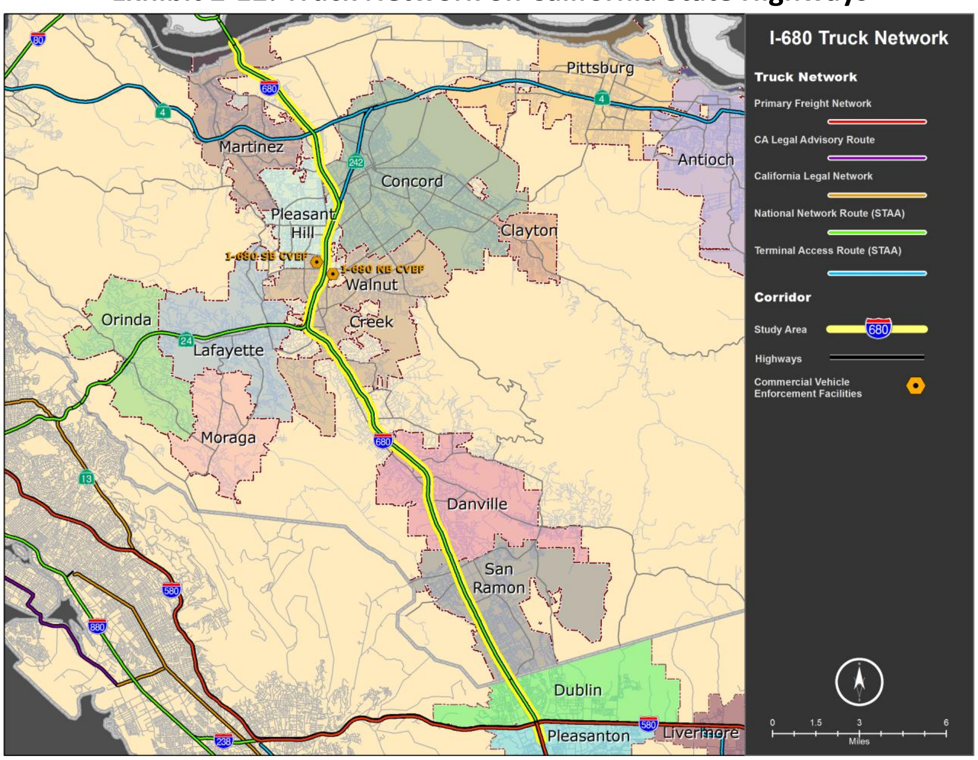
The Livermore Amador Valley Transit Authority (LAVTA) operates the *Wheels* fixed route and paratransit service that provides the Tri-Valley communities of Dublin, Livermore and Pleasanton with connections to BART. This includes the West Dublin/Pleasanton station at the I-580/I-680 interchange. Weekday commute service to Walnut Creek BART and Pleasant Hill/Contra Costa Centre BART is provided by Route 70x.

Freight and Intermodal Facilities

As shown in Exhibit 2-12, the entire length of Contra Costa I-680 is designated a Surface Transportation Assistance Act (STAA) National Network route, and the exhibit also shows which class of heavy duty trucks are allowed to operate on the freeway. In Alameda County, south of the I-580 interchange, I-680 is designated a Primary Freight Network (PFN) by the Federal Highway Administration (FHWA). According to the latest truck volumes from the 2012 Caltrans Annual Average Daily Truck Traffic (AADT) data, trucks comprise between three and eight percent of total daily traffic along the corridor. Reported total trucks as a percentage of total AADT are highest at the I-580/I-680 interchange (7.6 percent) and at the I-680/SR-4 interchange (6.8 percent), with approximately 5.3 percent reported at the Alameda County line. The percentage of heavy duty trucks (5-axles or more) follows a similar pattern with 4.3 percent of all AADT being comprised of heavy duty trucks at the I-580/I-680 interchange, followed by 2.6 percent at the I-680/SR-24 interchange, and 2.3 percent at the I-680/SR-4 interchange.

There is a California Commercial Vehicle Enforcement Facility (CVEF) adjacent to the Treat/Geary Boulevards interchange in Walnut Creek in the northbound and southbound directions. This CVEF is a class "D" facility with a platform scale. Class "D" facilities are those equipped with the minimum features required to be supplied by Caltrans and by the California Highway Patrol (CHP).

Exhibit 2-12: Truck Network on California State Highways



Source: Caltrans Division of Traffic Operations, Office of Truck Services. www.dot.ca.gov/hq/traffops/trucks/truckmap/

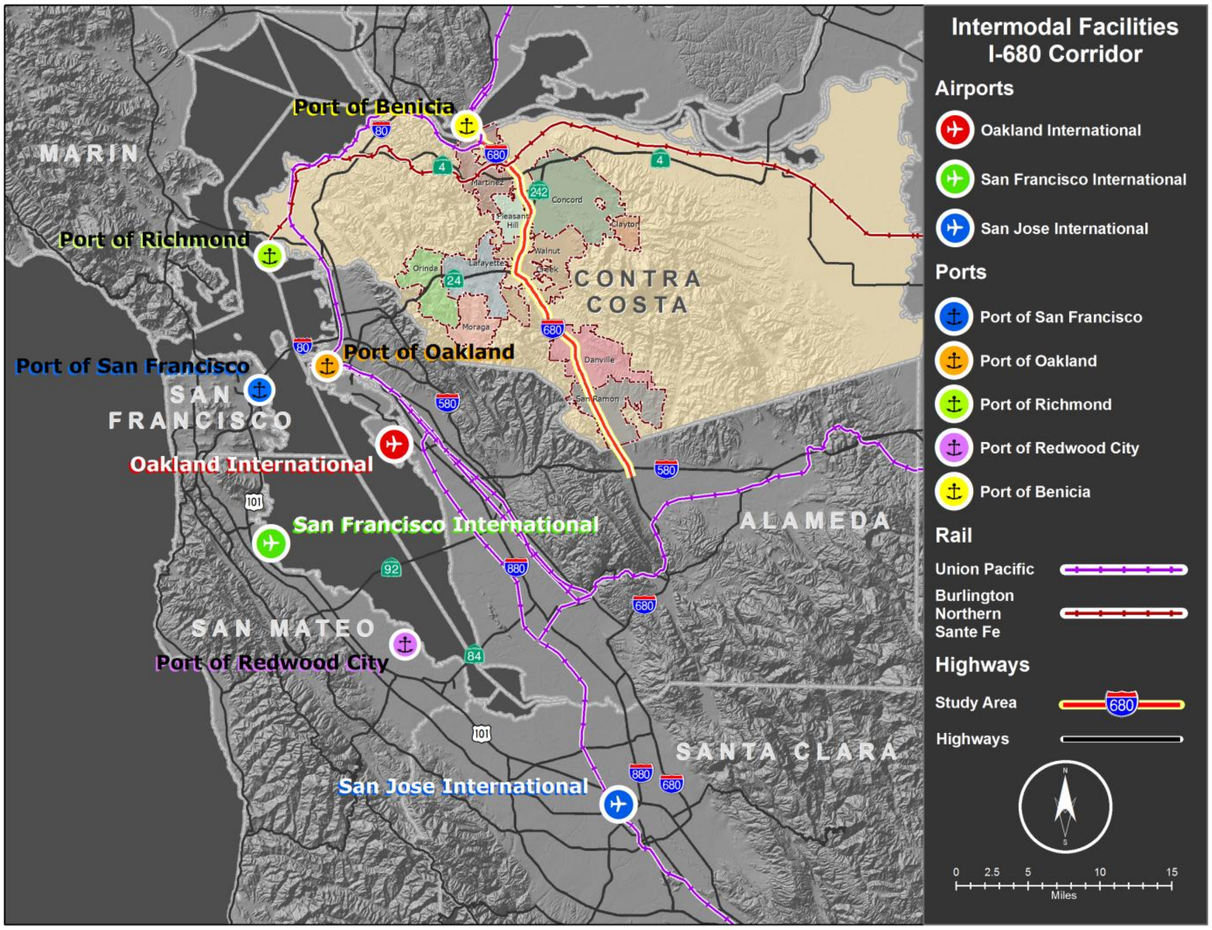
The San Francisco Bay Area has three major international airports that provide both passenger and air cargo services. In addition, the bulk Port of Richmond handles the most tonnage of any port in the Bay Area and the Port of Oakland is the fifth largest container port in the United States. The Port of Benicia lies adjacent to I-680 in Solano County and is served by the Union Pacific Railroad as shown in Exhibit 2-13.

Buchanan Field in Concord, California is one of the Bay Area's busiest general aviation airports and the only airport within five miles of the Contra Costa County I-680. The airport is a Federal Aviation Administration (FAA) Reliever Airport and is a California functional class Metropolitan-Business/Corporate airport. Buchanan Field had commercial air service until 1992, and MTC's Regional Aviation System Plan includes the return of commercial service to Buchanan when the Region's other commercial airports reach their capacity limits. The airport has an FAA control tower.

Buchanan Field is one of the emergency response facilities included in both Federal Emergency Management Agency (FEMA) and the California Governor's Office of Emergency Services (CalOES) Bay Area emergency response plans. The airport has multiple precision approaches and departures. Airport services include aircraft fuel, fire, law enforcement, search and rescue, emergency services, medical emergency flights, major aircraft and avionics repair service, oxygen, cargo transport, flight instruction sport flying, and aircraft rental and sales. There are 397 based aircraft, and 101,961 operations for the 12 month period ending September 2014, a 25% increase over 2013.

Buchanan Field Airport. Source: Caltrans.

Exhibit 2-13: Intermodal Facilities

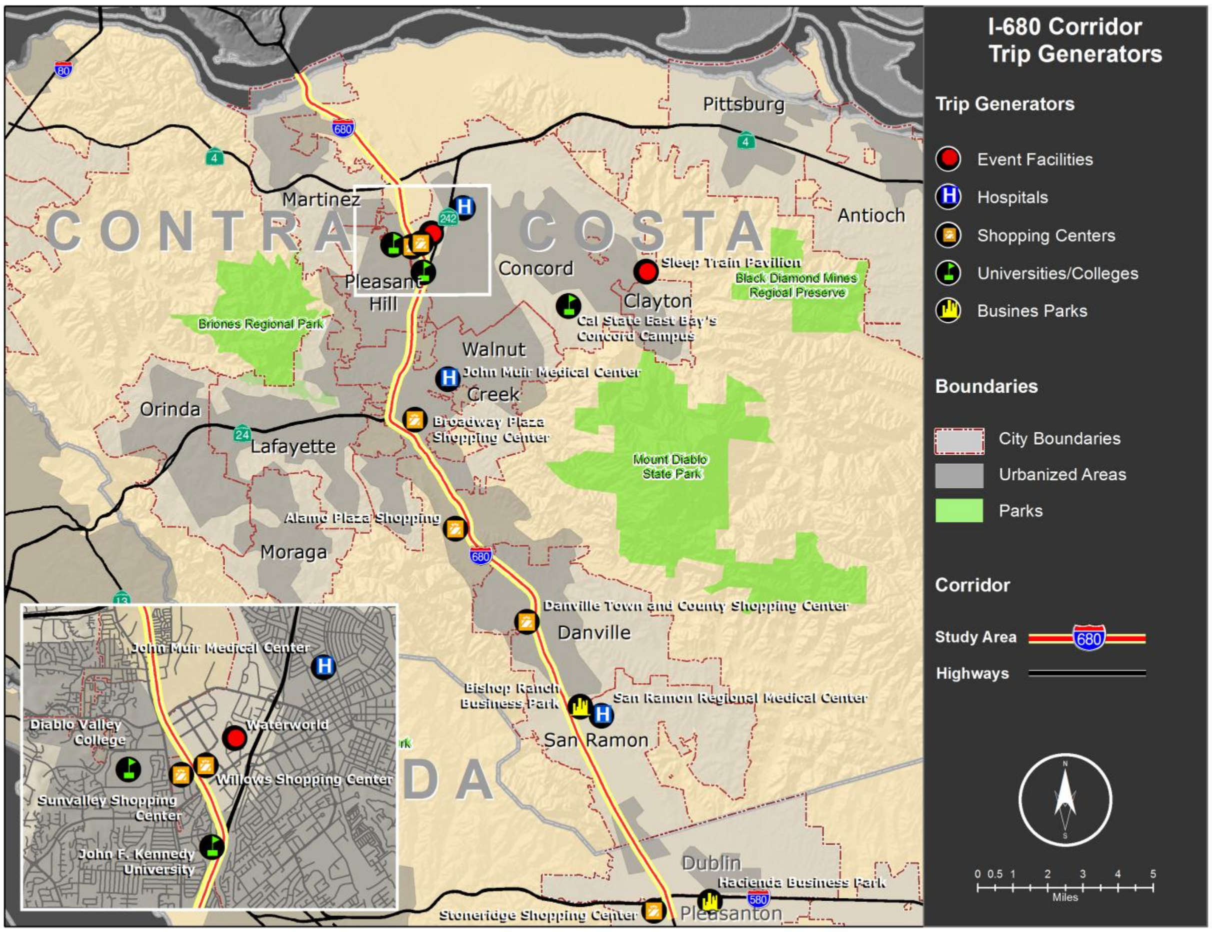


Source: System Metrics Group, Inc. analysis of Caltrans Division of Transportation Planning, Freight Planning Branch, Freight Planning Fact Sheets.

Trip Generators/Special Event Facilities

There are various facilities and institutions located along I-680 that have the potential to generate substantial trips along the corridor. Exhibit 2-14 shows the locations of potentially significant traffic generators. The major generators are discussed in the sections following this exhibit.

Exhibit 2-14: Major Trip Generators



Source: System Metrics Group, Inc./GIS/Internet

Bishop Ranch is a 10 million square foot business park adjacent to the Contra Costa County I-680 CSMP corridor in the City of San Ramon between the Bollinger Canyon Road and Crow Canyon Road interchanges. The business park currently houses approximately 550 businesses. Other employment-related trip generators include the County facilities in downtown Martinez, downtown Concord, Contra Costa Centre, downtown Walnut Creek, and Shadelands Business Park in Walnut Creek. In Alameda County, the Hacienda Business Park in Pleasanton is a 900 acre mixed use commercial and housing development.

There are also two major special event facilities in the corridor: Waterworld California, located between I-680 and SR-242, just north of the interchange in Concord and Sleep Train Pavilion, approximately eight miles east of I-680 on Kirker Pass Road (an extension of Ygnacio Valley Road) in Concord.
Universities and colleges also can potentially generate trips. The following institutions are located near the study corridor:

- Diablo Valley College (DVC) is a two-year community college located west of the I-680 on Golf Club Road in Pleasant Hill in Contra Costa County. Current enrollment is 26,000 students with 300 full-time and 370 part-time instructors.
- California State University (CSU) East Bay's Concord Campus is located east of the I-680 at Cowell Road and Ygnacio Valley Road in Concord, California. The campus is located on a 386 acre site at 4700 Ygnacio Valley Road, near downtown Concord and Walnut Creek.
- John F. Kennedy University is a nonprofit, private university located west of I-680 on Ellinwood Way in Pleasant Hill, California. Enrollment is approximately 1,600 (as of fall 2010) students, but has no campus housing.

There are several medical facilities close to I-680:

- John Muir Medical Center, Walnut Creek is a 572-bed hospital that is designated as a trauma center for Contra Costa County and portions of Solano County. The medical center is located east of I-680 on Ygnacio Valley Road and La Casa Via in Walnut Creek.
- John Muir Medical Center, Concord is a 313-bed hospital that serves Contra Costa and southern Solano counties. The medical center is located on East Street and Grant Street in Concord.
- San Ramon Regional Medical Center is a full-service, 123-bed, acute care hospital providing inpatient and outpatient services and is located on Norris Canyon Road just east of the I-680.

Several major shopping centers that are adjacent to the I-680 corridor include:

- Sunvalley Shopping Center is located at the northeast corner of Sunvalley Boulevard and Contra Costa Boulevard. It is the largest regional shopping center in the Contra Costa with approximately 160 retail shops, services, and restaurants.
- Willows Shopping Center is located north of Willow Pass Road on Diamond Boulevard. The center has numerous national retailers.
- Alamo Plaza Shopping Center is located at the northwest corner of Danville Boulevard and Stone Valley Road. The shopping center has 38 shops, restaurants, and services.
- Danville Town and County Shopping Center is located north of Sycamore Valley Road East on San Ramon Valley Road and contains 55,200 square feet of commercial space.

- Broadway Plaza Shopping Center is located in Walnut Creek between South Main Street and South Broadway. It houses multiple national retailers and additional specialty shops, restaurants, and cafes.
- Stoneridge Shopping Center in Pleasanton (Alameda County) is located on the southwest quadrant of the I-580/I-680 interchange and can be accessed from I-680 from the Stoneridge Drive interchange. It is an indoor mall that houses around 165 major chain retail stores and restaurants.

Trails and parks throughout the region along the I-680 consist of:

- Mount Diablo State Park, a 20,000 acre park, is located just east of the I-680 corridor. Preserved lands on and around Mount Diablo total more than 90,000 acres.
- Iron Horse Regional Trail is a pedestrian and bicycle rail trail in the East San Francisco Bay Area in California. The trail passes through the cities of Pleasanton, Dublin, San Ramon, Danville, Alamo, Walnut Creek, Pleasant Hill, and Concord.
- The California State Riding and Hiking Trail has not yet been completed. On completion, the trail will connect Martinez to Mt. Diablo State Park. The Contra Costa County segment of the trail was a pilot project of the program from Martinez to Concord. The final segment from Concord to Mt. Diablo will be completed in the near future.
- Contra Costa Canal Regional Trail is a multi-use; whole-access trail accessible to persons in wheelchairs with a paved pathway that provides connects Martinez, Pleasant Hill, Walnut Creek, and Concord.
- Briones-Mount Diablo Regional Trail lies between Briones Regional Park and Mt. Diablo State Park. It serves the communities of Lafayette and Walnut Creek, connecting major regional trails, including the Contra Costa Canal Trail, California State Riding and Hiking Trail, and the Iron Horse Regional Trail. The Briones-to-Mt. Diablo Trail also connects local schools, community facilities, city parks, and open space areas, including Briones Regional Park, Larkey Park, Heather Farm Park, Shell Ridge Open Space, Diablo Foothills Regional Park, and Mt. Diablo State Park. This trail is a multi-use, whole-access trail along paved portions.

3. CORRIDOR ENVIRONMENTAL CONSIDERATIONS

This environmental scan is a summary of the existing environmental setting. It can assist planners and engineers to avoid or minimize impacts, appraise design and programming, estimate project delivery resources, and further analyze the project delivery process. The information presented in this section does not represent all possible environmental considerations that may exist within the area surrounding the route.

Several areas are presented in this section:

- Recreational and Protected Lands (Section 4(f) Lands)
- Demographics/Environmental Justice
- Geology/Soils/Seismic
- Flood Plain
- Climate Change and Sea Level Rise Vulnerability
- Air Quality (Ozone)
- Special Status Species.

Recreational and Protected Lands (Section 4(f) Lands)

The Contra Costa County Courthouse Block in Martinez, registered under the National Register of Historic Places, is inspired by the Classical Revival Period. The courthouse and jail, which initially served as the major county government headquarters, eventually turned into financial offices. Mount Diablo State Park and Los Vaqueros Watershed are two protected open spaces that lie east of the corridor. The Corridor Description section presented above provides more details on recreational areas adjacent to the Contra Costa County I-680 CSMP corridor.

Demographics/Environmental Justice

Exhibit 3-1 shows the 2010 U.S. Census population by race for zip codes adjacent to the I-680 corridor. For comparative purposes it also shows the same information for Contra Costa County, the nine-county San Francisco Bay Area, and the State of California. The data indicate that the I-680 corridor has a smaller percentage of minorities than does the county, Bay Area, or California. Approximately 61 percent of the population adjacent to the corridor is non-Hispanic white, which is higher than Contra Costa County (48 percent), the Bay Area (42 percent), and for the state (40 percent). The Hispanic, or Latino, population along the corridor is lower than for the county and Bay Area, but on par with the statewide average of 13 percent.

Cities and census-designated communities along the corridor also report lower than average populations in poverty. The Pacheco neighborhood near Concord and Martinez reported a poverty rate higher than the countywide average of 7.9 percent, compared to 5.4 percent for Contra Costa County and 10.6 percent for California. Other areas along the corridor reported poverty rates lower than for the county as a whole.

Exhibit 3-1: Population by Race

Race	Population by Race (2010)				% of Population (2010)			
	Statewide	San Francisco Bay Area	Contra Costa County	Adjacent to I-680 Corridor	Statewide	San Francisco Bay Area	Contra Costa County	Adjacent to I-680 Corridor
White (Not Hispanic)	14,956,253	3,036,670	496,685	201,710	40%	42%	48%	61%
Black or African American (Not Hispanic)	2,163,804	460,170	93,470	11,058	6%	6%	9%	3%
American Indian and Alaska Native (Not Hispanic)	162,250	20,719	2,977	834	0%	0%	0%	0%
Asian (Not Hispanic)	4,775,070	1,645,999	148,273	44,159	13%	23%	14%	13%
Native Hawaiian/Other Pacific Islander (Not Hispanic)	128,577	41,002	4,379	1,243	0%	1%	0%	0%
Hispanic or Latino	14,013,719	1,681,462	255,274	56,237	38%	24%	24%	17%
Some other race/Two or more races	1,054,283	268,428	42,393	12,984	3%	4%	4%	4%
Total Population	**37,253,956**	**7,154,450**	**1,043,451**	**328,225**	**100%**	**100%**	**100%**	**100%**

Source: U.S. Census Bureau. Summary File 1 Table 3: Race ZIP Code Tabulation Areas in California.

Geology/Soils/Seismic

Contra Costa County mainly contains two types of rocks: Mesozoic metavolcanic rocks and quaternary deposits (California Geological Survey). The county consists of four distinct physiographic regions: the Coast Ranges, the intermountain valleys, the San Francisco Bay region and the Sacramento- San Joaquin Delta.

Mount Diablo, situated in the Coast Range, dominates drainage patterns (Standard Environmental Reference (SER)[7], Chapter 7). The Concord - Green Valley Fault is the easternmost strike-slip fault of the San Andreas Fault System in the Bay Area. This fault line begins just west of Mount Diablo in Contra Costa County, travels north under the Suisun Bay, and across Green Valley before ending roughly 10 miles east of Napa. United States Geological Survey mapping of the Suisun and Grizzly Bays suggest that soil liquefaction could be probable during a significant seismic event. The susceptibility of the route to seismic activity should be considered during the design and construction of transportation projects within the segment and during operations and maintenance activities.

Flood Plain

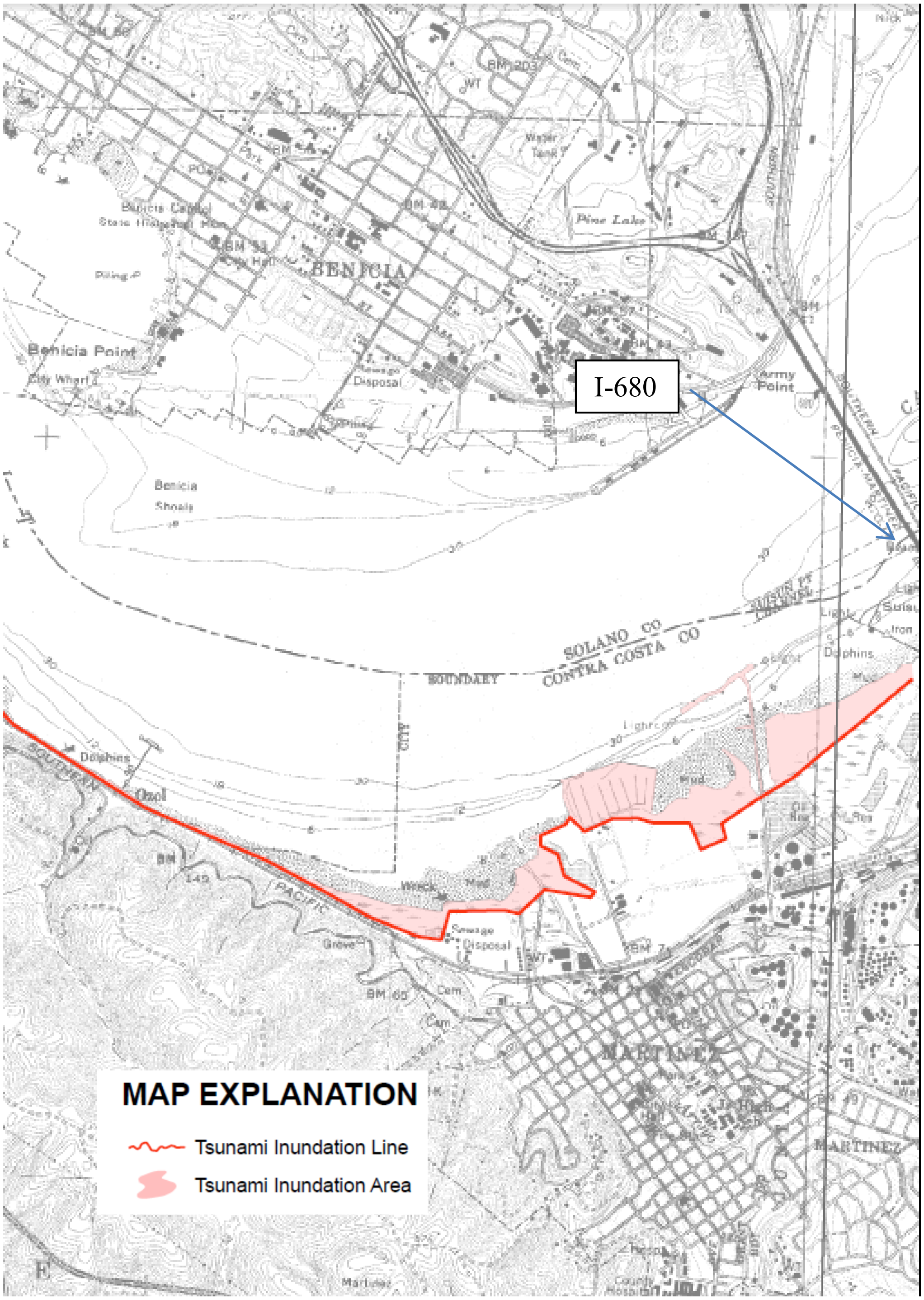
According to the California Emergency Management Agency, Benicia Quadrangle, Tsunami Inundation for Emergency Planning map, the northern-most segment of the Contra Costa County I-680 CSMP corridor includes areas that could be subject to inundation during a 100-year flood or Tsunami event. This area includes the coast line of the Suisun Bay as well as the low lands in the City of Martinez as shown in Exhibit 3-2.

Climate Change and Sea Level Rise Vulnerability

Exhibit 3-3 shows the projected changes in annual average temperature for low and high emissions scenarios. The low estimate assumes low carbon emissions in the future, and the high estimate assumes high carbon emissions in the future. Both scenarios show increasing temperatures. Exhibit 3-4 shows areas that are at risk of sea-level rise.

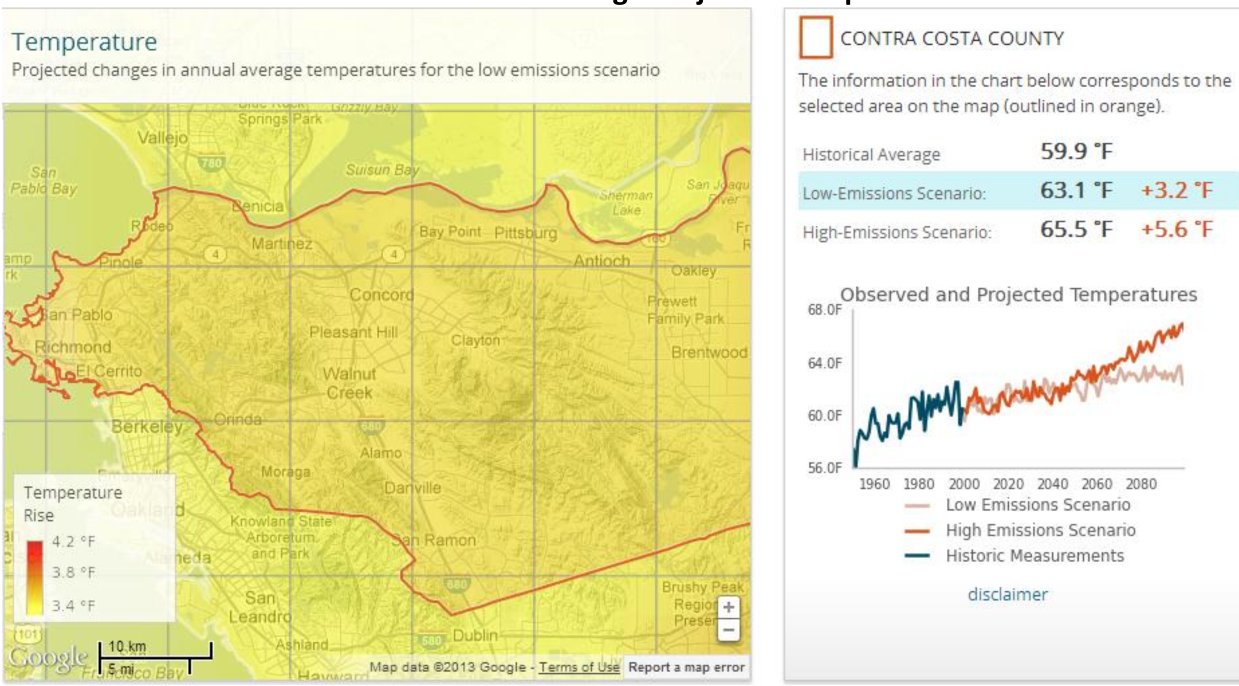
[7]The Standard Environmental Reference (SER) is an on-line resource to help state and local agency staff plan, prepare, submit, and evaluate environmental documents for transportation projects. The SER contains information appropriate to all transportation projects developed under the auspices of Caltrans, and to all local agency highway or local streets and roads projects with funding or approvals by the Federal Highway Administration (FHWA). http://www.dot.ca.gov/ser/

Exhibit 3-2: Tsunami Inundation Areas



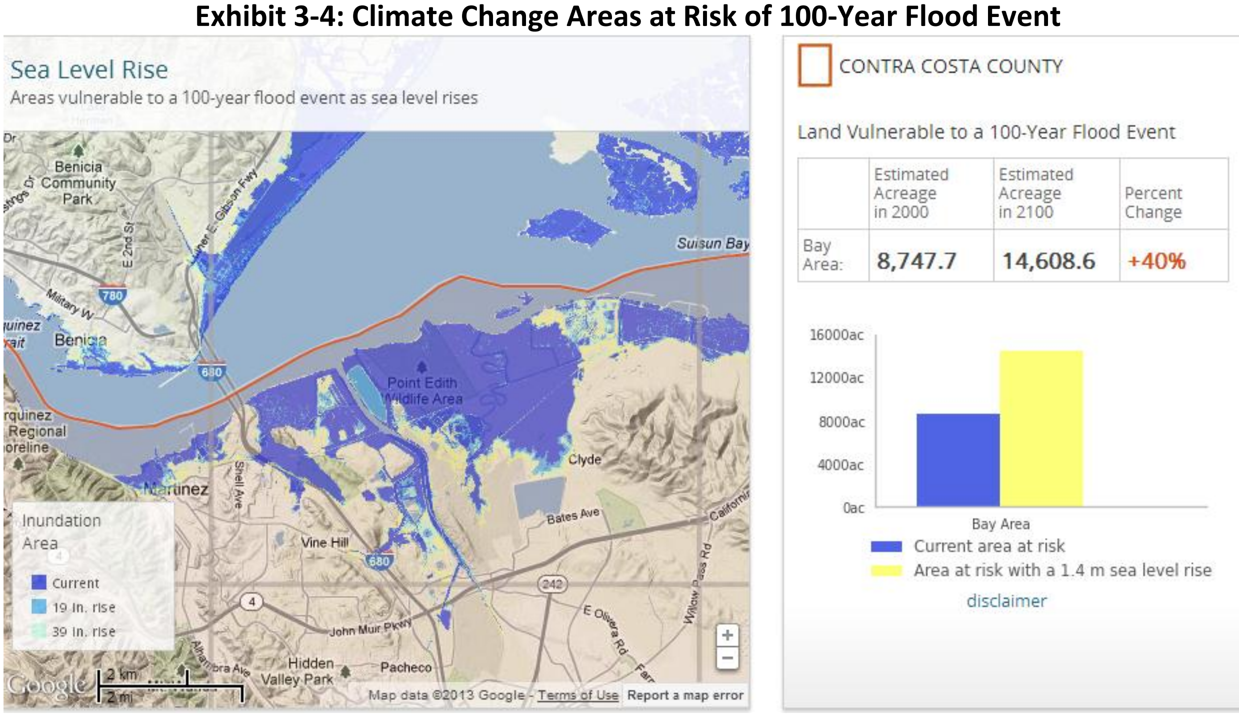
Source: California Department of Conservation Tsunami Inundation Map for Emergency Planning Benicia Quadrangle.
conservation.ca.gov/cgs/geologic_hazards/Tsunami/Inundation_Maps/ContraCosta/

Exhibit 3-3: Climate Change Projected Temperatures



Source: Cal-Adapt.org. University of California, Berkeley with funding and advisory oversight by the California Energy Commission. http://cal-adapt.org/.

Exhibit 3-4: Climate Change Areas at Risk of 100-Year Flood Event



Source: Cal-Adapt.org. University of California, Berkeley with funding and advisory oversight by the California Energy Commission. http://cal-adapt.org/.

<u>Ambient Air Quality</u>

Both the U.S. Environmental Protection Agency (USEPA) and the California EPA (CALEPA) set ambient air quality standards to protect public health with the California standards being generally more stringent than federal standards. Continuous air monitoring by the local agencies and the Bay Area Air Quality Management District (BAAQMD) ensure that air quality standards are being met and improved. Exhibit 3-5 shows the emittants that are currently monitored in the BAAQMD air basin, which includes Contra Costa County.

Cells color-coded in red represent pollutants for which the San Francisco air basin is does not meet (i.e., is in “nonattainment”) either the national or California ambient air quality standards. Green cells in the exhibit are those where the air basin meets the standard. As of 2014, the air basin (including Contra Costa County) does not meet standards for the following key pollutants:

- Ozone (nonattainment for both California and national standards)
- Particulate Matter PM10 and PM2.5 (California only).

Exhibit 3-5: Air Quality Standards and Bay Area Attainment Status

Pollutant	Averaging Time	California Standards		National Standards		Comment
		Concentration	Attainment Status	Concentration	Attainment Status	
Ozone	8 Hour	0.070 ppm (137μg/m3)	N	0.075 ppm	N	The 8-hour CA ozone standard was approved by the Air Resources Board on April 28, 2005 and became effective on May 17, 2006. National final designations effective July 20, 2012.
	1 Hour	0.09 ppm (180 μg/m3)	N			The national 1-hour ozone standard was revoked by U.S. EPA on June 15, 2005
Carbon Monoxide	8 Hour	9.0 ppm (10 mg/m3)	A	9 ppm (10 mg/m3)	A	In April 1998, the Bay Area was redesignated to attainment for the national 8-hour carbon monoxide standard.
	1 Hour	20 ppm (23 mg/m3)	A	35 ppm (40 mg/m3)	A	
Nitrogen Dioxide	1 Hour	0.18 ppm (339 μg/m3)	A	0.100 ppm	U	To attain this standard, the 3-year average of the 98th percentile of the daily maximum 1-hour average at each monitor within an area must not exceed 0.100ppm (effective January 22, 2010).
	Annual Arithmetic Mean	0.030 ppm (57 μg/m3)		0.053 ppm	A	
Sulfur Dioxide	24 Hour	0.04 ppm (105 μg/m3)	A	0.14 ppm (365 μg/m3)	A	On 6/2/10, USEPA established new 1-hour SO2 standard, effective 8/23/10 based on the 3-yr average of annual 99th percentile of 1-hour daily max concentrations. Existing 0.030 ppm annual and 0.14 ppm 24-hr SO2 NAAQS however must continue to be used until 1 yr following USEPA initial designations of new 1-hr SO2 NAAQS. EPA expects to designate areas by 6/12.
	1 Hour	0.25 ppm (655 μg/m3)	A	0.075 ppm (196 μg/m3)	A	
	Annual Arithmetic Mean			0.030 ppm (80 μg/m3)	A	
Particulate Matter (PM10)	Annual Arithmetic Mean	20 μg/m^3	N			In June 2002, CARB established new annual standards for PM10.
	24 Hour	50 μg/m^3	N	150 μg/m^3	U	
Particulate Matter - Fine (PM2.5)	Annual Arithmetic Mean	12 μg/m^3	N	15 μg/m^3	A	In June 2002, CARB established new annual standards for PM2.5.
	24 Hour			35 μg/m^3	N	On 1/9/13 EPA issued final rule to determine Bay Area attains 24-hr PM2.5 national standard. This EPA rule suspends key SIP requirements as long as monitoring data continues to show Bay Area attainment of standard. Despite EPA action, Bay Area will continue to be designated as “non-attainment” for the national 24-hr PM2.5 standard until such time Air District submits “redesignation request” and “maintenance plan” to EPA, and EPA approves the proposed redesignation.
Sulfates	24 Hour	25 μg/m^3	A			
Lead	30 day Average	1.5 μg/m^3		-	A	ARB has identified lead and vinyl chloride as ‘toxic air contaminants’ with no threshold level of exposure below which there are no adverse health effects determined
	Calendar Quarter	-		1.5 μg/m^3	A	
	Rolling 3 Month Average	-		0.15 μg/m^3		National lead standard, rolling 3-month average: final rule signed October 15, 2008. Final designations effective December 31, 2011.
Hydrogen Sulfide	1 Hour	0.03 ppm (42 μg/m3)	U			
Vinyl Chloride (chloroethene)	24 Hour	0.010 ppm (26 μg/m3	No information			
Visibility Reducing	8 Hour (10:00 to 18:00 PST)		U			Statewide VRP Standard (except Lake Tahoe Air Basin): Particles in sufficient amount to produce extinction coefficient of 0.23/km when relative humidity<70%. Standard intended to limit frequency and severity of visibility impairment due to regional haze equivalent to a 10-mile nominal visual range.
A=Attainment N=Nonattainment U=Unclassified						
mg/m^3=milligrams per cubic meter		ppm=parts per million		μg/m^3=micrograms per cubic		

Source: BAAQMD Air Quality Standards and Attainment Status. http://www.baaqmd.gov/Divisions/Planning-and-Research/AQSAS.aspx

Using data from the 2010 Base Year CCTA travel demand model as an input, Exhibit 3-6 shows estimated emittants from roadways within a two-mile buffer of the I-680 CSMP corridor based on outputs from the Caltrans Life-Cycle Benefit/Cost Analysis Model (Cal-B/C).

Exhibit 3-6: I-680 CSMP Corridor Pollutants (2010)

Pollutant	2010 Daily Equivalent CO_2 U.S. Short Tons
Carbon Dioxide (CO_2)	4,100
Carbon Monoxide (CO)	30.60
Oxides of Nitrogen (NOx)	3.60
Particulate Matter (PM10)	0.60
Oxides of Sulfur (SOx)	0.04
Volatile Organic Compounds (VOC)	2.60

Source: System Metrics Group, Inc. analysis of the CCTA travel demand model using Cal-B/C.

Special Status Species

The California Natural Diversity Database (CNDD)[8] identifies threatened or endangered special status species found in areas adjacent to the study corridor. Exhibit 3-7 shows the status of species in United States Geological Survey (USGS) 7.5 minute quadrangle map areas that surround the I-680 CSMP corridor in Contra Costa and northern Alameda Counties.

Exhibit 3-7: Threatened/Endangered Special Status Species

Category	Type	Scientific Name	Common Name	Federal Status	State Status
Animals	Amphibians	Ambystoma californiense	California tiger salamander	Threatened	Threatened
		Rana draytonii	California red-legged frog	Threatened	None
	Birds	Buteo swainsoni	Swainson's hawk	None	Threatened
		Laterallus jamaicensis coturniculus	California black rail	None	Threatened
		Rallus longirostris obsoletus	California clapper rail	Endangered	Endangered
	Fish	Hypomesus transpacificus	Delta smelt	Threatened	Endangered
		Oncorhynchus mykiss irideus	steelhead - central California coast DPS	Threatened	None
		Oncorhynchus tshawytscha	chinook salmon - Central Valley spring-run ESU	Threatened	Threatened
		Spirinchus thaleichthys	longfin smelt	Candidate	Threatened
	Insects	Callophrys mossii bayensis	San Bruno elfin butterfly	Endangered	None
		Speyeria callippe callippe	callippe silverspot butterfly	Endangered	None
	Mammals	Corynorhinus townsendii	Townsend's big-eared bat	None	Candidate Threatened
		Reithrodontomys raviventris	salt-marsh harvest mouse	Endangered	Endangered
		Sylvilagus bachmani riparius	riparian brush rabbit	Endangered	Endangered
		Vulpes macrotis mutica	San Joaquin kit fox	Endangered	Threatened
	Reptiles	Masticophis lateralis euryxanthus	Alameda whipsnake	Threatened	Threatened
Plants	Vascular	Chloropyron molle ssp. molle	soft salty bird's-beak	Endangered	Rare
		Lasthenia conjugens	Contra Costa goldfields	Endangered	None
		Oenothera deltoides ssp. howellii	Antioch Dunes evening-primrose	Endangered	Endangered

Source: California Natural Diversity Database (CNDD). https://map.dfg.ca.gov/bios/?tool=cnddbQuick

8 https://www.dfg.ca.gov/biogeodata/cnddb/.

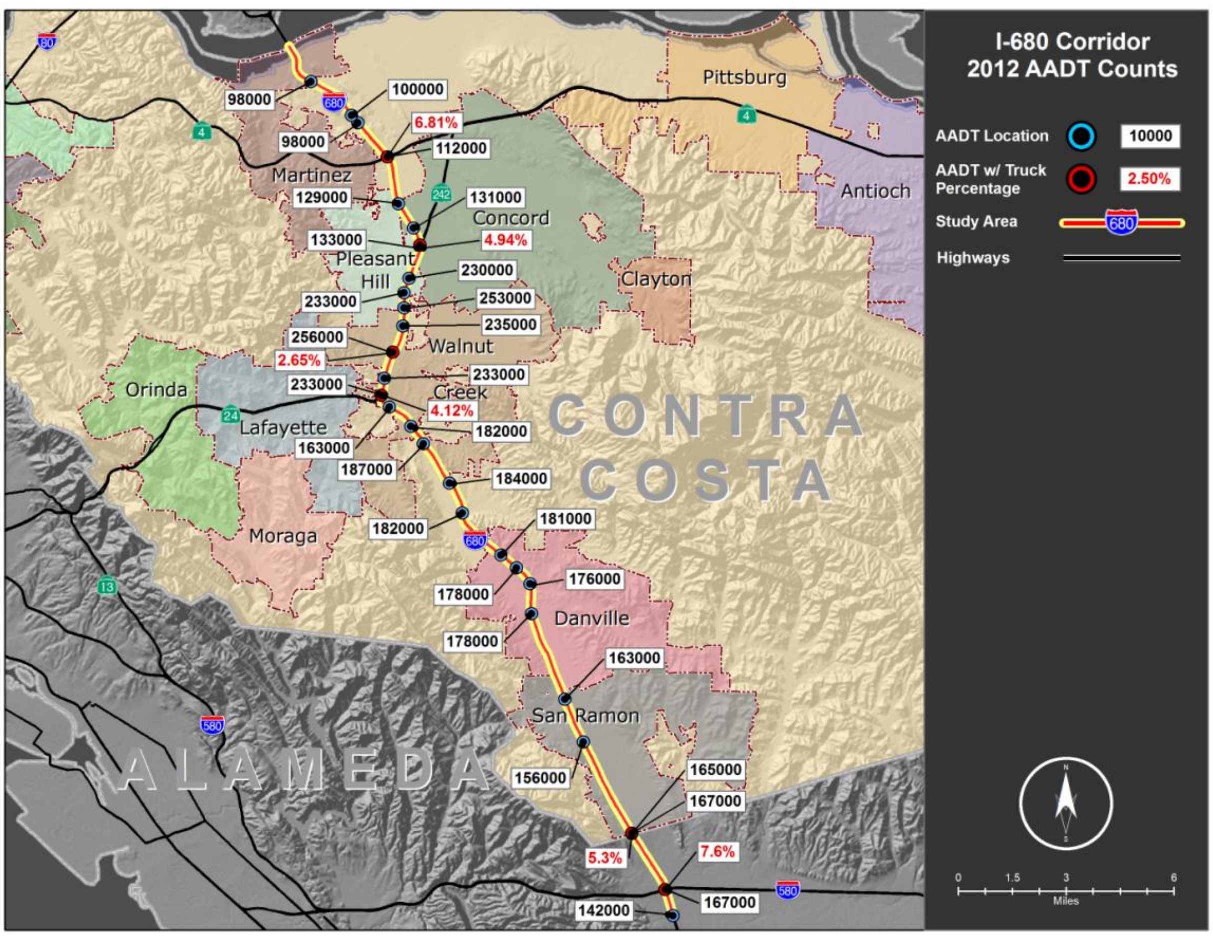
4. CORRIDOR PERFORMANCE AND TRENDS

This section summarizes the performance measures used to evaluate the existing conditions of the I-680 CSMP corridor. The measures provide a technical basis to describe traffic performance on I-680 and were used to help in the calibration of the micro-simulation model.

Freeway Volumes

Contra Costa County I-680 carries between 100,000 and 260,000 AADT, as shown in Exhibit 4-1. The highest average daily traffic volume on the corridor occurs near North Main Street in Walnut Creek, which is also one of the most congested locations on the corridor measured by vehicle-hours of delay (See *Section 5: Bottleneck Identification and Causality* for a more detailed discussion of bottlenecks in the corridor).

Exhibit 4-1: 2012 Annual Average Daily Traffic Volumes and Truck Percentages



Source: 2012 Caltrans Traffic and Vehicle Data Systems. www.dot.ca.gov/hq/traffops/saferesr/trafdata/

CSMP Performance Measures

Exhibit 4-2 shows the performance measures established for the Contra Costa County I-680 CSMP, which are based on nine SMF performance measures[9]. Each measure was linked to a goal of the CSMP effort, shown in the second column of Exhibit 4-2. Then one or more metrics were identified that could be used to evaluate existing conditions or forecast future conditions. The following performance areas are discussed in detail:

- *Transit, Pedestrian, and Bicycle Mode Shares* describe the percentage of transit, bicycle, and pedestrian travel in the region.
- *Travel Mobility* describes how quickly people and freight move along the corridor. It also quantifies productivity losses during congested periods.
- *Travel Time Reliability* captures the relative predictability of travel time along the corridor.
- *Safety* provides an overview of safety along the freeway corridor and discusses bicycle/pedestrian incidents near the corridor.
- *Service Quality* balances efficiency and comfort among users of all travel modes. Three approaches are used to evaluate service quality: multi-model level of service (MMLOS), Complete Streets, and pavement condition.

The emissions reduction performance measure is addressed in Section 9 of this report with the discussion of scenario evaluation results. The climate and energy conservation measure is also discussed in Section 9 and the results are presented in Appendix G. Forecast travel mobility and travel time reliability are also presented in the results section and existing trends for these two measures are presented below.

[9] Caltrans (2010) Smart Mobility 2010: A Call to Action for the New Decade.
www.dot.ca.gov/hq/tpp/offices/ocp/documents/smf_files/SMF_handbook_062210.pdf

Exhibit 4-2: Contra Costa County I-680 CSMP Performance Measures

Smart Mobility Framework (SMF) Performance Measure		CSMP Goal Addressed	Metric	Current Conditions	Forecasting	Potential Data sources
2	Transit Mode Share	Location Efficiency	% of non-SOV trips (includes carpool/vanpools)	Yes	Yes	CCTA model
4	Multi-Modal Travel Mobility	Reliable Mobility	Total user-hours of travel times and travel costs by mode for the corridor	Yes	Yes	PeMS, Tachometer Vehicle Runs, TOPL, CCTA model
			Congestion (Vehicle Hours of Delay) - Time Period - Month - Day of Week - Severity (at 60mph, 35mph) - Hour of Day - Bottleneck Locations & Severity	Yes	For average weekday modeled period	PeMS, TOPL
			Productivity - Lost Lane Miles - by Time of Day	Yes	No	PeMS
5	Multi-Modal Travel Time Reliability	Reliable Mobility	Travel time reliability measures by mode: buffer index, standard deviation; Travel time reliability relative to each mode	Yes	Yes	PeMS for baseline. Evaluating feasibility for forecasting
6	Multi-Modal Service Quality	Multimodal Level of Service	Level of Service (LOS)	Yes	Maybe (if forecast data available)	HCM 2010 MMLOS methodology data sources
		Complete Streets	Complete Streets Evaluation	Yes	No	Satellite imagery, field evaluation
		Sustainable Infrastructure	Pavement Condition - Distressed Lane-Miles - International Roughness Index	Yes	No	Caltrans Pavement Management System
7	Multi-Modal Safety	Health and Safety	Accidents/Accident Rates - by Mode - by Month - by Weekday/Weekend	Yes	No	TASAS, SWITRS, CCTA model, Highway Safety Manual, Caltrans Traffic Safety Index (from HSIP)
9	Pedestrian & Bicycle Mode Share	Health and Safety	Bicycle and pedestrian mode share in corridor	Yes	No	CCTA model, American Community Survey, National Household Travel Survey
10	Climate and Energy Conservation	Environmental Stewardship	VMT by speed range for the corridor	Yes	Yes	CCTA model
11	Emissions Reduction	Environmental Stewardship	Emissions by criteria pollutant	Yes	Yes	CCTA model, EMFAC
17	Return on Investment (ROI)	Robust Economy	Benefit-cost: Net present value of benefits (travel time, reliability) minus net present value of costs (capital, O&M, air pollution, crashes)	n/a	Yes	Results of previous performance measures (2, 4, 5, 7, 9, 10, and 11 above). Cal-B/C

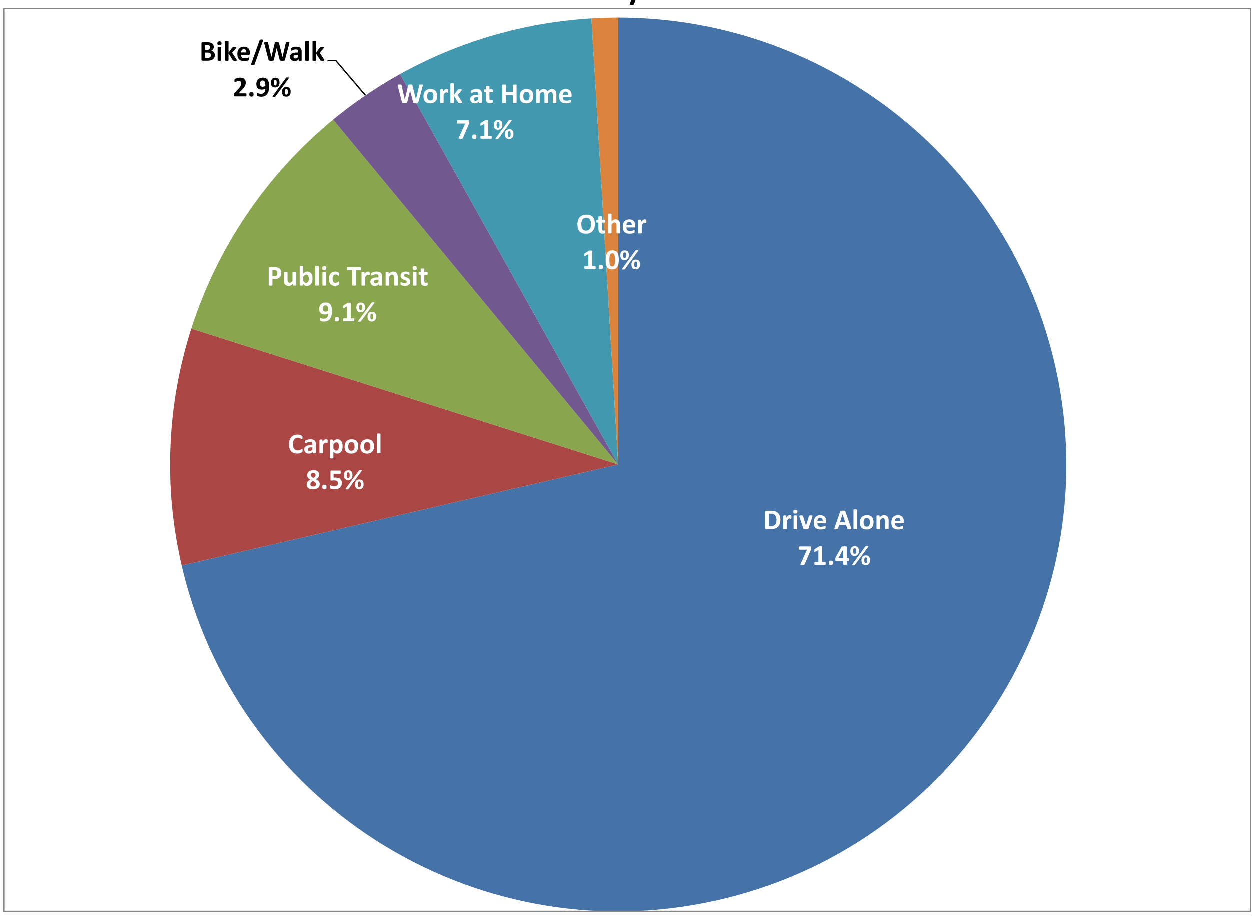
Transit, Pedestrian and Bicycle Mode Shares

The SMF measure of transit mode share serves as an indicator for the SMF principle of location efficiency, or how well integration of land use (e.g., housing, jobs, commerce, entertainment, parks, and other amenities) and transportation reduces vehicle trip making and trip distances by promoting walking, biking, and transit use. For the purposes of this analysis, transit mode share includes carpool and vanpool in addition to transit. The bicycle and pedestrian mode share is also used as a proxy for general health since these are active modes of transportation.

Exhibit 4-3 shows mode shares from the 2007-2011 American Community Survey (ACS) 5-year commute trip mode share estimates for census tracts near the CSMP corridor. Based on this survey, 71 percent of all commute trips for the adjacent tracts were drive alone, 18 percent were carpool or public transit, and the remaining 11 percent biked, walked, worked from home, or used some other mode.

The Caltrans District 4 Division of Traffic Operations produces a High Occupancy Vehicle lane annual compilation of statistics. Summarized in Exhibit 4-4, the 2011 report indicates that peak period carpool occupancies vary between 2.1 and 2.5 depending on the location and time of day.

Exhibit 4-3: Contra Costa County I-680 Mode Shares 2007-2011



Source: SMG analysis of 2007-2011 American Community Survey 5-year estimates.

Exhibit 4-4: Contra Costa County I-680 HOV Occupancy

Dir	Location	Lane-Miles	Minimum Occupancy Requirement	Time Period	Hours of Operation	Peak Period	Peak Hour	HOV Vehicular Volumes		HOV Occupancy		General Purpose	
								Peak Period	Peak Hour	Peak Period	Peak Hour	Peak Period	Peak Hour
NB	Benicia-Martinez Bridge Toll Plaza	1	3+	AM/PM	5-10 AM 3-7 PM	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
SB	Marina Vista to N/O N. Main St.	7.8	2+	AM	5-9 AM	6-9 AM	7-8 AM	2,836	1,149	2.3	2.3	1.3	1.2
				PM	3-7 PM	3-6 PM	4-5 PM	1,089	395	2.6	2.5	1.2	1.2
NB	Route 242 to Marina Vista I/C	4.4	2+	AM	5-9 AM	6-9 AM	7-8 AM	431	143	2.9	3.5	1.1	1.1
				PM	3-7 PM	3-6 PM	4-5 PM	1,791	683	2.4	2.5	1.1	1.1
SB	Rudgear Rd to Alcosta Blvd	12.9	2+	AM	5-9 AM	6-9 AM	7-8 AM	2,979	1,193	2.7	2.6	1.1	1.2
				PM	3-7 PM	3-6 PM	4-5 PM	2,976	1,136	2.5	2.5	1.1	1.2
NB	Alcosta Blvd to Livorna Rd	11.9	2+	AM	5-9 AM	6-9 AM	7-8 AM	1,680	637	2.7	2.5	1	1
				PM	3-7 PM	3-6 PM	3-4 PM	3,357	927	2.4	2.2	1.1	1.3

Source: Caltrans. 2012 Bay Area HOV Lanes: Volumes, Occupancies and Violation Rates. 2012.
http://www.dot.ca.gov/dist4/highwayops/docs/Final-Managed-Lane-2012.pdf

BART provides rail service to five stations near the I-680 corridor: North Concord/Martinez, Concord, Pleasant Hill, Walnut Creek, and Lafayette (adjacent to SR-24). From 2009 to the end of June 2013 (Fiscal Year 2012/13), BART average weekday ridership from these four stations rose from just over 23,000 riders to more than 25,200 riders (an increase of nine percent). Ridership from these stations comprises about six percent of all BART system ridership.

The primary fixed route bus transit provider for the Contra Costa I-680 corridor is County Connection, a service provided by the CCCTA. Ridership on express bus services using I-680 (primarily serving Bishop Ranch in San Ramon, but also with service to Martinez) has grown by more than one-third each year since 2009. As of the end of 2012, it carries approximately 1,200 average weekday riders.[10]

Other transit operators that provide services in the corridor and contribute to the transit mode share in the corridor include: FAST, SolTrans, Tri Delta Transit, WestCAT, and Wheels. These services were summarized in Section 2 of this report.

Multimodal Travel Mobility

Travel mobility describes how well the corridor moves people and freight. Multimodal travel mobility was evaluated as part of the SMF Pilot Study and during the Complete Streets evaluation. The SMF Pilot Study evaluated seven arterial locations near the I-680 corridor. They calculated a multi-model level of service (MMLOS) for transit, pedestrian, and bicycle modes at the intersection and link levels. The Complete Streets evaluation examined multimodal connectivity for all modes of arterials and multi-use paths parallel to and crossing the I-680 CSMP corridor. The freeway facility was evaluated using a range of sources including the Caltrans Performance Measurement System (PeMS).

SMF Multimodal Level of Service Evaluation

The Caltrans Division of Transportation Planning Office of Community Planning SMF Pilot Study assessed the interaction among the modes and interfaces with freeway traffic at key interchanges and along parallel arterials to the I-680 corridor. This interaction is particularly important on urban arterials where all modes are sharing the public right-of-way, and it can be useful for understanding the trade-offs

[10] Central Contra Costa Transit Authority (CCTA). Short Range Transit Plan: FY2011-12 through FY2020-21. 2011.

associated with addressing the needs of multiple modes. The effort applied the 2010 Highway Capacity Manual (HCM) MMLOS methodology on seven arterials adjacent to the I-680 study corridor. The arterials were selected for evaluation because they had characteristics that would best allow the SMF consultant to effectively test emerging MMLOS applications. Detailed findings and conclusions from that effort can be found in the *Pilot Area 1: Complete Streets Assessment using HCM 2010 – Analysis Results* memo shown in Appendix A.

Exhibit 4-5 summarizes the findings from the MMLOS analysis for: transit, bicycle, and pedestrian at the intersection (where two or more roadways meet), the link (roadway between two signalized intersections), the segment (link plus downstream intersection), and the facility (several contiguous segments) levels. An MMLOS score and letter designation were developed for each of the three elements of analysis segments. Portions of a segment for which analysis was not performed due to limitations of the methodology are shown by gray cells. An "A" MMLOS indicates excellent service as measured by the MMLOS approach while an MMLOS of "F" indicates poor service quality.

Segment LOS combines the intersection and link MMLOS scores and includes some additional factors, such as the number of access points along the right side of the road. The methodology does not analyze transit service at the intersection or link levels, but only analyzes transit LOS at the segment level. In addition, streets with T-intersections that do not have through movements cannot be analyzed for bicycle MMLOS.

Exhibit 4-5: SMF Multimodal Level of Service Assessment Summary Findings

Street	Community	From - To	Analysis Direction	Analysis Time Period	Analysis Section	Mode	Intersection		Link		Segment	
							Score	LOS	Score	LOS	Score	LOS
Alcosta Blvd	San Ramon	Norris Canyon Terrace to Crow Canyon Rd	NB	PM	1	Transit						F
						Bike			2.48	B		
						Ped	3.34	C	4.00	D	4.33	E
Buskirk Ave	Pleasant Hill	Hookston Rd to Oakpark Blvd (Coggins Dr)	NB	PM	1	Transit					5.59	F
						Bike	3.94	D	4.89	E	4.20	D
						Ped	2.65	B	6.00	F	4.92	E
California Blvd	Walnut Creek	Lacassie Ave to Ygnacio Valley Rd	NB	PM	1	Transit					2.25	B
						Bike	3.01	C	2.29	B	3.44	B
						Ped	2.81	C	3.18	C	2.59	C
Danville Blvd	County	Cedar Lane to Stone Valley Rd	SB	PM	1	Transit					3.79	D
						Bike			3.02	C	3.56	D
						Ped			5.25	F	3.93	D
					2	Transit					3.59	D
						Bike	3.21	C	2.74	B	4.49	E
						Ped	2.04	B	4.03	D	2.67	B
Diamond Blvd	Concord	Willows Shopping Center to Willow Pass Rd	SB	PM	1	Transit					4.15	D
						Bike	4.15	D	4.44	E	4.43	E
						Ped	3.18	C	3.11	C	3.16	C
Pacheco Blvd	Martinez	Buchanan Circle to Center Dr	SB	AM	1	Transit					4.06	D
						Bike	1.92	A	2.13	B	3.70	D
						Ped	2.45	B	2.66	C	2.47	B
Railroad Ave	Danville	Church St to San Ramon Valley Blvd	NB	AM	1	Transit					4.86	E
						Bike			1.83	A		
						Ped	2.13	B	2.08	B	2.35	B

[gray cell] - No analysis performed due to the limitations of the methodology.

Source: Caltrans Division of Transportation Planning Office of Community Planning.

Complete Streets Evaluation

The Complete Streets evaluation examined multimodal connectivity of arterials and multi-use paths parallel to and crossing the I-680 CSMP corridor for all modes. Considering that most limited access highways will not allow all users to access the facility and per the guidance in the Caltrans' *Deputy Directive DD-64-R1, Complete Streets- Integrating the Transportation System*, a definition of a Complete Streets Freeway Corridor was needed to guide the formation of an evaluation methodology. Two guiding principles were developed to frame what a Complete Streets Freeway Corridor must achieve:

- A Complete Streets Freeway Corridor must allow all users access to services along the entire corridor.
- A Complete Streets Freeway Corridor must provide all users with the ability to safely and efficiently move from one end of the corridor to the other.

Based on these guiding principles, a minimum standard definition of a Complete Streets Freeway Corridor, in the context of a limited access highway, was developed to include:

- Frequent pedestrian, bicycle, and transit accessible crossings over/under the freeway, preferably connecting to the parallel alternatives.
  - At the corridor level, the freeway can present an obstacle that prevents bicyclists or pedestrians from getting across the barrier to reach destinations on one side of the freeway when originating on the other side.
- Parallel alternative arterial routes (or shared-use paths) on either side of the freeway with sufficient walking, biking, and transit facilities.
  - The existence of a contiguous, alternative route, preferably on each side of the freeway, is important for providing equitable access to facilities for non-motorized travelers traveling along the corridor. The importance of an alternate on each side is dependent on the frequency of crossings. More frequent crossings render the dual alternates less important.
- Limited obstructions to safe and convenient passage of pedestrians and cyclists at freeway ramps.
  - Freeway ramp intersections can be an obstacle for pedestrians and cyclists. They most often occur on streets crossing the freeway. The design and operation of the freeway ramp is also frequently directly within the Caltrans jurisdiction.
- Limited obstructions to safe and convenient access to transit centers providing alternatives to the freeway.
  - Regional transit centers provide alternatives to the freeway corridor and Caltrans can work with transit agencies and local municipalities to help ensure safe and convenient access for non-motorized users.

A methodology was developed to select freeway ramp intersections, routes that cross the freeway, and parallel alternatives to the freeway corridor for evaluation based on this definition for a Complete Streets Freeway Corridor. These facilities could potentially meet the needs of non-motorized users if they are safe, connected, signed, and designed to minimize conflict with vehicular traffic. The segment evaluation methodology was designed to prioritize ease of moving through and across the corridor by identifying and prioritizing specific locations where improvement is needed to achieve a Complete Streets Freeway Corridor. The highest priority segments with recommended treatments include:

- El Pintado Road to Stone Valley Road
- Stone Valley Road to Livorna Road
- Livorna Road to Rudgear Road
- Concord Avenue to Pacheco Boulevard/Arthur Road
- Pacheco Boulevard/Arthur Road to Marina Vista Road/Waterfront Road.

More detailed descriptions of the treatments for these segments, and all the segments along the corridor, can be found in the Complete Streets evaluation in Appendix C.

Freeway Mobility

For the I-680 freeway mobility performance assessment, three primary measures were used to quantify freeway mobility: travel times, congestion, and productivity. All three are readily measurable and straightforward for documenting current conditions and can be applied to forecast conditions making them useful for future comparisons. The data for this assessment came from Caltrans' PeMS. PeMS is an internet-based repository for transportation data including data collected from freeway and ramp sensors. This data can be used to estimate travel times and delays on the freeway corridor.

Between 2010 and 2012, due largely to copper wire theft from detector stations, data quality had declined such that there existed major coverage gaps throughout the corridor. By September 2013, many of the broken detector stations had been repaired, but some spatial gaps remained (e.g., near Alamo and between Danville and San Ramon). Due to these data issues, it was decided that the PeMS analysis would be limited to the three years, from 2008 through 2010, when quality remained reasonably high. To supplement the PeMS data, tachometer runs and field observations were performed in 2012 and 2013 to help identify bottleneck locations (See *Section 5: Bottleneck Identification and Causality* for more details).

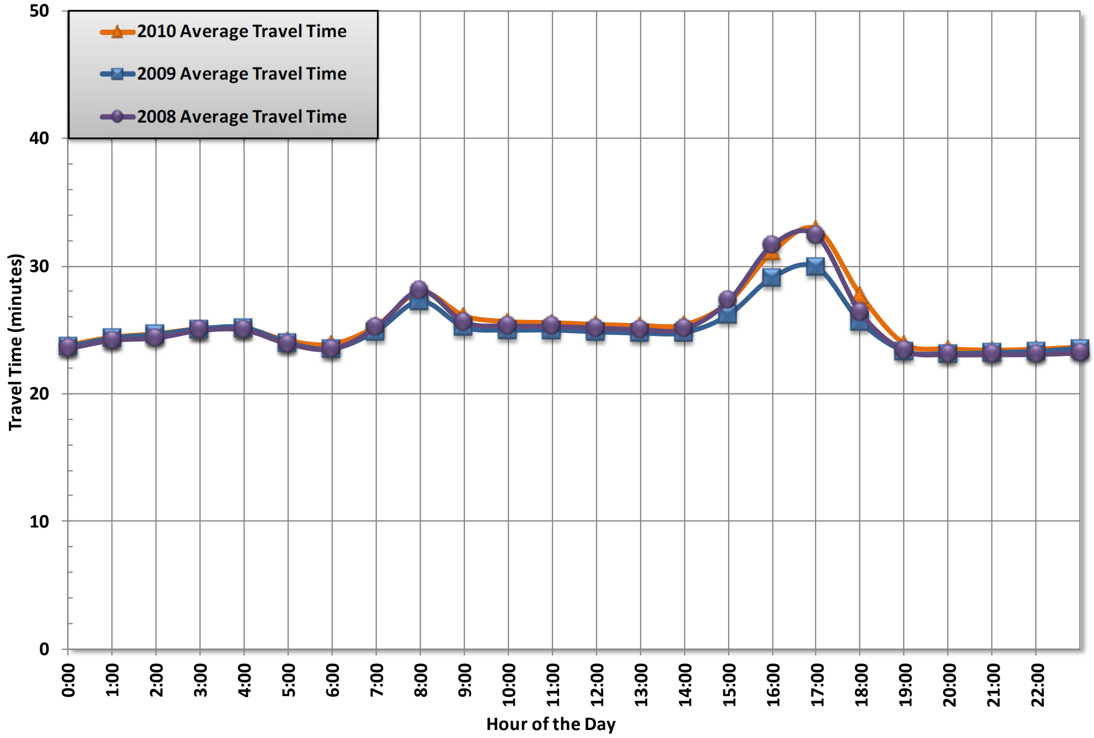
Travel Times

Travel time is the amount of time it takes a vehicle to travel between two points on a roadway, as estimated using automatic detector data in this analysis. Travel time on parallel arterials is not included in the analysis. Exhibits 4-6 and 4-7 summarize average annual travel times estimated by hour of day for weekdays in the years 2008 through 2010 for each direction of the mainline freeway facility.

Exhibit 4-6 shows that the northbound direction had travel times ranging from 23 to 33 minutes. During the 5:00 PM peak hour, travel times in the northbound direction decreased slightly from 32 minutes in 2008 to 30 minutes in 2009. However, they increased again to 33 minutes in 2010.

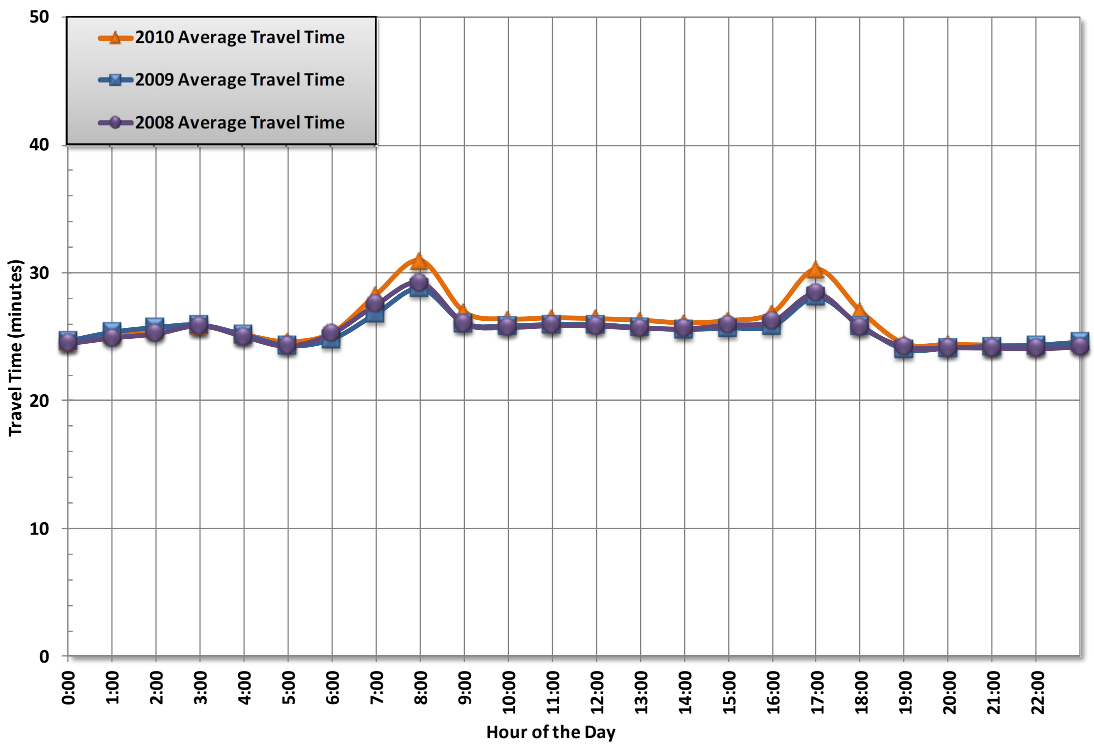
The southbound direction, shown in Exhibit 4-7, had travel times ranging between 23 to 31 minutes. The AM peak hour at 8:00 AM and the PM peak hour at 5:00 PM had similar travel times ranging from 25 to 31 minutes. Travel times decreased slightly from 2008 to 2009 and increased from 2009 to 2010. Travel times were at their highest in 2010 compared to the prior two years.

Exhibit 4-6: Northbound I-680 Travel Time by Hour (2008-2010)



Source: SMG analysis of Caltrans Performance Measurement System (PeMS) data

Exhibit 4-7: Southbound I-680 Travel Time by Hour (2008-2010)



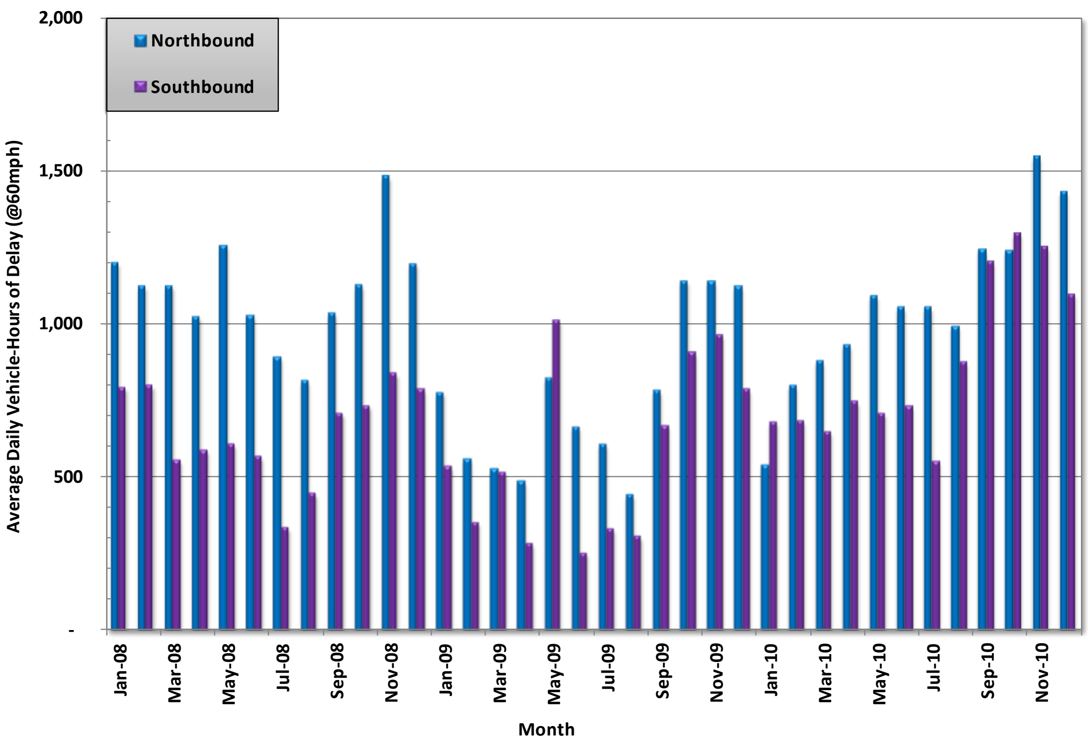
Source: SMG analysis of Caltrans Performance Measurement System (PeMS) data

Congestion

Traffic congestion can be measured in terms of travel delay, which is defined as the actual travel time minus the travel time under uncongested conditions. This delay is reported as vehicle-hours of delay (VHD). For this analysis, 60mph was used as the free-flow speed for the freeway facility, with 35mph used as the threshold for "severe" congestion in order to be consistent with the Caltrans Mobility Performance Report (MPR)[11] speed thresholds. As with the travel time measure, three years of automatic detector data were used from 2008 to 2010 due to the sufficiently good data available. Exhibit 4-8 shows the average, non-holiday, weekday, daily vehicle-hours of delay for each month between 2008 and 2010. This exhibit reveals the following delay trends:

- *Growth of Congestion*. Following the start of the "Great Recession" in the fall of 2008, congestion declined dramatically, but since the autumn of 2009, congestion has been growing consistently.
- *Directionality of Congestion*. The PM peak period has more total congestion than the AM peak period, representing between 55 to 60 percent of all daily congestion.
- *Seasonality of Congestion.* The months between September and the end of December are typically the most congested of the year. On the Contra Costa County I-680 CSMP corridor, these four months account for about 45 percent of all annual congestion.

Exhibit 4-8: I-680 Average Weekday Delay by Month (2008-2010)



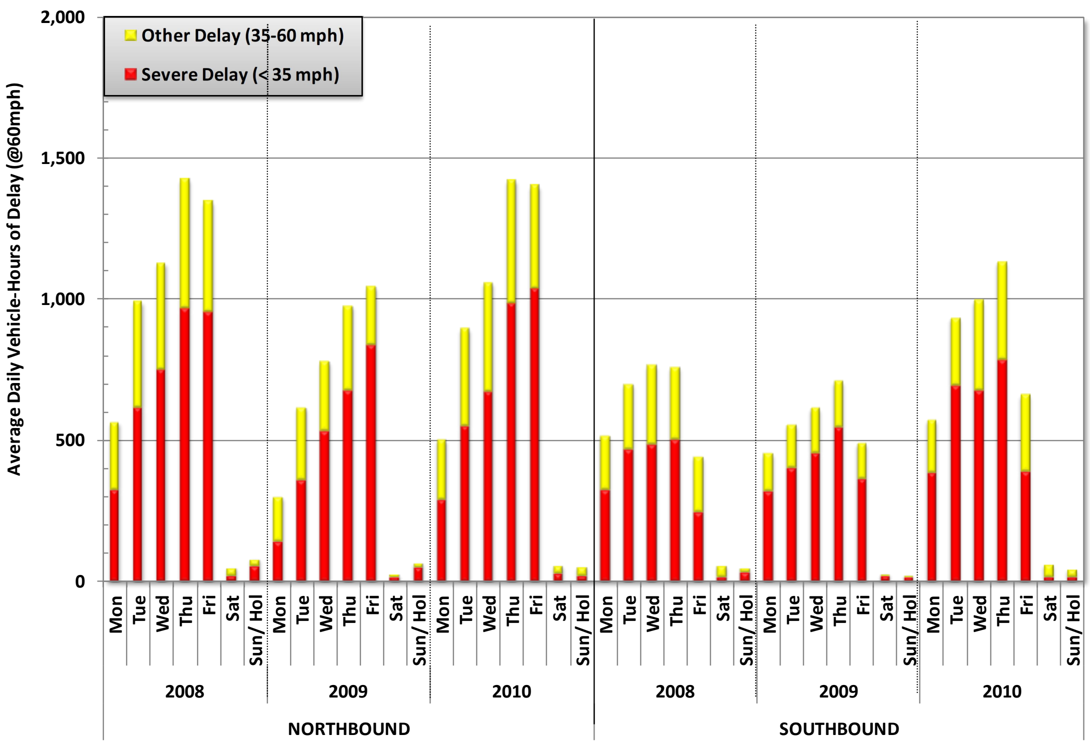
Source: SMG analysis of Caltrans Performance Measurement System (PeMS) data

[11] Caltrans Division of Traffic Operations, Office of System Management Planning. Mobility Performance Report. 2010. www.dot.ca.gov/hq/traffops/sysmgtpl/MPR/index.htm.

Exhibit 4-9 shows average VHD by day of week. "Severe" delay represents breakdown conditions when speeds fall below 35mph, while "other" delay represents conditions approaching breakdown congestion, leaving the breakdown condition or areas that cause temporary slowdowns. The exhibit reveals the following conditions:

- Severe delay makes up for over 60 percent of all weekday delay on the corridor in either northbound or the southbound directions.
- Thursdays experienced the highest delays in both the northbound and southbound directions. In the northbound direction, Thursdays and Fridays were similar, but in the southbound direction, Friday was the least congested weekday.
- Delay was highest in 2010 for the southbound direction as compared to previous years. Delay was highest in 2008 for the northbound direction and greater in the northbound direction than the southbound.

Exhibit 4-9: I-680 Average Delay by Day of Week by Severity (2008-2010)



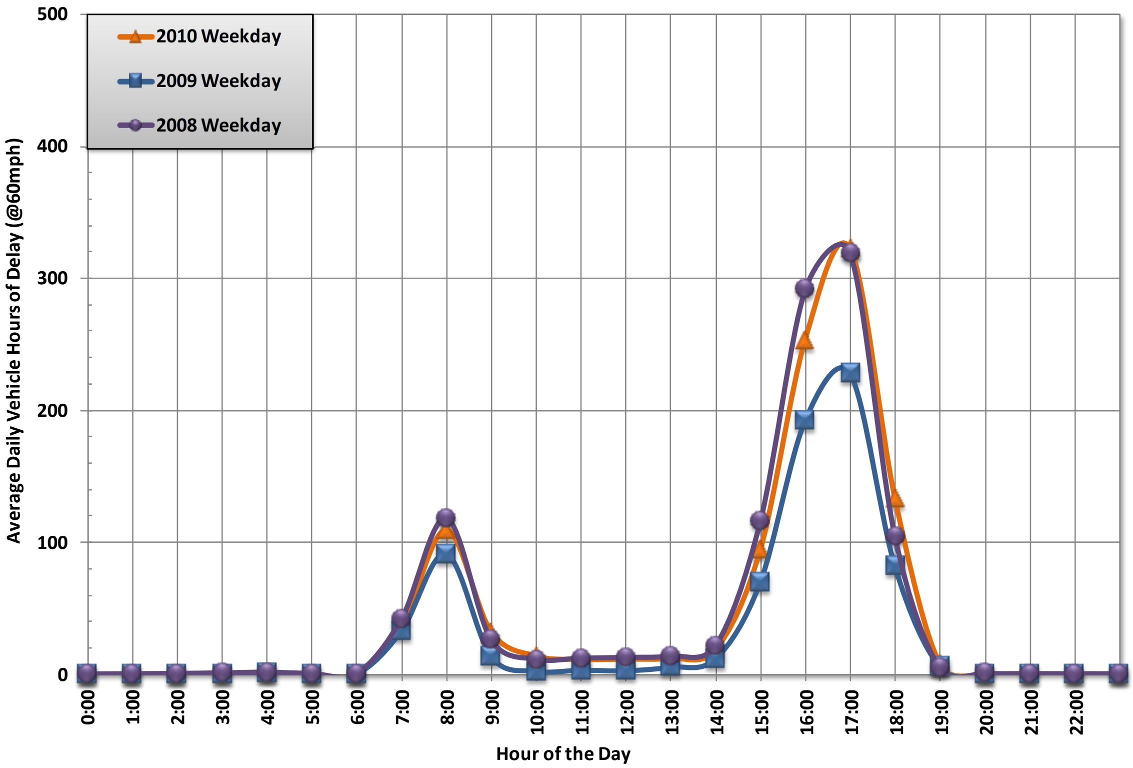
Source: SMG analysis of Caltrans Performance Measurement System (PeMS) data

Exhibits 4-10 and 4-11 summarize, for each direction, the average weekday hourly delay by year from 2008 to 2010 to understand the peaking characteristics of congestion and how they change over time.

In both the northbound (Exhibit 4-10) and southbound (Exhibit 4-11) directions, delay in the PM peak period exceeded delay in the AM peak period. In the northbound direction, the AM peak period occurred between 6:00 AM and 9:00 AM, and the PM peak period occurred between 2:00 PM and 7:00 PM. During the 5:00 PM peak hour, in the northbound direction, delay decreased slightly from almost 330 VHD in 2008 to around 230 VHD in 2009. Conversely, it increased to about 330 VHD in 2010.

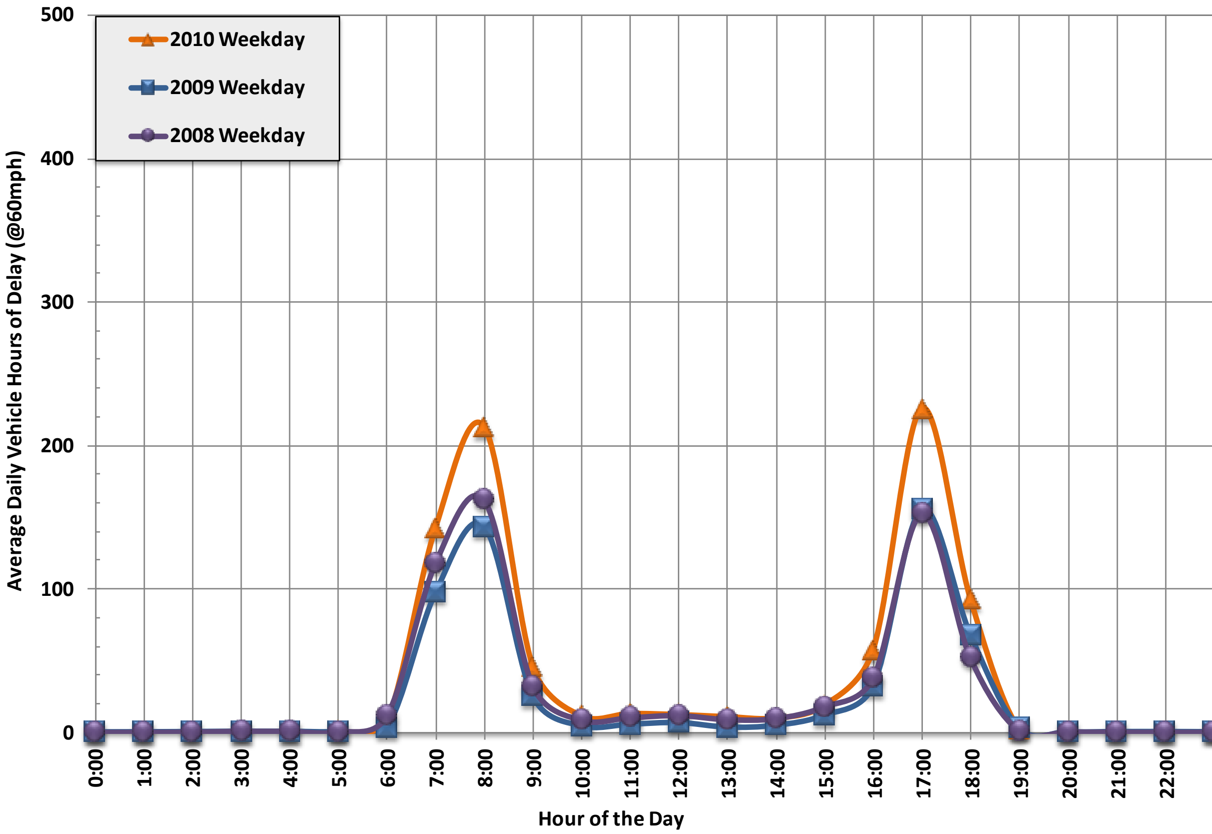
The southbound direction showed a similar pattern to the northbound direction. The biggest delays occurred during the PM peak hours, centered at 5:00 PM, but the AM peak period also showed delay. During the 5:00 PM peak hour, congestion increased from 155 VHD in 2008 to nearly 230 VHD in 2010. The 8:00 AM peak hour experienced the highest delay in 2010, accumulating 215 vehicle-hours.

Exhibit 4-10: Northbound I-680 Average Weekday Hourly Delay (2008-2010)



Source: SMG analysis of Caltrans Performance Measurement System (PeMS) data

Exhibit 4-11: Southbound I-680 Average Weekday Hourly Delay (2008-2010)



Source: SMG analysis of Caltrans Performance Measurement System (PeMS) data

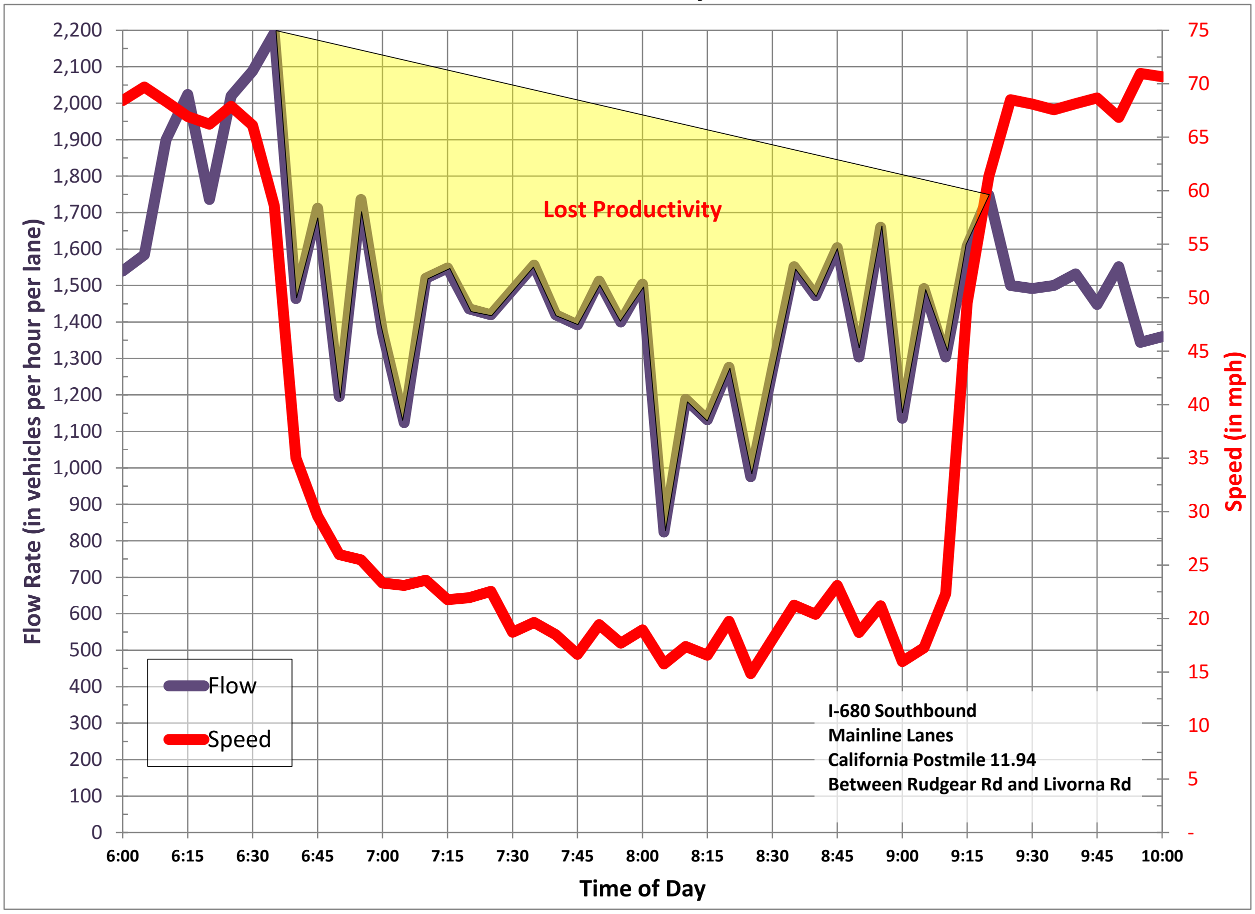
Productivity

Productivity is a system efficiency measure used to analyze the capacity of the corridor and is defined as the ratio of output (or service) per unit of input. In the case of roadway transportation, productivity is the percent utilization of a facility or mode under peak congested conditions.

For highways, it is the number of vehicles compared to the capacity of the roadways. The output is the number of people or vehicles that can pass through that roadway and is calculated as the actual volume divided by the theoretical capacity of the highway. Highway productivity is particularly important because where capacity is needed the most, the lowest amount of "production" from the system often occurs. Highway segments with the lowest productivity (at least under recurring congested conditions) are those in the queue approaching a bottleneck. Where capacity is needed the most is in the bottleneck section itself since it is the cause of the congestion and has a volume to capacity (v/c) ratio of 1.0 or greater.

This loss in productivity example is illustrated in Exhibit 4-12. As traffic flow increases to the roadway's capacity limit, speeds decline rapidly, and throughput drops drastically. This loss in throughput is the productivity lost in the system.

Exhibit 4-12: Lost Productivity on I-680 Corridor

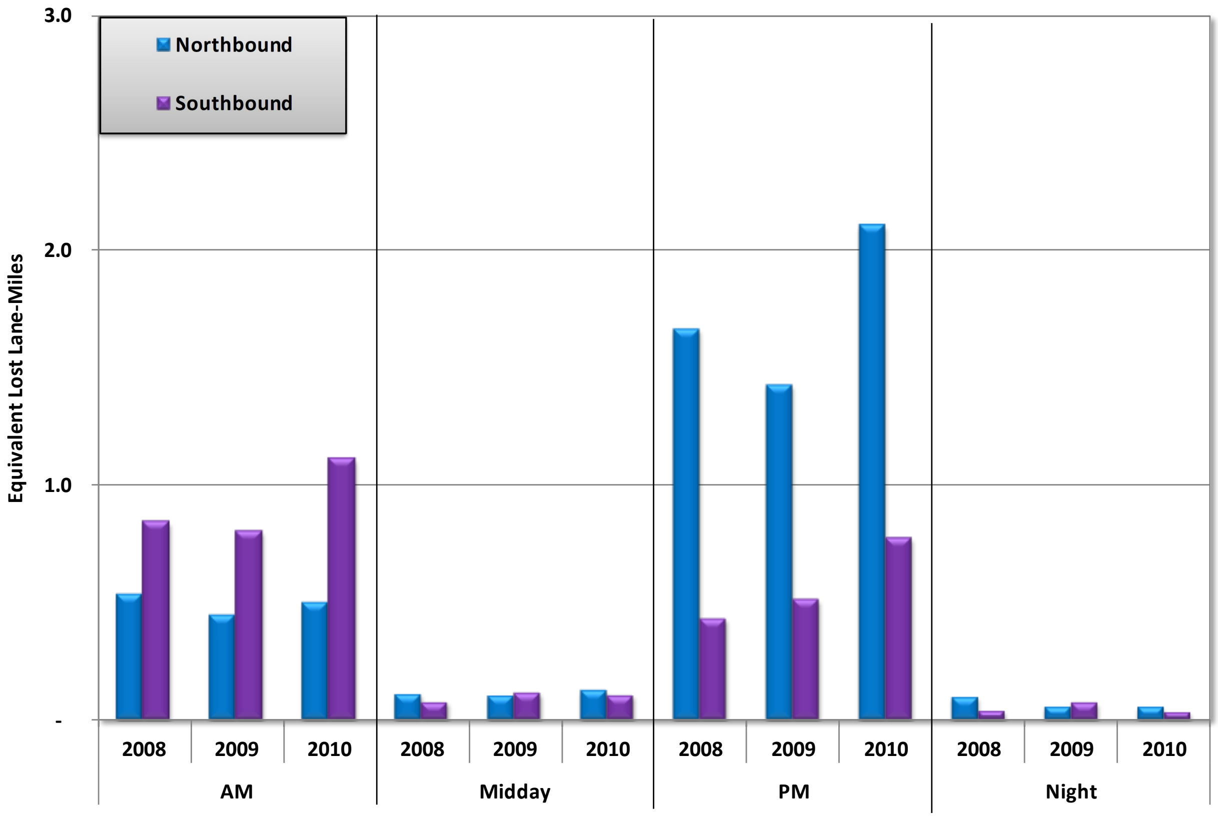


Source: SMG analysis of Caltrans Performance Measurement System (PeMS) data.

There are several ways to estimate productivity losses. Regardless of the approach, highway productivity calculations require good detection and/or significant field data collection at congested locations. One approach is to convert this lost productivity into "equivalent lost lane-miles". It is calculated for congested locations as follows: $LostLaneMiles = \left(1 - \frac{ObservedLaneThroughput}{2000vphpl}\right) \times Lanes \times CongestedDistance$

Exhibit 4-13 summarizes the productivity losses on Contra Costa I-680 CSMP corridor's mainline lanes from 2008 to 2010. The largest productivity losses occurred during the PM peak hours in the northbound direction (noted by the taller blue shaded bars). It is also the time period and direction that experienced the most congestion or delay. During the PM peak period in 2010, the northbound direction lost over two equivalent lane-miles. The southbound direction of the mainline (purple shaded bars) experienced productivity losses during the PM peak, but experienced the highest loss in productivity during the AM peak in 2010.

Exhibit 4-13: I-680 Daily Equivalent Lost Lane-Mile by Direction and Period (2008-2010)



Source: SMG analysis of Caltrans Performance Measurement System (PeMS) data

Multimodal Travel Time Reliability

Travel time reliability captures the degree of predictability in travel time. This measure reflects the impacts of accidents, incidents, weather, and special events. Improving reliability is an important goal for transportation agencies since reliability impacts automobiles, trucks, and transit buses. Efforts to improve reliability include incident management, traveler information, and special event planning.

Bus transit service reliability is typically reported by a schedule adherence measure, such as percentage of bus arrivals at stops no later than five minutes after the scheduled arrival time. BART reports a patron-on-time measure: the percentage of riders who arrive at the destination station within five minutes of the scheduled arrival time. Unfortunately, there is no clear way to forecast transit service reliability because it is affected by unpredictable factors such as equipment reliability, driver availability, and passenger loading times in addition to traffic conditions. For certain types of alternatives, for example where express bus service on reserved right-of-way is being considered (e.g., express bus on HOV lanes), it is clear that the alternative would improve transit service reliability, but the degree to which it would do so would be difficult to quantify.

Bicycle travel time reliability is related in some ways to auto travel time reliability on surface streets. But bicycle often have the advantage that they can often travel while traffic is slowed or stopped. Hence, relating bicycle travel time reliability to auto travel time reliability is uncertain at best. As in the case of transit, alternatives involving dedicated facilities such as bike trails would increase bike travel time reliability, but this effect would be difficult to quantify.

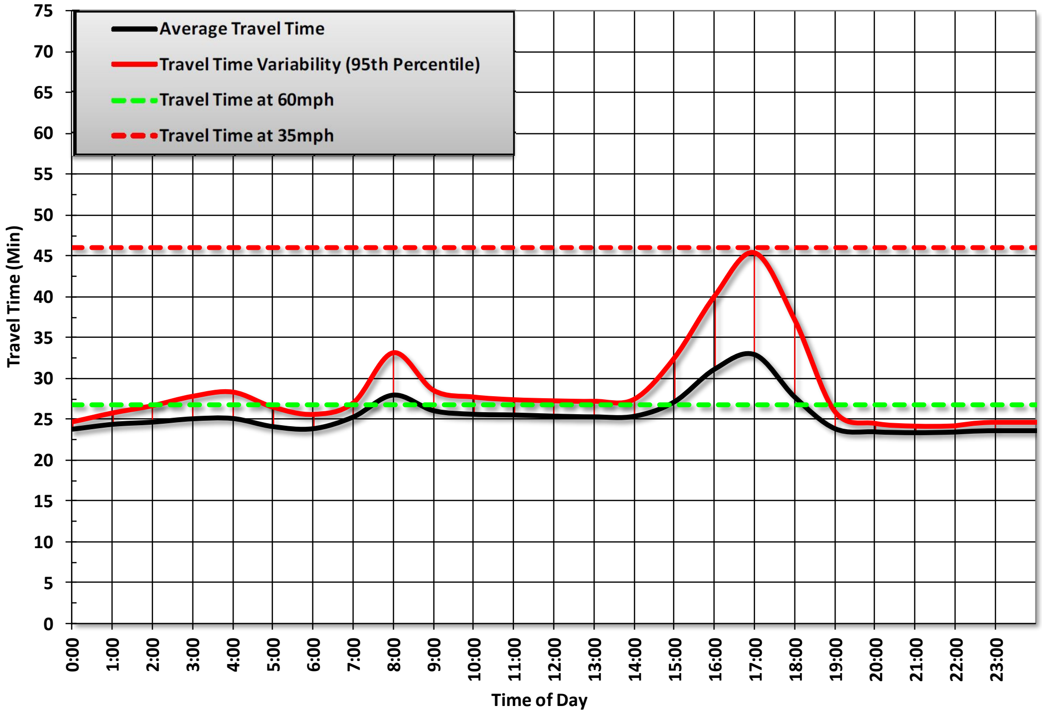
Pedestrian travel time can probably be assumed to be reliable most of the time. Pedestrian wait times at signalized intersections depend on signal cycle times, which normally do not vary from day to day.

To measure freeway reliability automatic detector data were used to estimate the "buffer index." The buffer index is the additional time required to ensure an on-time arrival 95 percent of the time. To illustrate, a person needing to be on time 19 out of 20 workdays per month should add additional time to their average travel time to ensure an on-time arrival. Non-recurring events, could cause longer travel times, but the 95th percentile represents a balance between days with extreme events (e.g., major accidents) and other, more average travel days.

Exhibits 4-14 and 4-15 show the variability of weekday travel time along I-680 for 2010 by direction. In the northbound direction (Exhibit 4-14), the 5:00 PM peak hour was the most unreliable, in addition to being the slowest hour on average. To insure an on-time arrival 95 percent of the time at 5:00 PM, a driver would have to add nearly 12 minutes to their average time of 33 minutes equaling a total travel time of 46 minutes.

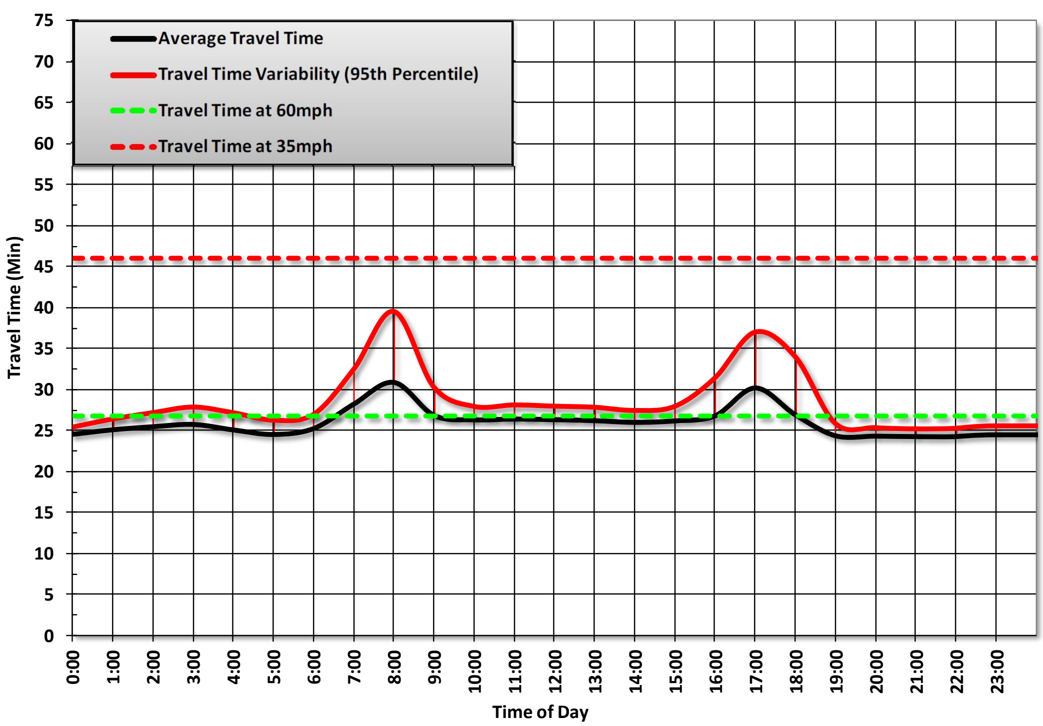
In the southbound direction (Exhibit 4-15) of the mainline facility, the most unreliable hours were 8:00 AM and 5:00 PM. Unlike the northbound direction, which experienced the highest travel time variability during the PM peak period, the southbound direction experienced similarly high travel time variability during both AM and PM peak periods. In 2010 (Exhibit 4-15), time needed was 40 minutes at 8:00 AM and 36 minutes at the 5:00 PM hour.

Exhibit 4-14: Northbound I-680 Travel Time Variation (2010)



Source: SMG analysis of Caltrans Performance Measurement System (PeMS) data

Exhibit 4-15: Southbound I-680 Travel Time Variation (2010)



Source: SMG analysis of Caltrans Performance Measurement System (PeMS) data

Multimodal Safety

Safety data were reviewed for bicycles/pedestrians and for the I-680 freeway facility.

Bicycle/Pedestrian Collisions

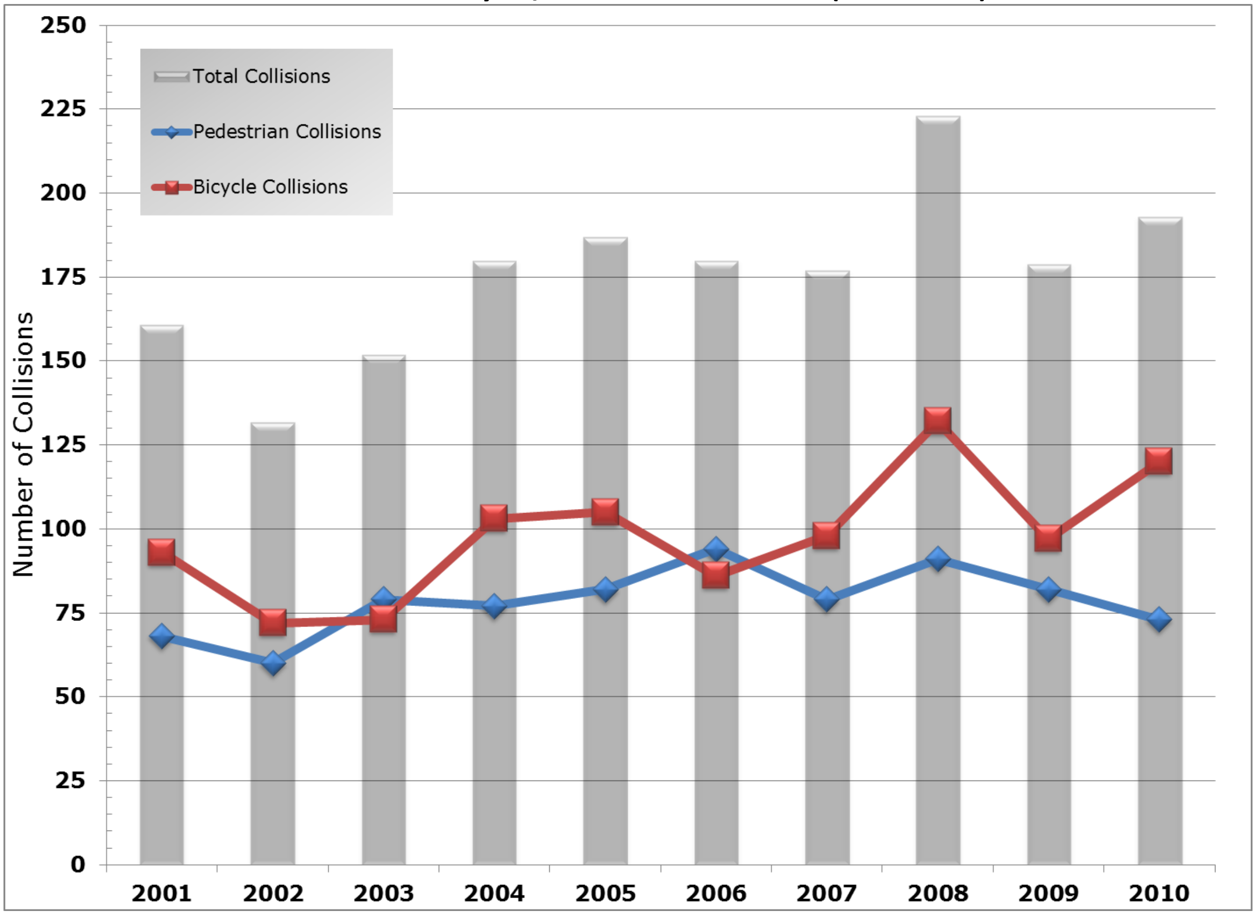
Exhibit 4-16 is a chart showing the number of reported bicycle and pedestrian collisions occurring within a two-mile buffer around I-680 between the years 2001 and 2010. This chart includes collisions on arterials and other facilities not owned or operated by Caltrans (note that pedestrians and bicyclists are not permitted on the I-680 freeway). The data are from the Statewide Integrated Traffic Records System (SWITRS)[12] database maintained by CHP and accessed through the Transportation Injury Mapping System (TIMS) [13] of the Safe Transportation Research and Education Center (SafeTREC) at the University of California, Berkeley.

Over the 10-year period there were on average 175 annual collisions. Slightly more than half (55 percent) of these collisions involved bicycles. While the number of pedestrian collisions remained flat over the ten year period, bicycle collisions grew slightly. These numbers reflect total reported collisions and do not represent a collision rate, which could be declining if the total number of bicycles or pedestrians is increasing faster than the rate of collisions. In other words, there could be more collisions occurring simply because there are more bicyclists on the road. Data were not available to establish a rate for this analysis.

Exhibit 4-17 shows the locations of each of these reported collisions. As might be expected, most of the collisions occur in areas with more people. More urbanized areas in Concord, Pleasant Hill, Walnut Creek, and Dublin, where there are more opportunities for bike/pedestrian and vehicle conflicts to occur, experience the most collisions.

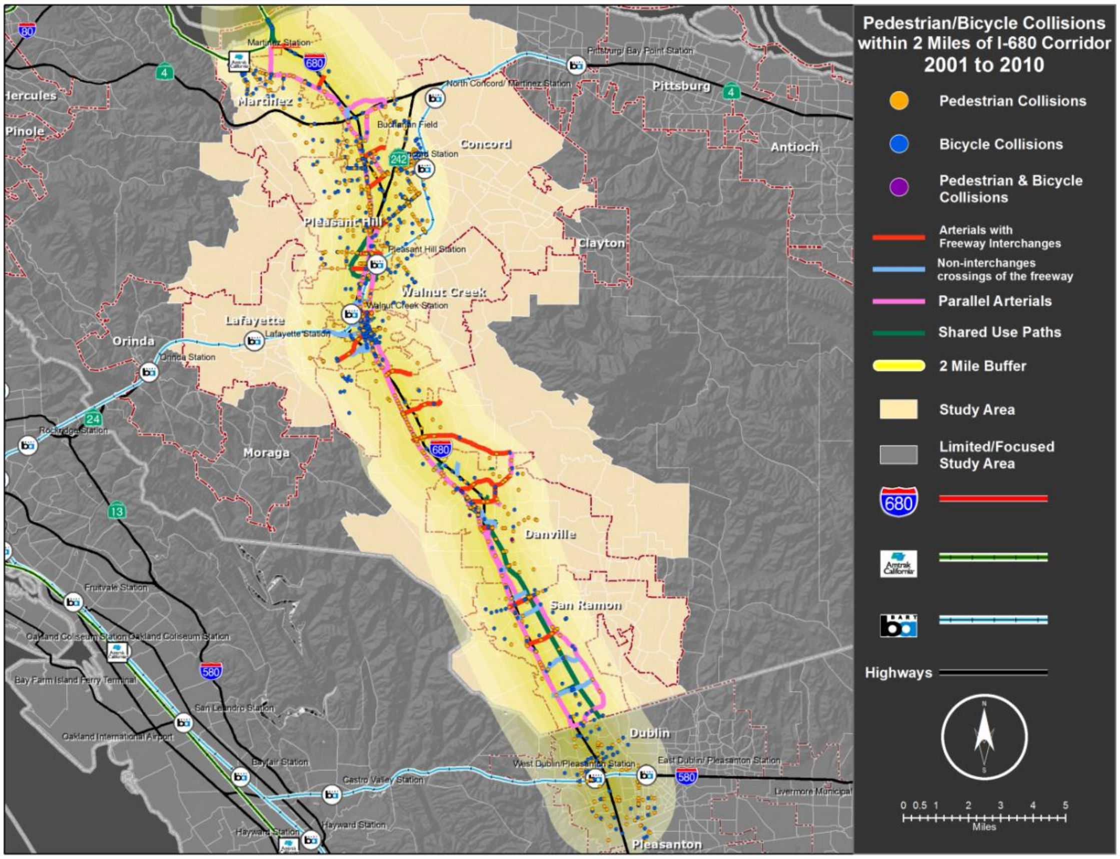
[12] Statewide Integrated Traffic Records System (SWITRS). iswitrs.chp.ca.gov.
[13] Transportation Injury Mapping System (TIMS) http://tims.berkeley.edu

Exhibit 4-16: Bicycle/Pedestrian Collisions (2001-2010)



Source: SMG analysis of CHP SWITRS data.

Exhibit 4-17: Bicycle/Pedestrian Collision Locations (2001-2010)



Source: SMG analysis of CHP SWITRS data.

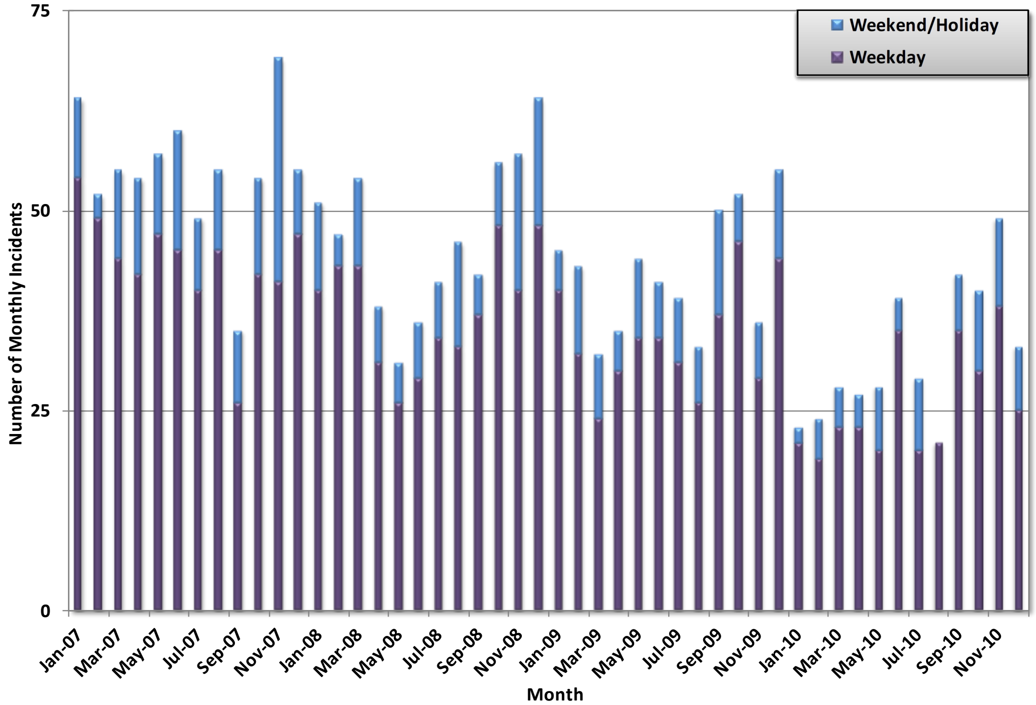
Freeway Collisions

The freeway collision and rate data used for this analysis came from the Caltrans Traffic Accident Surveillance and Analysis System (TASAS). TASAS is a traffic records system that links accident data to a highway geometric database. The highway database contains descriptive elements of highway segments, intersections and ramps, access control, traffic volumes, and other data. TASAS contains specific data for accidents on state highways. Collisions on non-state highways are not included (e.g., local streets and roads) as well as those not reported to authorities.

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

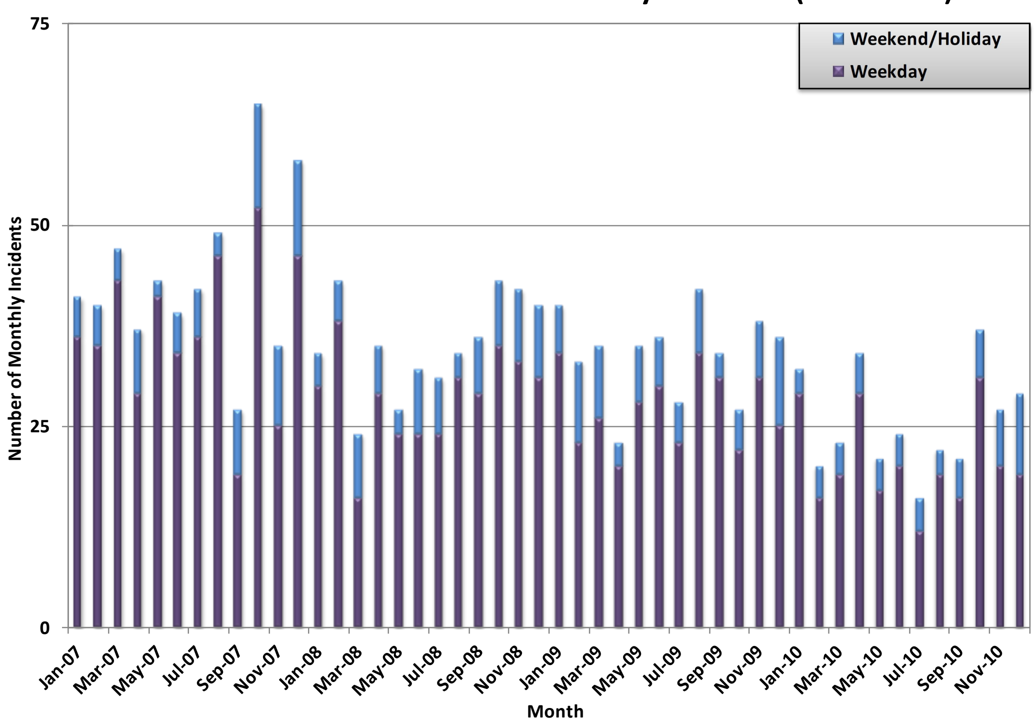
Exhibits 4-18 and 4-19 show the number of weekday and weekend/holiday collisions by month for each direction, respectively. Exhibit 4-18 shows that the number of northbound collisions decreased from an average of 50 per month in 2007 to around 30 per month in 2010. In the southbound direction (Exhibit 4-19), collisions also decreased monthly during the four-year period from 42 in 2007 to 20 in 2010. Northbound collision totals exceeded southbound collisions for each of the four years.

Exhibit 4-18: Northbound I-680 Monthly Collisions (2007-2010)



Source: SMG Analysis of Caltrans TASAS data

Exhibit 4-19: Southbound I-680 Monthly Collisions (2007-2010)



Source: SMG Analysis of Caltrans TASAS data

Multimodal Service Quality

The SMF measure for service quality balances efficiency and comfort among users of all travel modes. There are three ways to evaluate service quality. The MMLOS analysis of select locations summarized above in the discussion of multimodal travel mobility and presented in more detail in Appendix A is a measure of customers' satisfaction with the travel experience.

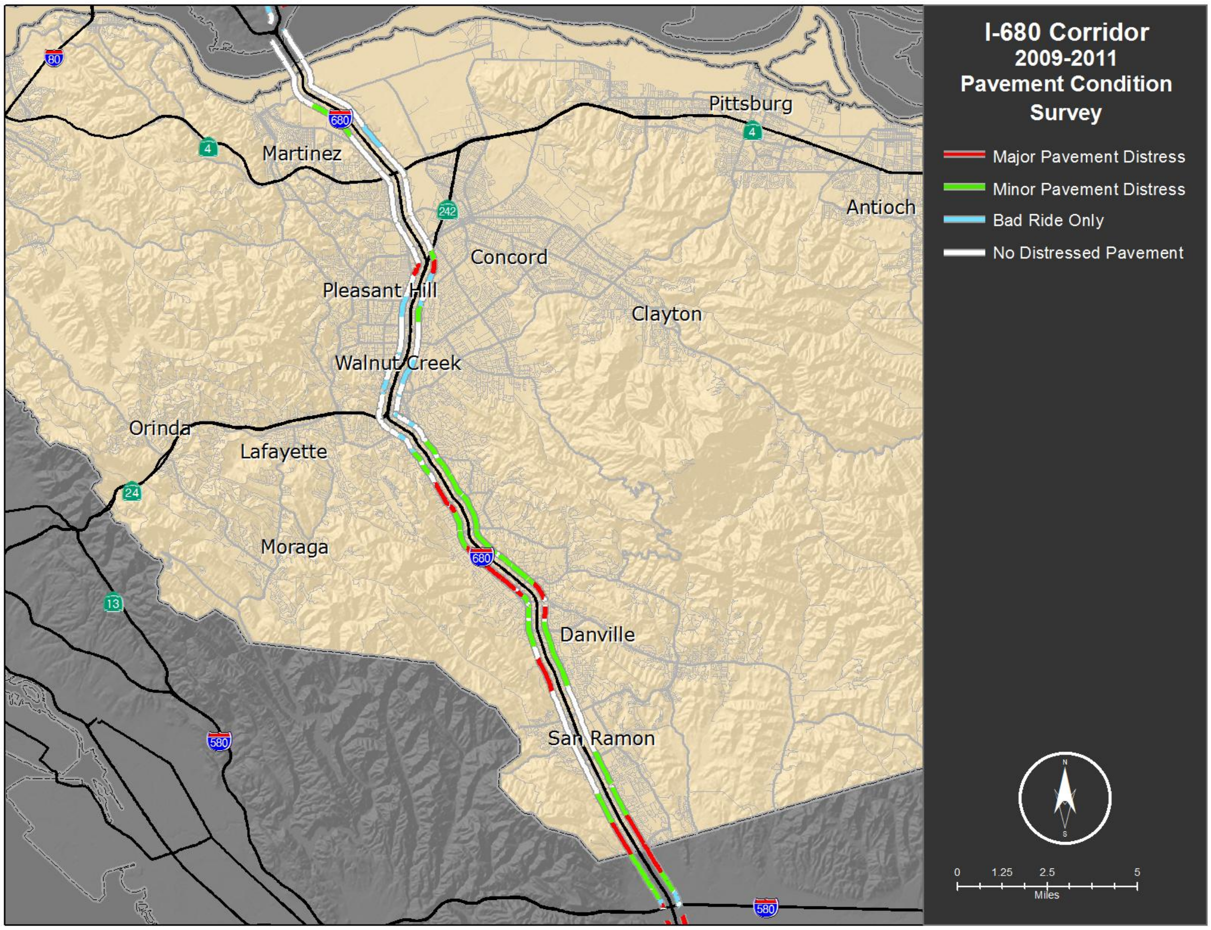
Complete Streets evaluations are also described in the SMF as a way to capture multimodal service quality. The Contra Costa I-680 CSMP Complete Streets analysis is also presented above and is detailed in Appendix C.

The third way to improve multimodal service quality is by maintaining infrastructure asset condition. Pavement condition can influence traffic performance, public transit performance, and state of good repair.

Rough or poor pavement conditions can decrease the mobility, reliability, safety, and productivity of the corridor. The goal of pavement preservation is to maintain the structural adequacy and ride quality of the roadway.

Caltrans conducts an annual Pavement Condition Survey (PCS) that can be used to estimate the number of distressed lane-miles on the corridor. Distressed lane-miles help to distinguish between pavement segments that require only preventive or corrective maintenance at relatively low costs and segments that require major rehabilitation/replacement at higher costs. Exhibit 4-20 shows pavement distress along the I-680 corridor according to the 2011 PCS data.

Exhibit 4-20: I-680 Distressed Lane-Miles (2011)



Source: Caltrans 2011 Pavement Condition Survey data

5. BOTTLENECK IDENTIFICATION AND CAUSALITY

Major bottlenecks are the primary cause of congestion and lost productivity. A bottleneck is a location where traffic demand exceeds the effective carrying capacity of the roadway. A bottleneck can be caused by a sudden reduction in effective capacity, such as a physical loss in capacity when a lane drop occurs or when heavy merging and weaving take place near on and off-ramps. On the demand side, surges in demand, often from on-ramps, can be greater than a roadway can accommodate when the road is approaching its maximum capacity.

Exhibit 5-1 summarizes the identified bottleneck freeway sections based on analysis performed in 2013. Major, controlling and minor bottlenecks were identified. Minor bottlenecks include hidden bottlenecks that are overtaken by queuing from a downstream bottleneck or by reduced traffic flow from an upstream bottleneck. The average queue lengths and the duration of congestion for each bottleneck are also provided. Exhibits 5-2 and 5-3 are maps showing these sections for the AM and PM peak periods, respectively. These bottlenecks were identified using various data sources and years, but were verified in the spring of 2013.

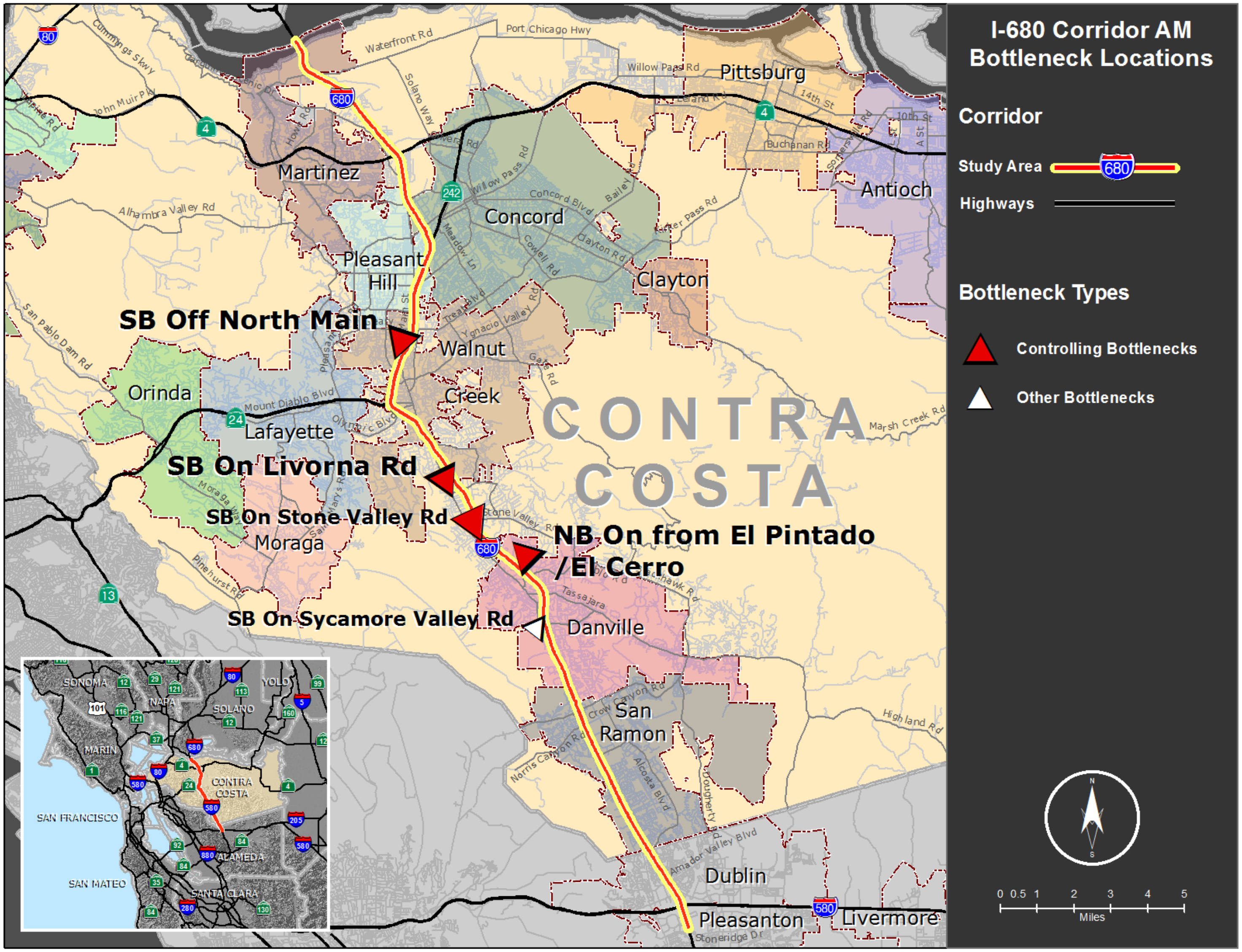
Appendix E presents detailed analysis for identifying bottlenecks.

Exhibit 5-1: I-680 CSMP Corridor Bottleneck Freeway Sections

Dir	Length of Bottleneck Area/ (Expected Queue Length)	Bottleneck Location	Absolute Postmile	Caltrans Postmile	Average Duration AM/(PM)	Causality
Northbound	6.9/ (1.0+/-)	NB On From Stoneridge Dr (Pleasanton)	028.91	R19.371		End of corridor. Not a bottleneck
		NB On From Crow Canyon Rd	**035.85**	**R4.44**	(3:30PM-6:30PM)	NB On merging. Usually resolves jso Greenbrook Ave
	4.4/ (1.5+/-)	NB On From Sycamore Valley Rd	038.26	R6.72	7:00AM-9:00AM/ (3:30PM-6:30PM)	Some slowing at NB on-ramp, but downstream El Cerro bottleneck sometimes queues past this location
		NB On From El Pintado Road/El Cerro Blvd	**040.24**	**R8.84**		High volumes at El Cerro On
	7.0/ (4.25 - 4.5+/-)	NB On From Livorna Rd	042.79	R11.398	(3:00PM-7:00PM)	Minor slowing
		NB Off To WB SR-24/Ygnacio Valley Rd Off/Olympic On	045.99	014.49		Lane drop from 5 to 3 lanes. Combination of SR-24/ I-680/ Olympic On auxiliary lane ending and curvature/geometrics that cause weaving issues
		NB Off To N Main St	047.02	015.52		Lane drop from 6 to 5 lanes at NB Off to N Main St
		NB On From Lawrence Way/NB Off To Treat Blvd	**047.24**	**015.73**		High on/off ramp volumes at Lawrence Way On/Treat Off
	9.9	Solano County Line	057.16	025.66		End of corridor. Not a bottleneck
Southbound	19.0	SB Off to Stoneridge Dr (Pleasanton)	029.05	R19.511		End of corridor. Not a bottleneck
		SB On From Sycamore Valley Rd	038.03	R6.636		Minor intermittent slowing. Not a major bottleneck. On-ramp surges can contribute to slowing.
	Approx 1/ (2.0+/-)	**SB On From Stone Valley Rd**	041.60	R10.208	7:00AM-9:00AM	Some slowing. Not a major bottleneck, but could become one in the future. Relatively high AM on-ramp volumes can contribute to slowing.
	4.6/ (1.5+/-)	**SB On From Livorna Rd**	**042.79**	**R11.481**	7:00AM-9:00AM/ (4:00PM-6:00PM)	Lane drop from 5 to 4 to 3 lanes in succession. Some queuing in #1 Lane jno HOV (at AbsPM=44.4) due to anticipation of HOV lane ingress by HOVs
	9.8/ (3.0-4.0+/-)	**Lane Drop jso SB Off to North Main**	**047.38**	**15.883**	6:30AM-9:00AM	Lane drop at SB off ramp
		Solano County Line	057.16	25.657		End of corridor. Not a bottleneck

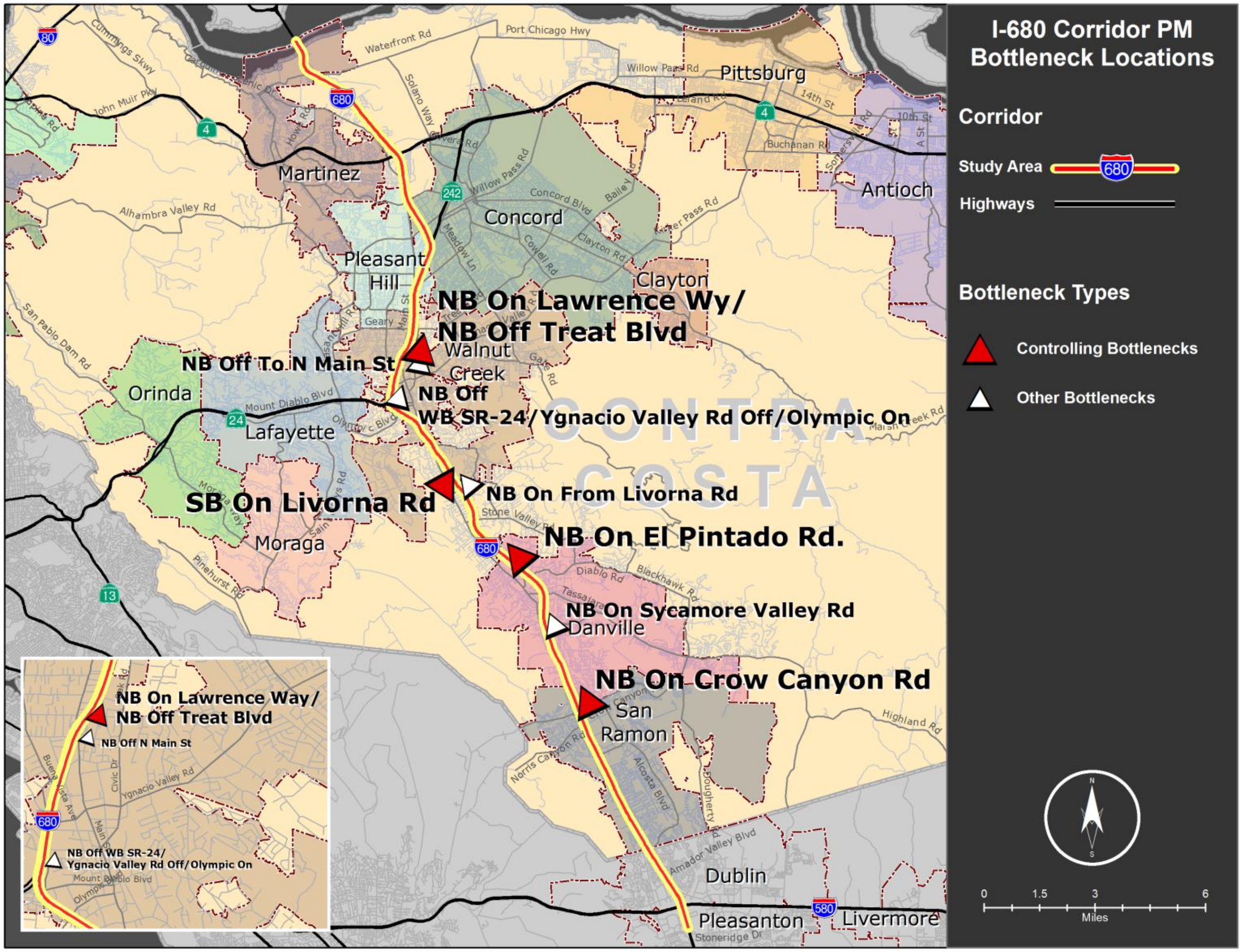
XXX - Controlling bottleneck location
YYY - Other bottleneck/slowing
ZZZ - Not a bottleneck location

Exhibit 5-2: AM Bottlenecks Locations



Source: System Metrics Group, Inc. analysis

Exhibit 5-3: PM Bottleneck Locations



Source: System Metrics Group, Inc. analysis

Bottleneck Causality

This section discusses the causes of the bottlenecks listed in Exhibit 5-1 above. The northbound bottlenecks are discussed first followed by the southbound bottlenecks.

Northbound Bottlenecks

This section discusses the following six northbound direction bottlenecks, starting from the furthest upstream:

- NB On From Crow Canyon Road
- NB On From Sycamore Valley Road
- NB On From El Pintado Road/El Cerro Boulevard
- NB On From Livorna Road
- NB Off To WB SR-24/Ygnacio Valley Road Off/Olympic Boulevard On
- NB Off To N Main Street and NB On From Lawrence Way/NB Off To Treat Boulevard.

The location of the bottlenecks will be described using both the absolute and California postmile systems. The California postmile system typically begins with 0.00 at the county line and ascends from west to east and from south to north (in the case of I-680). The absolute postmile system begins at the absolute beginning of a route and ascends from west to east and from south to north. In the case of I-680, absolute postmile begins at the beginning of I-680 in Santa Clara County and ascends north to the I-80 interchange in Solano County.

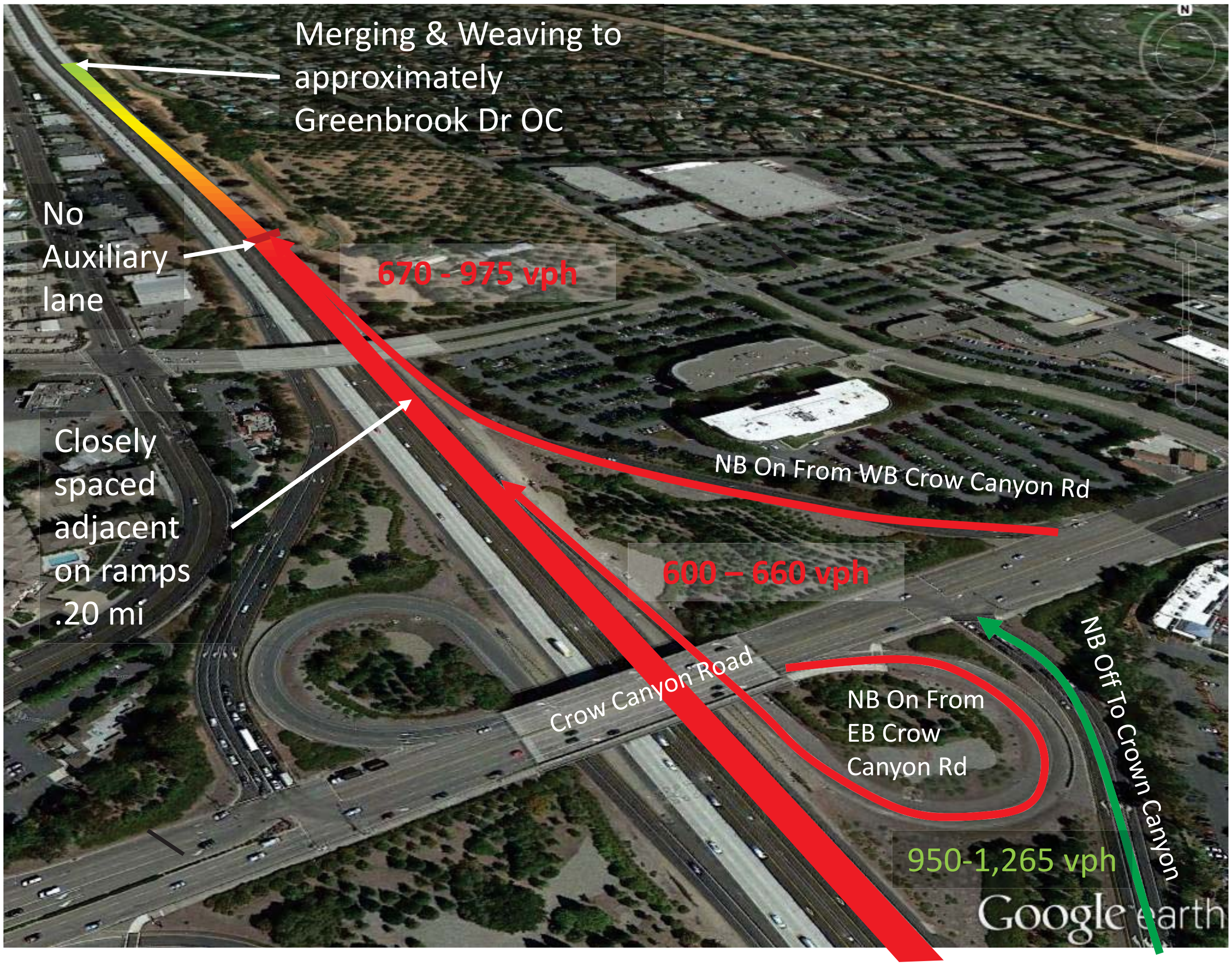
NB On From Crow Canyon Road (AbsPM 035.85, CaPM R4.44)

Exhibit 5-4 shows key features of the bottleneck section at Crow Canyon, which occurs at the westbound diagonal on-ramp to I-680 to the Sycamore Valley Road off-ramp. This bottleneck is one of three major PM peak period bottlenecks along with the El Pintado/El Cerro location and the Lawrence Way locations.

The bottleneck is caused by multiple merges from high-volume adjacent on-ramps. Specifically, downstream merging onto mainline traffic at the northbound on-ramp from westbound Crow Canyon Road, which loads between 670 and 975 vehicles per hour, is the primary cause of this bottleneck.

Another contributing factor is the merging from the HOV lane and the #1 mainline lane (i.e., the innermost lane to the median) into the #3 lane in preparation for exiting at the downstream Sycamore Valley Road off-ramp. The merging is not completed until approximately at the Greenbrook Avenue overcrossing when speeds return to free flow. Queuing from the bottleneck can extend upstream approximately one mile past Bollinger Canyon Road.

Exhibit 5-4: NB Crow Canyon Bottleneck



NB On From Sycamore Valley Road (AbsPM 038.26, CaPM R6.72)

Exhibit 5-5 illustrates key features of the Sycamore Valley Road bottleneck in the section from the northbound on-ramp at Sycamore Valley Road to the Diablo Road off-ramp.

This bottleneck is not active during the AM peak period and is very minor during the PM peak period with minor queuing that rarely can extend upstream past Greenbrook Drive. It is sometimes overwhelmed by queues from the downstream El Pintado/El Cerro bottleneck. A picture of the queue from the El Pintado/El Cerro bottleneck backing into the Sycamore Valley Road location is shown in Exhibit 5-6. There is also some slowing approaching this section.

Exhibit 5-5: NB Sycamore Valley Bottleneck

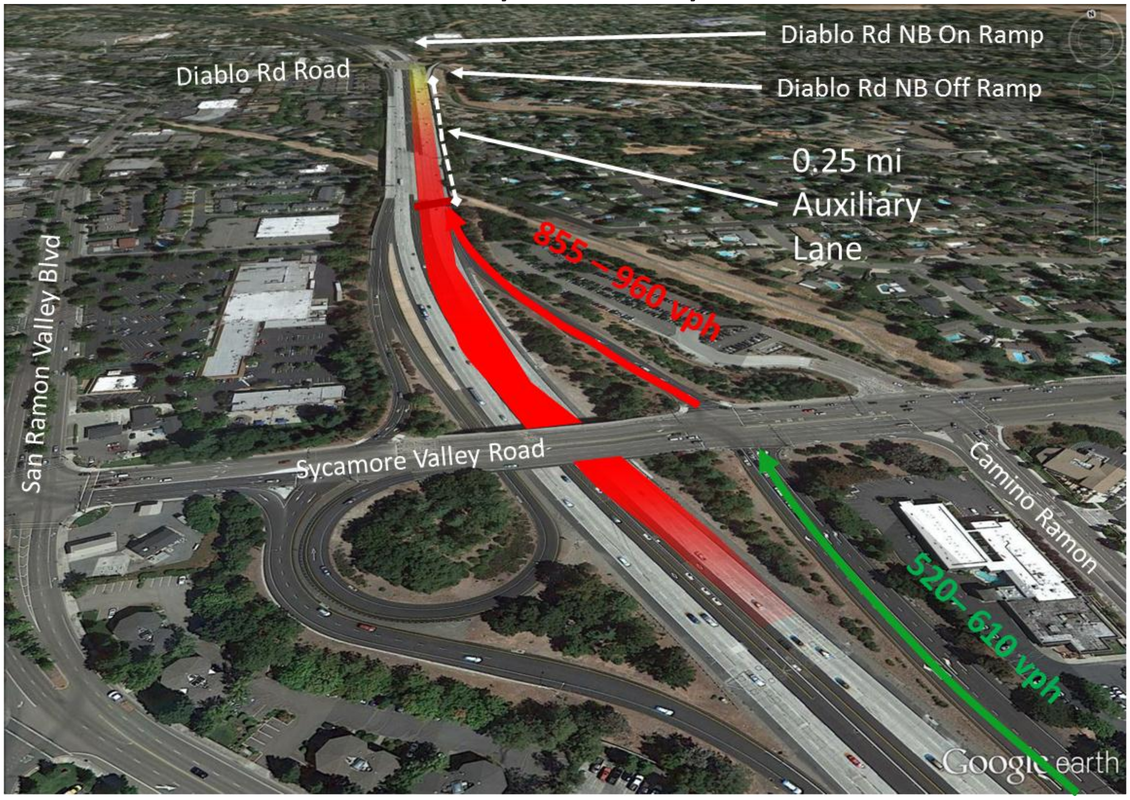


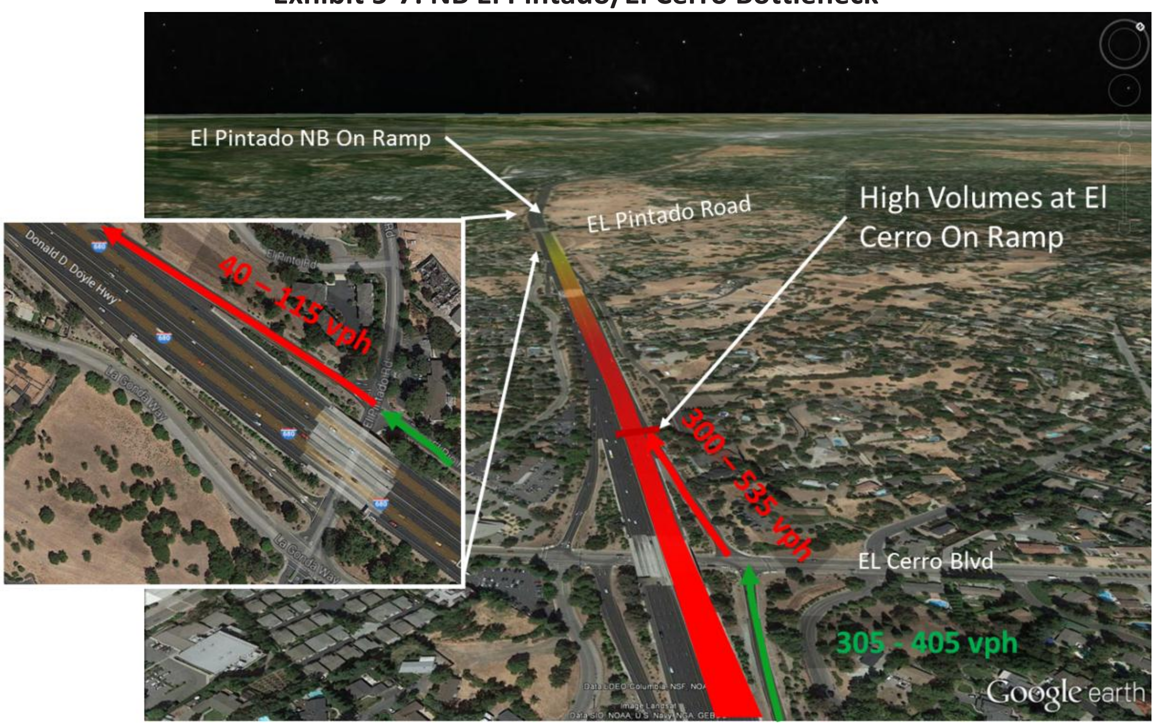
Exhibit 5-6: NB El Pintado Rd/El Cerro Boulevard Queue

NB On From El Pintado Rd/El Cerro Blvd (AbsPM 040.24, CaPM R8.84)

Exhibit 5-7 shows the bottleneck location at northbound El Pintado Road and El Cerro Boulevard on-ramps. This section extends north to Stone Valley Road. This is the second of three major northbound bottlenecks.

This bottleneck is caused by the interaction between the El Cerro Boulevard northbound on-ramp and the downstream El Pintado on-ramp, which lies approximately ½ mile downstream. The El Pintado on-ramp introduces relatively few vehicles (less than 115 vehicles per hour) to the traffic stream during the PM peak period. However, when the sections upstream operate at or very close to capacity, any additional traffic entering the mainline lanes causes demand to exceed capacity and the bottleneck to develop. The El Cerro on-ramp adds up to 535 peak hour vehicles. Combined with more than 1,000 vehicles added to the mainline lanes from upstream Sycamore Valley Road (see Exhibit 5-5) and Diablo Road (300-450 vehicles per hour during the PM peak), the additional flows from El Cerro and El Pintado create this bottleneck.

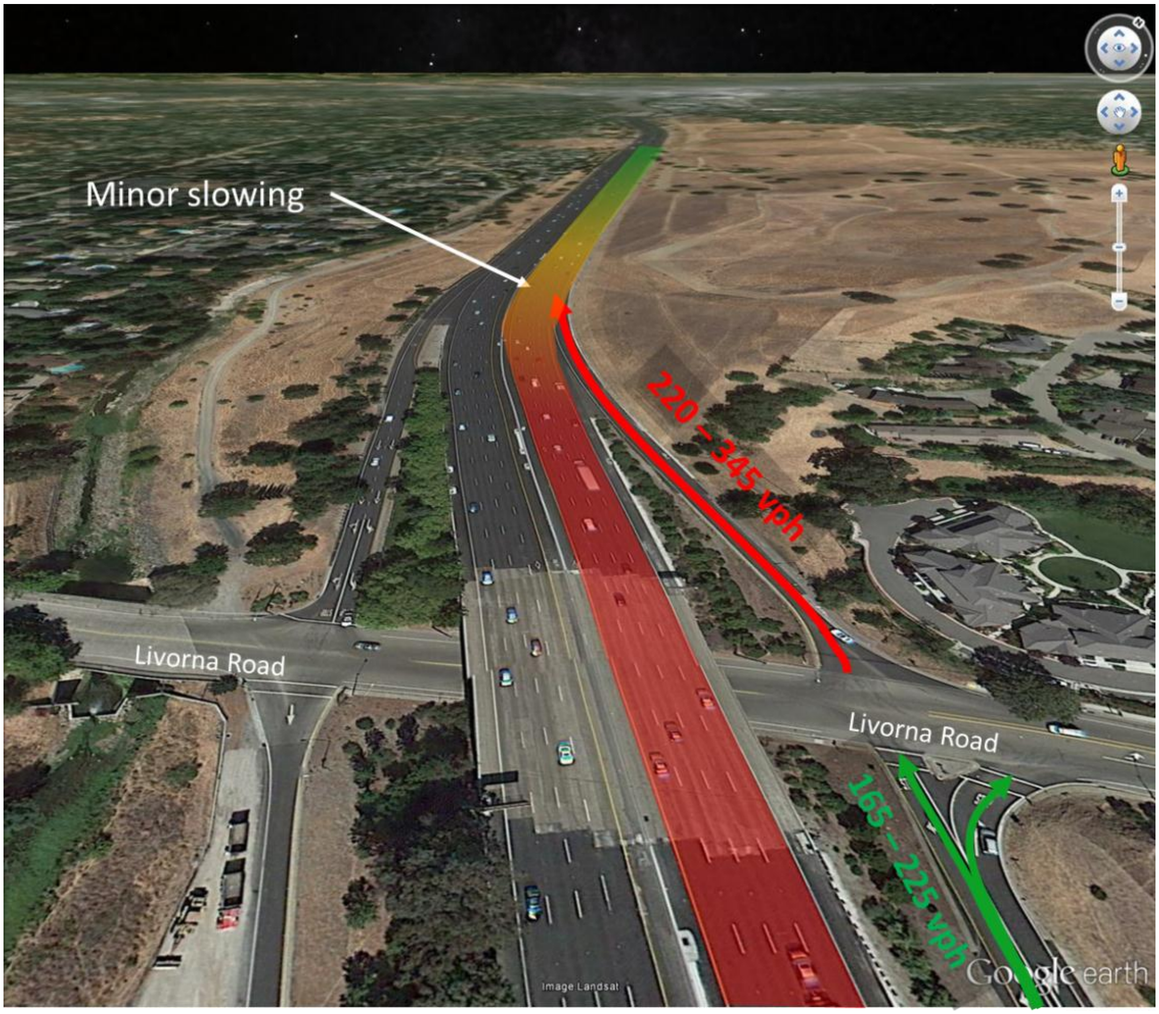
Exhibit 5-7: NB El Pintado/El Cerro Bottleneck



NB On From Livorna Road (AbsPM 042.79, CaPM R11.398)

This section from Livorna Road to Rudgear Road is illustrated in Exhibit 5-8. This bottleneck is not active during the AM peak period and is very minor during the PM peak period. There is only minor slowing approaching this section, but a bottleneck can develop when approaching mainline volumes are high and added on-ramp traffic causes the capacity of the freeway to be exceeded. Queues from the Lawrence Way bottleneck typically extend upstream through this bottleneck section.

Exhibit 5-8: NB Livorna Bottleneck

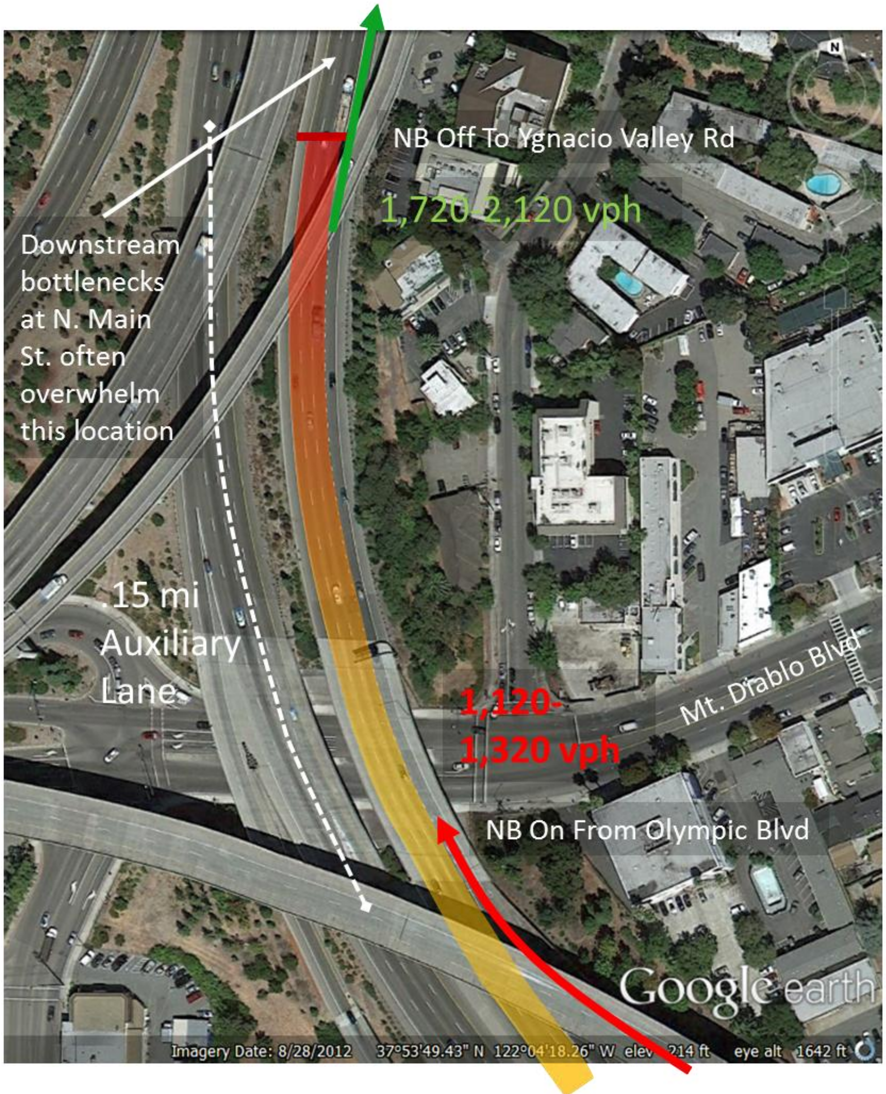


NB Off To WB SR-24/Ygnacio Valley Road Off/Olympic On (AbsPM 045.99, CaPM 014.49)

Exhibit 5-9 shows the minor bottleneck location between the Olympic Boulevard on- and the Ygnacio Valley Road off-ramps. This location is not active during the AM peak period, is only minor during the PM peak, and almost always is overwhelmed early in the PM peak period by the downstream North Main off-ramp and Lawrence Way on-ramp bottlenecks.

There is also a lane drop at the westbound off-ramp to SR-24 that contributes to this bottleneck. Very high volumes emerging from the Olympic Avenue on-ramp (approximately 1,100 to 1,300 vehicles per hour) combined with high volumes attempting to exit Ygnacio Valley Road (between 1,720 to 2,120 vehicles per hour) on a short auxiliary lane (less than0.20 of a mile) cause weaving and merging issues. Heavy mainline flow rates caused by the lane drop at the SR-24, westbound off-ramp combined with limited sight distances due to the curvature of the roadway contribute to this bottleneck.

Exhibit 5-9: NB SR-24/Ygnacio Valley/Olympic Bottleneck



NB On From Lawrence Way/NB Off To Treat Boulevard (AbsPM 047.24, CaPM 015.73)

The most congested segment of the corridor contains two major bottlenecks at the Lawrence Way on-ramp/Treat Boulevard off-ramp and at the North Main Street off-ramp, shown in Exhibit 5-10. The downstream controlling bottleneck is caused by high on- and off-ramp volumes between the Lawrence Way on-ramp and the Treat Boulevard off-ramp. Exhibit 5-11 is a videotaped image that shows the queuing from this bottleneck.

Just upstream from this location is the bottleneck at the North Main Street off-ramp with a lane drop from six to five lanes. Heavy mainline traffic volumes from the SR-24 westbound/I-680 northbound merge approximately one mile upstream are required to merge into five lanes. The North Main off-ramp only reports around 330 to 410 vehicles per hour exiting during the PM peak period, while up to 1,800 vehicles per hour enter from Lawrence Way, and up to 1,700 typically exit at Treat.

Exhibit 5-10: NB N Main/Lawrence Way Bottleneck

Exhibit 5-11: Queuing at Lawrence Way On

Southbound Bottlenecks

This section presents the causality findings for each of the four southbound bottleneck locations starting with the furthest downstream bottleneck:

- North Main Street
- Livorna Road
- Stone Valley Road
- Sycamore Valley Road.

North Main Lane Drop (AbsPM 047.38, CaPM 15.883)

Exhibit 5-12 shows the key features of this bottleneck, which is the most congested bottleneck in the southbound direction. This bottleneck is caused by the lane drop at North Main Street, just south of the southbound off-ramp to North Main in Walnut Creek. This bottleneck is not active during the PM peak period, but is the major, controlling bottleneck in the southbound direction during the AM peak period.

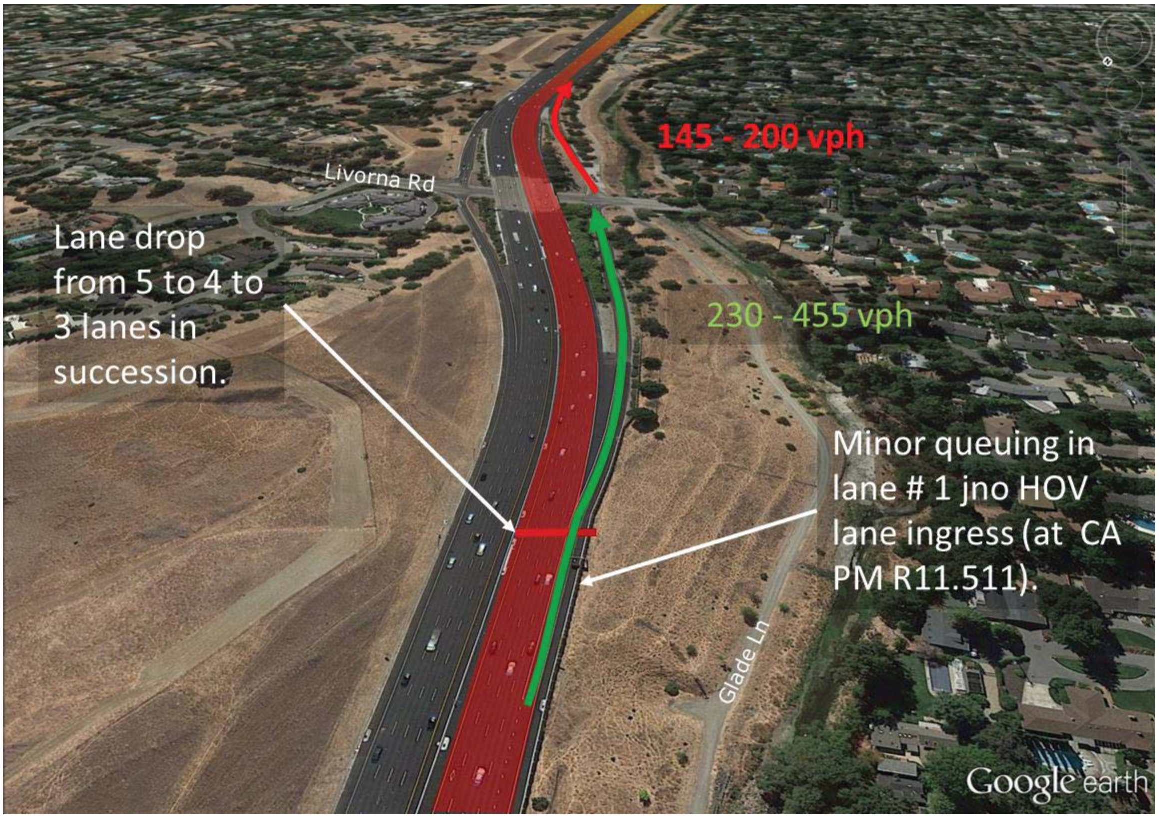
Along with heavy mainline volumes, the additional on-ramp volumes from Geary/Treat Boulevard, just upstream from the North Main off-ramp, combined with merging from the terminus of the HOV lane to contribute to this bottleneck. The leftmost #1 lane is underutilized because mixed-flow vehicles do not have enough time to merge into it due to the short distance between the end of the HOV lane just north of the Treat/Geary Boulevard overcrossing and the bottleneck location, just south of the North Main St. off-ramp.

Exhibit 5-12: SB North Main Bottleneck

SB On From Livorna Road (AbsPM 042.79, CaPM R11.481)

Shown in Exhibit 5-13, Livorna Road is one of two major southbound bottlenecks on the corridor (the other being the North Main Street off-ramp lane drop described above). Active during both peak periods, this bottleneck is the result of successive lane drops upstream combined with Livorna on-ramp volumes. The congestion upstream is directly caused by the bottleneck. Weaving and merging into the southbound HOV lane, beginning near Rudgear Road, upstream of Livorna Road, at approximately absolute postmile 44.3 (CaPM R13.98), also contribute to the congestion at this location.

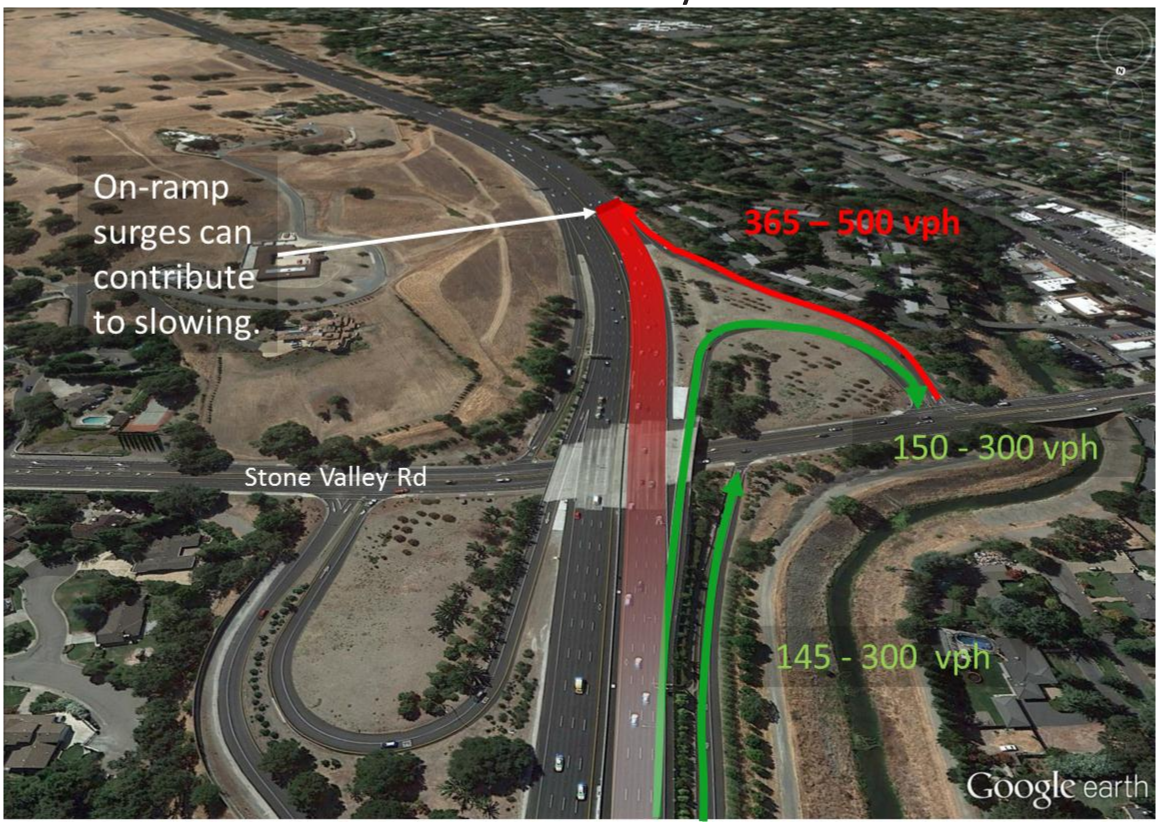
Exhibit 5-13: SB Livorna Bottleneck



SB On From Stone Valley Road (AbsPM 041.60, CaPM R10.208)

This is another minor AM peak period bottleneck location, shown in Exhibit 5-14. Relatively high on-ramp volumes contribute to the slowing approaching this section. This could become a major bottleneck in the future.

Exhibit 5-14: SB Stone Valley Bottleneck



SB On From Sycamore Valley Road (AbsPM 038.03, CaPM R6.636)

Exhibit 5-15 shows the southbound Sycamore Valley Road bottleneck location. This is a very minor bottleneck in the PM peak period, and is not active during the AM peak period. Slowing approaching this section was observed using PeMS and on field visits. High on-ramp volumes contribute to this bottleneck. Merging and weaving to arrive at the southbound HOV lane, as well as merging to exit at the downstream Crow Canyon off-ramp, also contribute to slowing approaching this section.

Exhibit 5-15: SB Sycamore Valley Road Bottleneck

6. FUTURE CONDITIONS

This section describes the future, baseline conditions on the I-680 CSMP corridor based on the CCTA travel demand model. It discusses vehicle-miles traveled (VMT), vehicle-hours traveled (VHT) and average VHD for the I-680 facility, connecting freeways, and parallel and connecting arterials within two miles of the I-680 freeway. The results are summarized in Exhibit 6-1.

According to the model results from 2010 to 2030, VMT on the I-680 general purpose lanes is expected to grow by 13 percent and by 61 percent on the HOV lanes. VHT is expected to grow by 35 percent on the general purpose lanes and by 77 percent on the HOV lanes. This growth in VMT, and even higher growth in VHT, translates into a more than doubling of delay on the I-680 freeway, from just over 22,500 VHD in 2010 to more than 47,000 VHD in 2030. While HOV delay grew by more than five times over the same period, the total delay on the carpool lanes is anticipated to be around 2,300 VHD. Other nearby facilities are also expected to see triple-digit growth in VHD.

Exhibit 6-1: Base and Future Conditions by Facility Type

Facility	Average Daily Vehicle-Miles Traveled				Average Daily Vehicle-Hours Traveled (VHT)				Average Daily Vehicle-Hours of Delay (VHD)			
	2010 Base Year	2030 Constrained / Revised	Difference (2030 vs. 2010) Absolute	Difference (2030 vs. 2010) %	2010 Base Year	2030 Constrained / Revised	Difference (2030 vs. 2010) Absolute	Difference (2030 vs. 2010) %	2010 Base Year	2030 Constrained / Revised	Difference (2030 vs. 2010) Absolute	Difference (2030 vs. 2010) %
I-680 Corridor												
I-680 General Purpose & Auxiliary Lanes	4,999,053	5,618,456	619,403	12%	101,926	136,632	34,706	34%	22,705	47,571	24,866	110%
I-680 Ramps & Connectors	315,201	401,578	86,377	27%	8,143	10,928	2,785	34%	432	1,230	798	185%
I-680 Express Lanes	543,899	874,716	330,817	61%	9,201	16,262	7,062	77%	448	2,354	1,906	425%
Total I-680 Freeway	5,858,153	6,894,750	1,036,597	18%	119,270	163,822	44,553	37%	23,586	51,155	27,569	117%
Connecting/Parallel Routes												
I-580 Freeway (w/in 2-mi buffer of I-680)	1,338,838	1,760,698	421,860	32%	25,316	48,298	22,982	91%	4,719	21,211	16,492	350%
SR-4 Freeway (w/in 2-mi buffer of I-680)	321,664	340,723	19,059	6%	5,456	6,278	822	15%	507	1,036	529	104%
SR-24 Freeway (w/in 2-mi buffer of I-680)	305,689	353,978	48,289	16%	6,726	9,193	2,468	37%	1,360	2,988	1,628	120%
SR-242 Freeway	315,602	361,567	45,965	15%	5,911	7,753	1,842	31%	651	1,727	1,076	165%
Arterials and Other Ramps (w/in 2-mi buffer of I-680)	2,642,552	3,395,169	752,617	28%	84,548	112,474	27,926	33%	2,624	8,165	5,541	211%

Source: System Metrics Group, Inc. analysis of CCTA travel demand model.

These delay estimates differ from the measured delay, shown in Section 4 (Corridor Performance and Trends), for a number of reasons. Travel demand models assign all demand to the network, even if in the real world the roadway cannot accommodate the demand. The data used in Section 4 comes from PeMS, which measures the actual volumes on the freeways. Since the actual volume on a facility is less than the demand to use that facility, the measured delays will be lower than the modeled delays. Models also rely on formulas to estimate speeds. When the modeled volumes on the network approach the theoretical capacity of the roadway, the formulas adjust the speeds used along with volumes to calculate delay. The delays measured using PeMS are based on speeds estimated from the sensors on the roadway. The modeled speeds for some freeway links appear to be lower than what have been measured historically using PeMS. This discrepancy contributes to the modeled delays being higher than the measured delays.

7. SCENARIO DEVELOPMENT APPROACH

A framework was developed to combine projects into scenarios. Ideally, one would evaluate every possible combination of projects. However, this would entail thousands of model runs. Instead, projects were combined based on a number of factors, as follows:

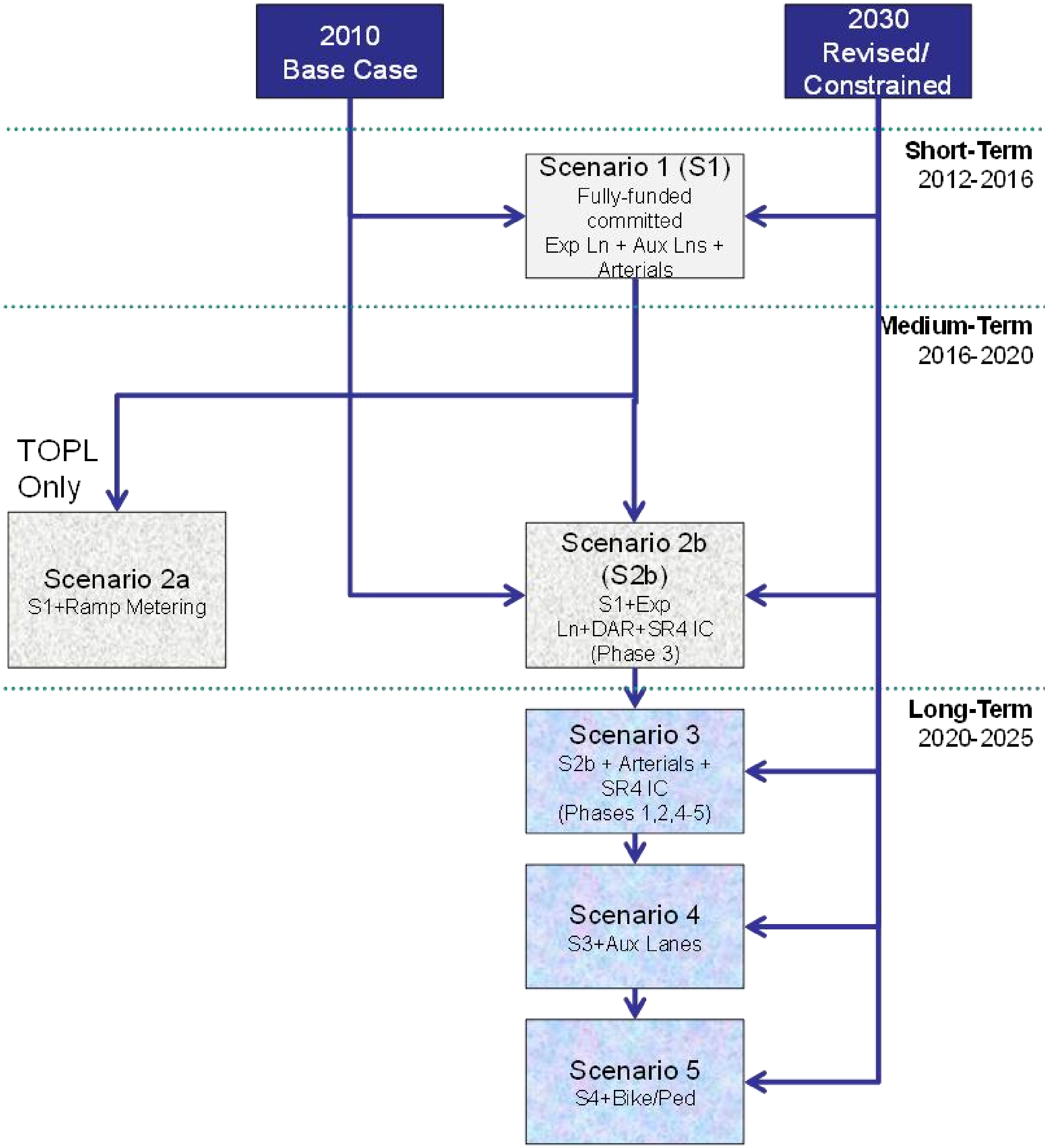
- Fully programmed and funded projects were combined separately from projects that were not yet funded.
- Short-term projects were used to develop scenarios that can be tested in the near-term once TOPL is operational.
- Long-term projects were used to develop scenarios tested only with the 2030 CCTA model.

Scenario testing performed for the I-680 CSMP differs from traditional alternative evaluations or Environmental Impact Reports (EIRs). These studies focus on identifying alternative solutions to address current or projected corridor problems. Each alternative is evaluated separately, and outcomes among competing alternatives are compared, resulting in a locally preferred alternative. This contrasts with the CSMP approach. For the I-680 CSMP, scenarios build on previous scenarios, as long as the incremental scenario results show an acceptable level of performance improvement. This incremental scenario evaluation approach is important since CSMPs are often confused with alternatives studies.

Evaluation Scenarios

Exhibit 7-1 summarizes the I-680 modeling approach and the scenarios tested. The exhibit also summarizes the projects included for each scenario. Appendix E provides a detailed list of the projects included in each scenario.

Exhibit 7-1: Scenario Evaluation Framework

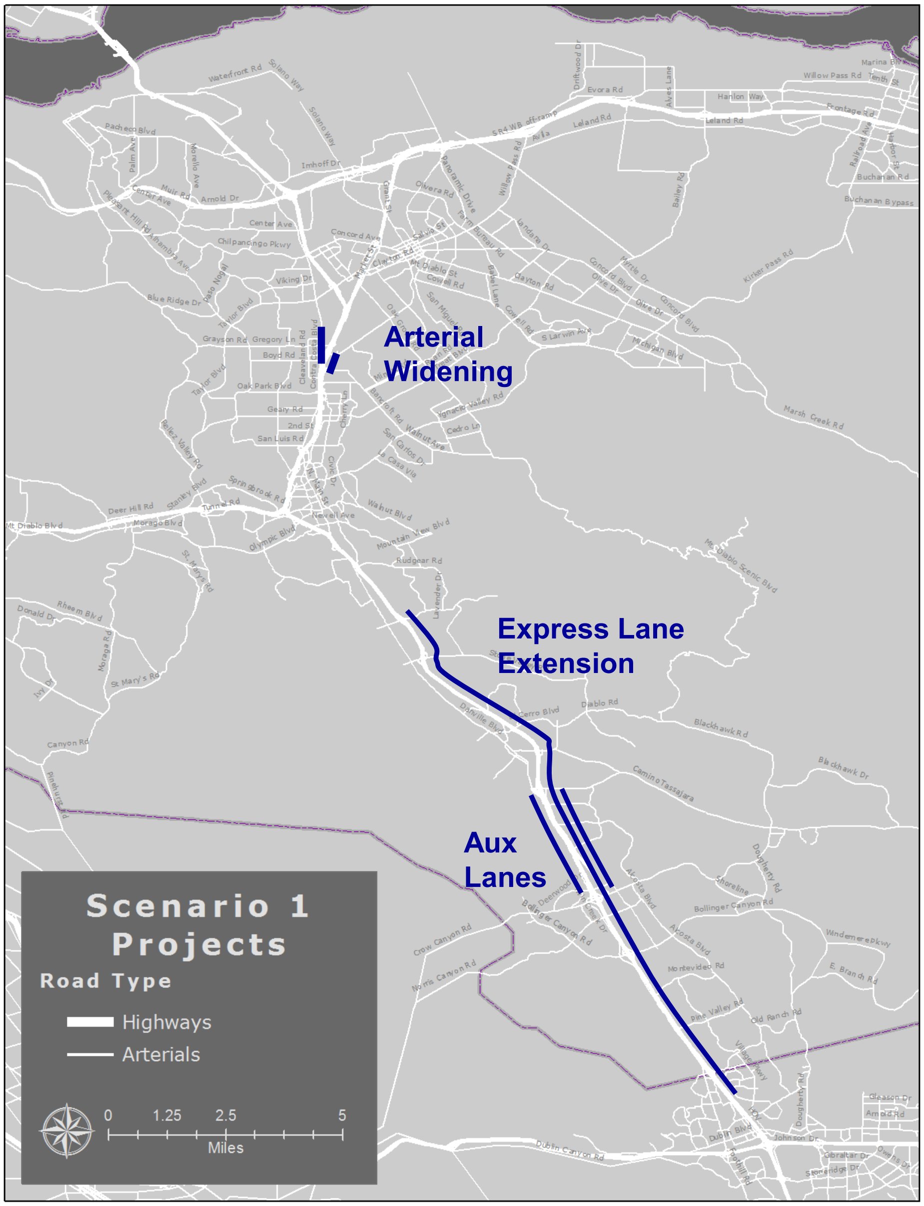


The first scenario tested (Scenario 1) combines most, near-term (up to 5 years), fully-funded, programmed mobility related projects, which include:

- Arterial widenings: Buskirk and Contra Costa Boulevards
- Auxiliary Lanes: Sycamore Valley Road to Crow Canyon Road
- Express Lanes: Extend I-680 Express Lanes north to Livorna Road in the Alamo community.

Exhibit 7-2 is a map of the study area that shows the approximate location of the Scenario 1 projects.

Exhibit 7-2: Scenario 1 Project Locations



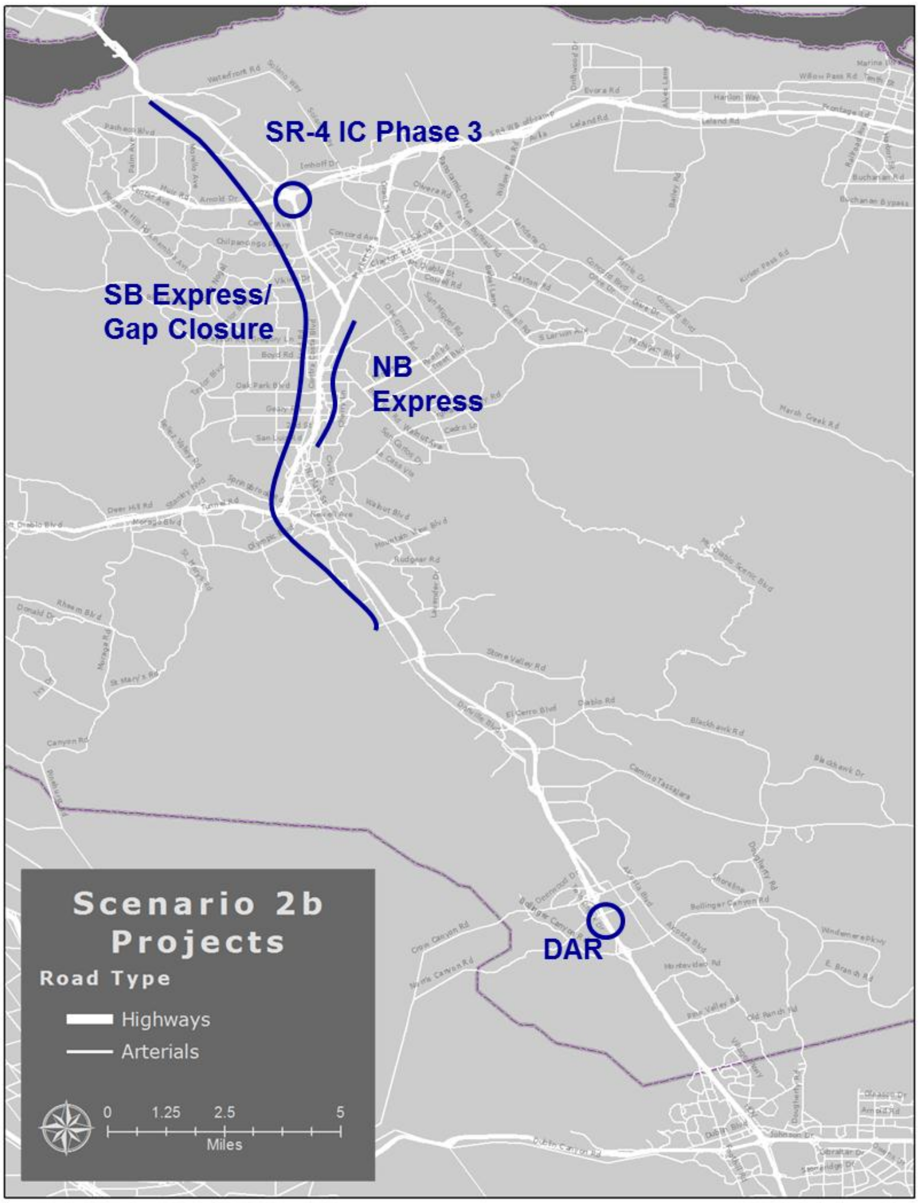
Scenario 2 tests other near-term, operational projects. These have been separated into two scenarios, 2a and 2b. Scenario 2a tests ramp metering alone to isolate its impacts on freeway and on-ramp performance. This scenario can only be evaluated using a tool, such as TOPL, that is sensitive enough to evaluate the dynamic interactions on the freeway caused by changes in merging due to ramp metering. Scenario 2b includes other operational strategies that are likely to be completed in the near future, which include:

- Express Lanes:
    - Northbound from Main Street to SR-242
    - Southbound from Marina Vista to Livorna (includes Southbound HOV Gap Closure)

- High Occupancy Vehicle, direct access ramps (DAR) located at an unspecified location in the San Ramon area.
- I-680/SR-4 Interchange Improvements (Phases 1-3 of 5. Phases 4 and 5 were evaluated in Scenario 3 below).

Exhibit 7-3 shows the study area and the approximate location of the Scenario 2 projects.

Exhibit 7-3: Scenario 2 Project Locations



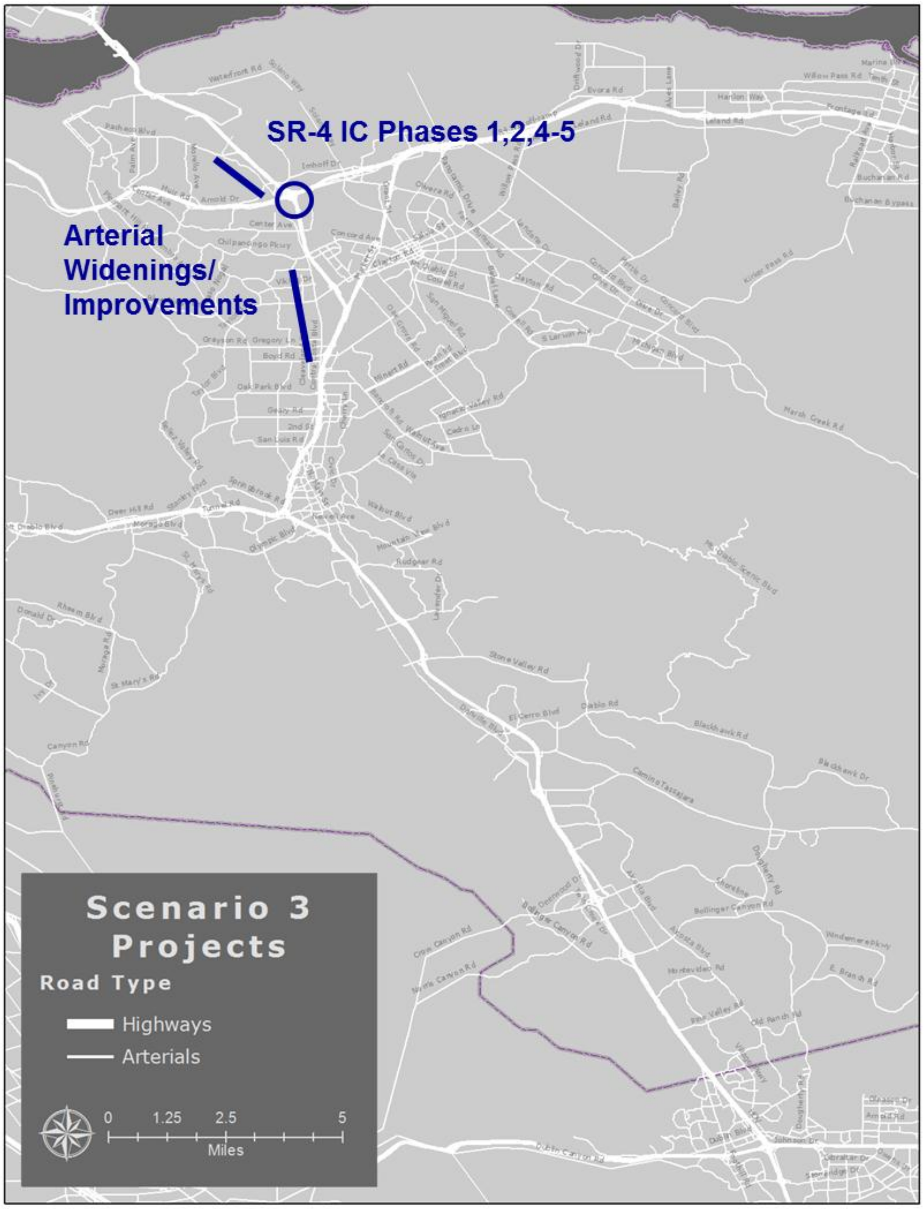
Scenario 3 combines other programmed or fully committed projects to be delivered at a later date (greater than 5-years into the future). Scenario 3 improvements include:

- Arterial Improvements: Contra Costa and Pacheco Boulevards

- I-680/SR-4 Interchange Improvements (Phases 4-5 of 5)

Exhibit 7-4 shows the study area and the approximate location of the Scenario 3 projects.

Exhibit 7-4: Scenario 3 Project Locations



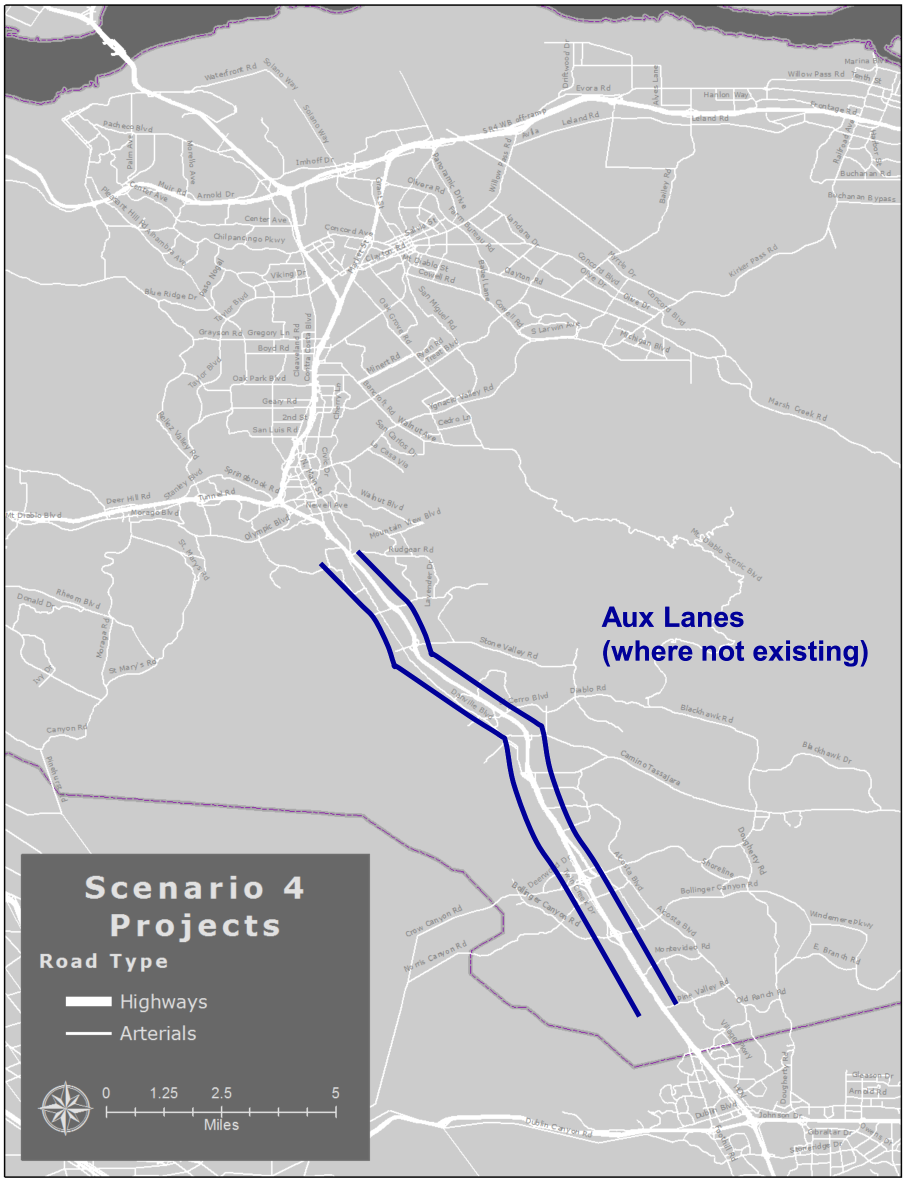
Scenario 4 is a long-term scenario that tests potential auxiliary lane additions that have been presented in other long-range planning reports:

- Alcosta Road to Bollinger Canyon Road
- El Cerro Road to El Pintado Road
- El Pintado Road to Stone Valley Road

- Stone Valley Road to Livorna Road
- Livorna Road to Rudgear Road.

Exhibit 7-5 shows the study area and the approximate location of the Scenario 4 projects.

Exhibit 7-5: Scenario 4 Project Locations



The final scenario tested (Scenario 5) evaluates the potential impacts due to improvements in bicycle and pedestrian improvements if trip-making were reduced by 1.5 percent per day. This reduction is based on an analysis presented in Appendix A: Bicycle Demand Forecasting of the *2009 Contra Costa Countywide Bicycle and Pedestrian Plan*.

8. MODELING APPROACH

The previous sections presented the diagnostic part of the CSMP by describing the corridor, examining its performance trends, and pinpointing its bottleneck locations and their causes. The results presented in that section primarily focus on the Contra Costa County portion of I-680, with some limited evaluations performed on the Alameda County portion of the corridor. This section discusses the approach used for forecasting demand and the process used to evaluate scenarios on Contra Costa I-680 and Alameda I-680 to south of the I-580/I-680 interchange. Subsequent sections detail the evaluation results and the findings from that analysis.

Two models were used for the evaluation as follows:

- The CCTA travel demand model was used to conduct a comprehensive evaluation of the scenarios described in the previous section. As a four-step travel demand model, the CCTA model captures the land use and transportation interactions based on the future growth projections and proposed transportation improvements. It also includes all transit investments planned for implementation.

  This model allows for the analysis of diversion between the I-680 freeway and arterials in the county. The 2010 and 2030 CCTA models were used for short term scenarios (Scenarios 1 and 2). For longer term scenarios, only the 2030 CCTA model was used. Exhibit 8-1 shows the CCTA travel demand model network. The analysis presented in this report primarily focuses on the I-680 freeway, on- and off-ramps to the freeway, and connecting and parallel arterials within two miles of the I-680 freeway including those in northern Alameda County near the I-680 freeway. Projects that benefit the I-680 freeway may also extend beyond the two-mile buffer, but for this CSMP, the analysis only focused on roadways near the study corridor.

  Modeling scenarios were input into the CCTA 2030 constrained forecast model. The constrained model was revised by removing all projects that are part of the I-680 CSMP evaluation scenarios described above, but keeping other projects that are in the constrained MTC Regional Transportation Plan, which includes projects in Alameda County. This produced a forecast year, base case against which the scenarios could be evaluated.

  The model produced outputs including flows, speeds, and travel times from which delays could be directly calculated and emissions estimated. These outputs were used to evaluate the impacts on various facilities and for the study area as a whole.

- The TOPL simulation model was used to conduct traffic analysis. Operational strategies such as ramp metering and incident management can only be evaluated with simulation tools. For instance, stakeholders asked the study team to identify ramp back-ups and delays for the ramp metering implementation. This cannot be accomplished with a travel demand model.

  Two TOPL models were developed. The first is for the 2012/2013 timeframe. It was calibrated using data from various sources, including MTC and Caltrans ramp volumes, detection data used in the assessment of current conditions and the bottleneck identification and verification previously presented in this report.

Exhibits 8-2 and 8-3 depict the speed contours for the calibrated 2012/2013 model for northbound during the afternoon peak period and southbound for the morning peak period respectively and include the main bottlenecks discussed in previous sections. This is a critical step since the calibration had to reasonably represent the aforementioned bottlenecks. The second model is a 2025 horizon model used to conduct traffic analysis for longer term projects. Inputs to TOPL scenario analysis consisted of demand changes at ramps based on the CCTA model runs.

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Exhibit 8-1: CCTA Travel Demand Model Network

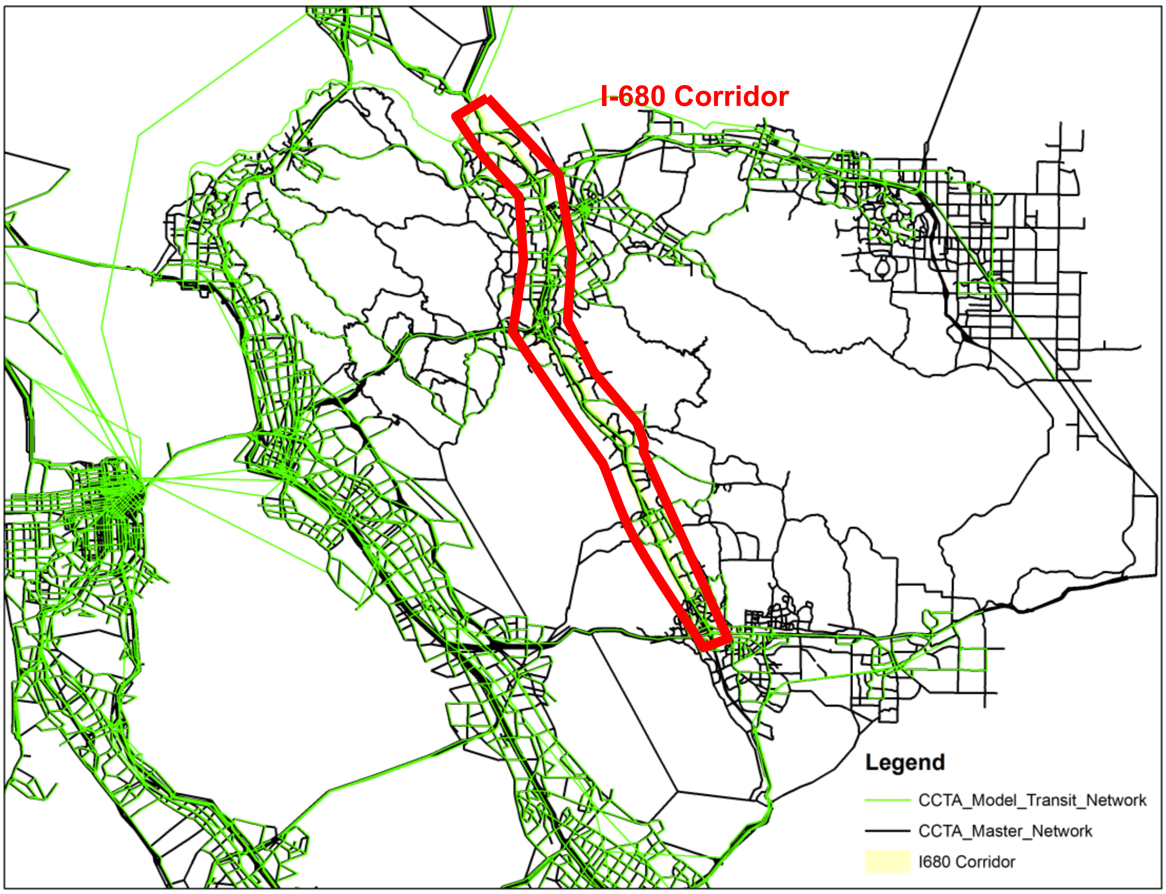


Exhibit 8-2: Northbound PM Peak Period Base Year TOPL Speed Contour Map

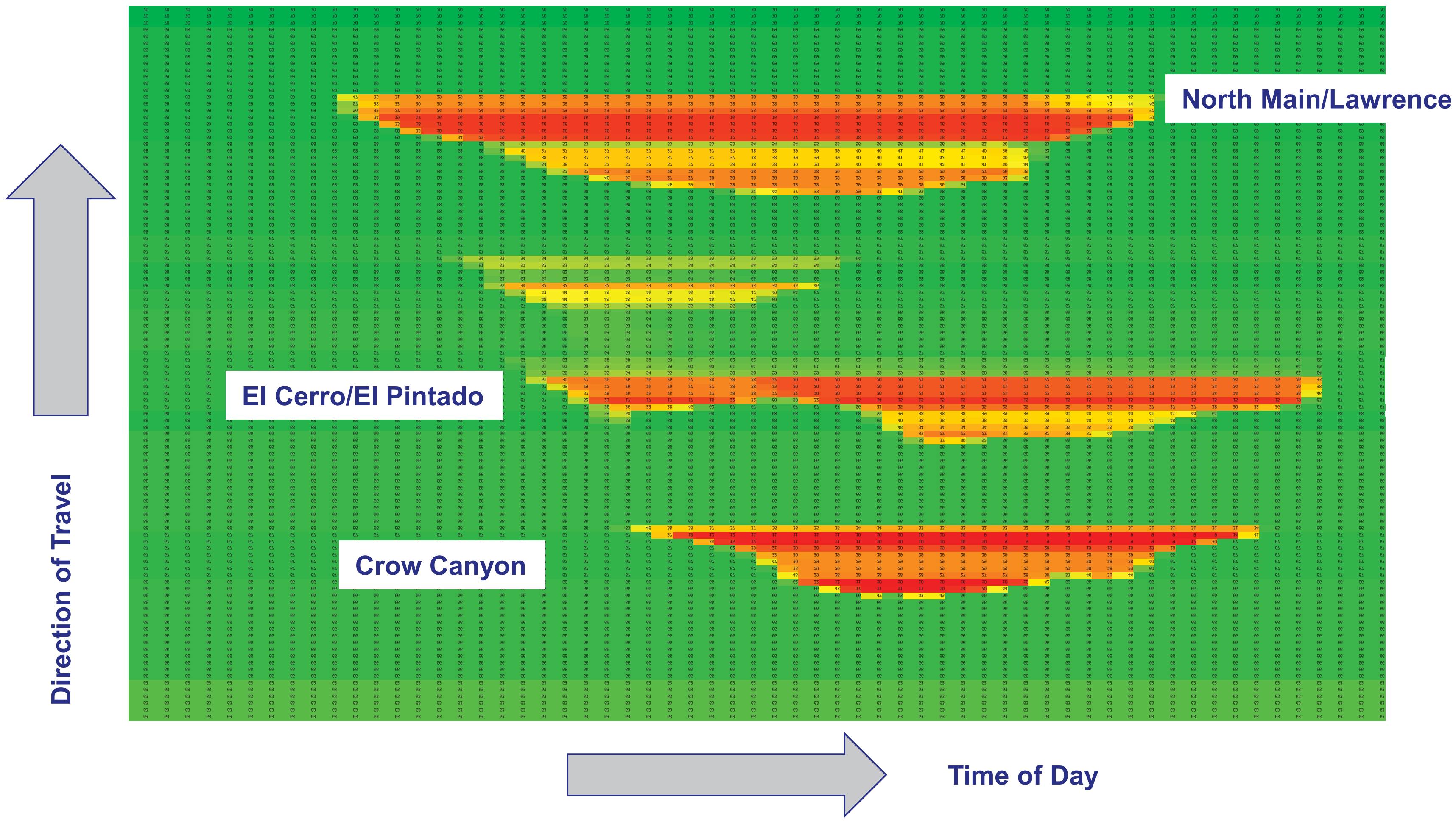
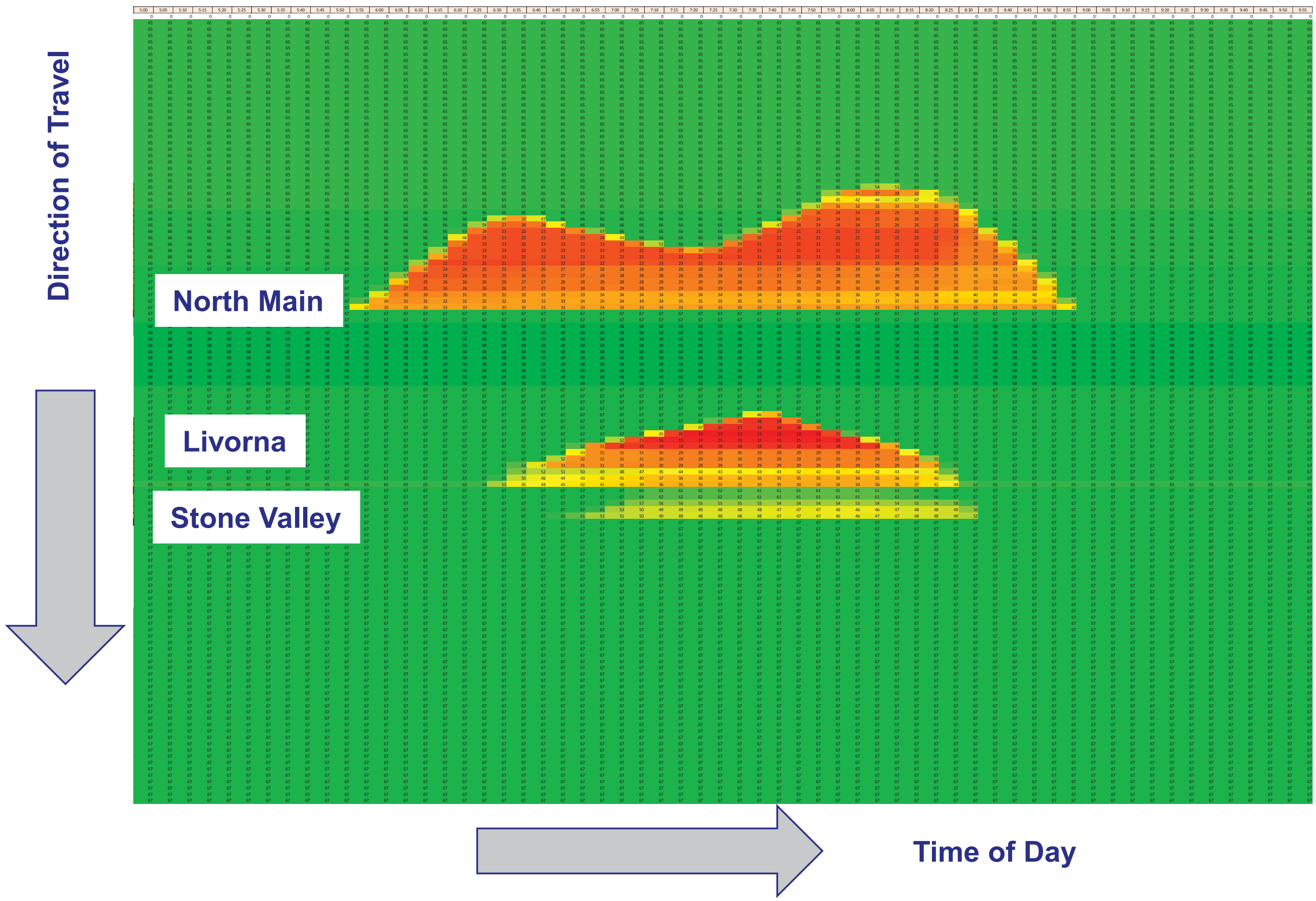


Exhibit 8-3: Southbound AM Peak Period Base Year TOPL Speed Contour Map



9. SCENARIO EVALUATIONS

This section presents the findings from the scenario evaluations using the modeling approach described in the previous section. First, the comprehensive evaluation results are presented followed by the TOPL freeway traffic evaluation results.

CCTA Travel Demand Model Comprehensive Evaluation

Scenarios 1 and 2 are both short- and medium-term scenarios and were evaluated against both the 2010 CCTA Base Case model as well as the 2030 constrained model. The longer-term scenarios (3 through 5) were evaluated using only the 2030 model. For clarity, only model data for links that lie within two miles of the I-680 freeway are shown. For each link in the model, delay was estimated by taking the average travel time across the link for each time period in the model (AM peak period, PM peak period, and off-peak period), compared that travel time to the model free-flow travel time for that link, and multiplied the difference by the modeled flow over that link, arriving at the vehicle hours of delay.

Exhibit 9-1 lists the tested scenarios, their associated projects, and the key SMF performance measures evaluated: mobility, travel time reliability, and emissions. As described in Section 7, above mobility was calculated for each scenario using the travel times and vehicular flows from the CCTA travel demand model. Reliability was estimated by using a formula developed as part of work done by the Transportation Research Board (TRB) Strategic Highway Research Program (SHRP) on forecasting reliability. This formula, based on the relationship between roadway volumes and capacities, was applied to the model outputs for each scenario. The climate and energy conservation measure of VMT by speed bin is addressed in Appendix G at the end of this report.

A benefit cost analysis (BCA) was performed using Cal-B/C to estimate benefits in three areas: travel time, vehicle operating costs, and emissions. The analysis does not capture the benefits after the 20-year lifecycle, benefits received outside the study area, or benefits due to improvements in transit travel times. Project costs were obtained from the CCTA 2009 Countywide Transportation Plan, the MTC Regional Transportation Plan/Sustainable Communities Strategy, and the Caltrans Transportation System Development Plan, as well as from CCTA.

SHORTER TERM SCENARIOS 1 AND 2

Scenarios 1 and 2 are comprised of projects that are anticipated to have an impact on freeway performance in the one to five year time frame. Exhibits 9-2 through 9-4 are maps showing the average, daily VHD reported by the 2010 Base Case CCTA travel demand model for each of the three facility types: mainline of I-680, HOV/Express Lanes, and arterials/ramps. As is expected, the I-680 freeway shows congestion along the corridor. There is also heavy congestion on I-580, SR-4, and SR-24. Some of the most congested arterials reported by the CCTA model in 2010 (Exhibit 9-4) include Ygnacio Valley Road in Walnut Creek, Willow Pass Road in Concord and Pleasant Hill, Diablo Road in Danville, and Danville Boulevard running parallel to the I-680 freeway.

Exhibits 9-5 through 9-7 summarize the 2010 Base Case, Scenario 1, and Scenario 2 findings. Exhibit 9-5 shows VMT, Exhibit 9-6 shows VHT, while Exhibit 9-7 reports VHD results. The sections following the exhibits discuss the findings in more detail.

Exhibit 9-1: I-680 CSMP Scenarios, Projects, and Results

Scenario	Scenario Description	Scenario Projects	Mobility– Average Weekday VHD (1000s)	Reliability– I-680 Highest Travel Time Index	Emissions– Average Daily Short Tons
2010 Base	CCTA 2010 Base Year model with no scenario projects included		33	1.4	4,390
2030 Base	CCTA 2030 Constrained Plan Travel Demand Model results with programmed/planned scenario projects removed for the analysis		87	1.5	5,550
S1 (2030)	Most near-term (≤ 5 years), fully funded, programmed mobility-related projects on or near I-680. Evaluated using the 2010 and 2030 models.	• Arterials: Buskirk & Contra Costa Blvd widening • Aux Lanes: Sycamore Valley Rd-Crow Canyon Rd • Express Lanes: Extend north to Livorna Rd	83	1.5	5,530
S2 (2030)	Other near-term operational projects Scenario 2a tests ramp metering alone to isolate its impacts. S2a tested only with TOPL (when available) Scenario 2b includes other operational strategies likely to be completed in the near future. Evaluated using the 2010 and 2030 models.	• Express Lanes: NB Main St-SR-242 • Express Lanes: SB Marina Vista Ave-Livorna Rd (includes SB HOV gap closure) • HOV direct access ramps (unspecified location in San Ramon area) • I-680/SR-4 interchange improvements (Phase 3)	78	1.5	5,520
S3 (2030)	Other programmed or fully committed projects to be delivered ≥5 years. Evaluated using the 2030 model.	• Arterial Improvements: Contra Costa & Pacheco Blvds • I-680/SR-4 interchange improvements (Phases 1,2,4,5)	78	1.5	5,520
S4 (2030)	Long-term potential auxiliary lane additions that have been presented in other long-range planning reports. Evaluated using the 2030 model.	• Alcosta Rd to Bollinger Canyon Rd • El Cerro Rd to El Pintado Rd • El Pintado Rd to Stone Valley Rd • Stone Valley Rd to Livorna Rd • Livorna Rd to Rudgear Rd	73	1.5	5,515
S5 (2030)	Trip-making reduced by 1.5% per day due to bicycle/pedestrian improvements. Reduction based on analysis from Appendix A: Bicycle Demand Forecasting of the *2009 Contra Costa Countywide Bicycle and Pedestrian Plan*. Evaluated using the 2030 model.		73	1.5	5,510

Exhibit 9-2: 2010 Base Case Freeway Congestion

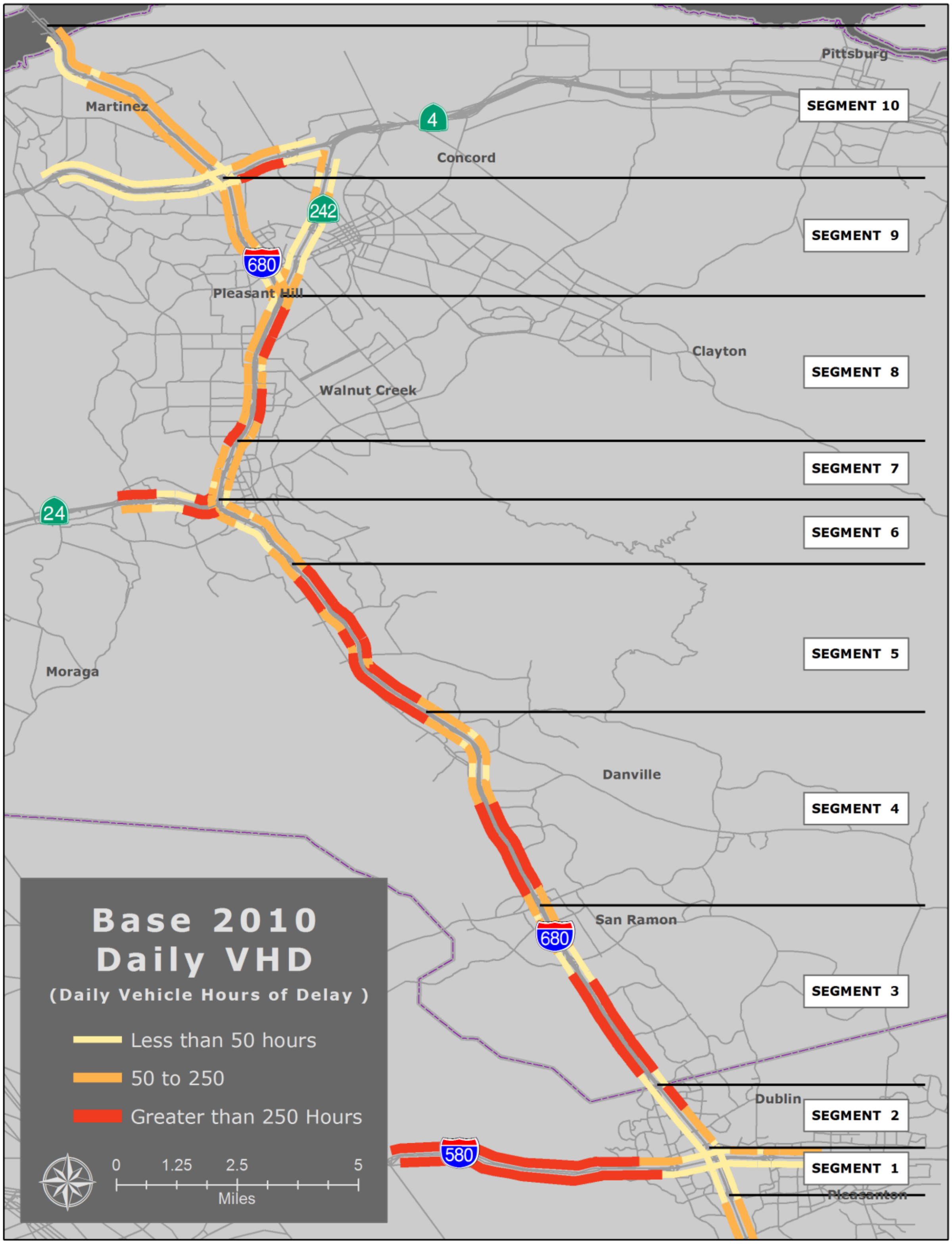


Exhibit 9-3: 2010 Base Case HOV Lane Congestion

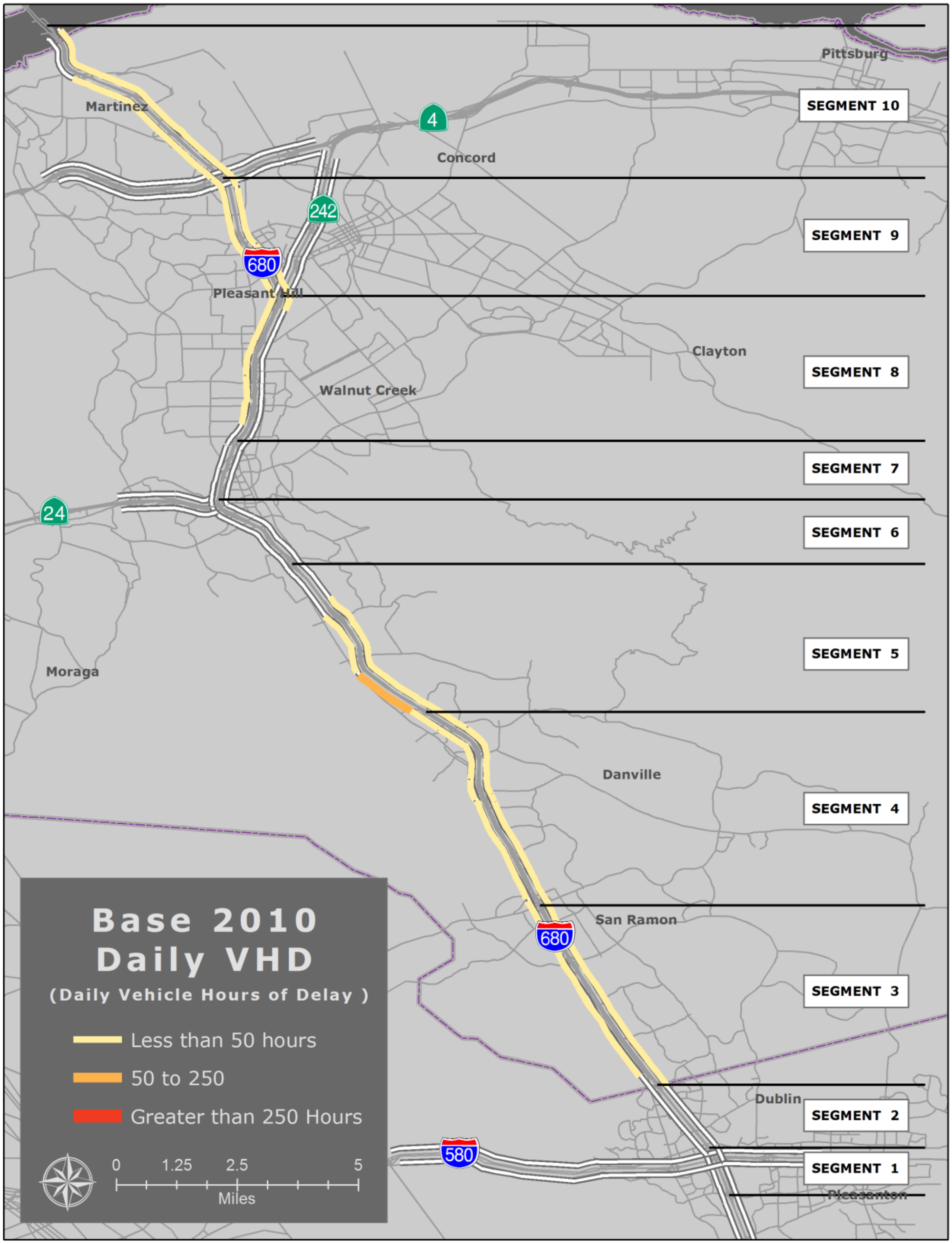


Exhibit 9-4: Base Case 2010 Arterial/Ramp Congestion

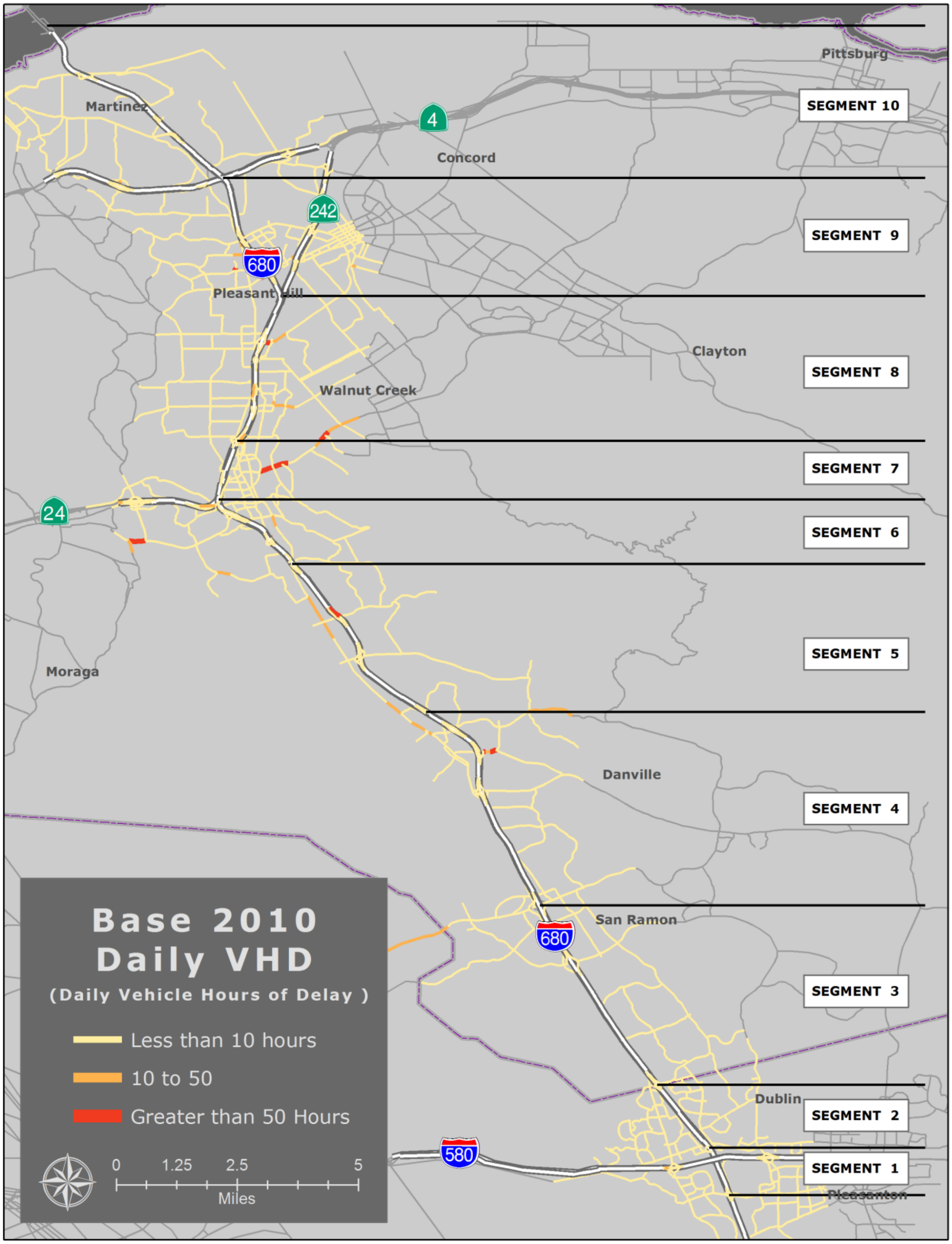


Exhibit 9-5: 2010 VMT by Scenario

Facility	2010 Base Case	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
I-680 Corridor						
I-680 General Purpose & Auxiliary Lanes	4,999,053	4,972,415	4,867,465	Not Evaluated using 2010 Model		
		-0.5%	-2.6%			
I-680 Ramps & Connectors	315,201	314,216	317,870			
		-0.3%	0.8%			
I-680 Express Lanes	543,899	665,739	888,610			
		22.4%	63.4%			
Total I-680 Freeway	5,858,153	5,952,370	6,073,945			
		1.6%	3.7%			
Connecting/Parallel Routes						
I-580 Freeway (w/in 2-mi buffer of I-680)	1,338,838	1,335,857	1,339,103	Not Evaluated using 2010 Model		
		-0.2%	0.0%			
SR-4 Freeway (w/in 2-mi buffer of I-680)	321,664	321,957	336,201			
		0.1%	4.5%			
SR-24 Freeway (w/in 2-mi buffer of I-680)	305,689	305,330	306,583			
		-0.1%	0.3%			
SR-242 Freeway	315,602	316,498	319,466			
		0.3%	1.2%			
Other Ramps & Connectors	151,278	150,918	152,380			
		-0.2%	0.7%			
Arterials (w/in 2-mi buffer of I-680)	2,491,273	2,464,775	2,420,577			
		-1.1%	-2.8%			

Exhibit 9-6: 2010 VHT by Scenario

Facility	2010 Base Case	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
I-680 Corridor						
I-680 General Purpose & Auxiliary Lanes	101,926	98,132	93,101	Not Evaluated using 2010 Model		
		-3.7%	-8.7%			
I-680 Ramps & Connectors	8,143	8,396	8,343			
		3.1%	2.5%			
I-680 Express Lanes	9,201	12,565	17,154			
		36.6%	86.4%			
Total I-680 Freeway	119,270	119,094	118,598			
		-0.1%	-0.6%			
Connecting/Parallel Routes						
I-580 Freeway (w/in 2-mi buffer of I-680)	25,316	25,187	25,311	Not Evaluated using 2010 Model		
		-0.5%	0.0%			
SR-4 Freeway (w/in 2-mi buffer of I-680)	5,456	5,457	5,205			
		0.0%	-4.6%			
SR-24 Freeway (w/in 2-mi buffer of I-680)	6,726	6,678	6,779			
		-0.7%	0.8%			
SR-242 Freeway	5,911	5,932	5,955			
		0.4%	0.7%			
Other Ramps & Connectors	3,872	3,864	3,905			
		-0.2%	0.9%			
Arterials (w/in 2-mi buffer of I-680)	80,676	79,819	78,171			
		-1.1%	-3.1%			

Exhibit 9-7: 2010 VHD by Scenario

Facility	2010 Base Case	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
I-680 Corridor						
I-680 General Purpose & Auxiliary Lanes	22,705	19,329	16,018	Not Evaluated using 2010 Model		
		-14.9%	-29.5%			
I-680 Ramps & Connectors	432	590	586			
		36.4%	35.4%			
I-680 Express Lanes	448	1,913	2,966			
		326.7%	561.8%			
Total I-680 Freeway	23,586	21,832	19,570			
		-7.4%	-17.0%			
Connecting/Parallel Routes						
I-580 Freeway (w/in 2-mi buffer of I-680)	4,719	4,636	4,710	Not Evaluated using 2010 Model		
		-1.8%	-0.2%			
SR-4 Freeway (w/in 2-mi buffer of I-680)	507	504	33			
		-0.6%	-93.6%			
SR-24 Freeway (w/in 2-mi buffer of I-680)	1,360	1,320	1,401			
		-3.0%	3.0%			
SR-242 Freeway	651	657	630			
		1.0%	-3.2%			
Other Ramps & Connectors	127	128	146			
		1.0%	15.6%			
Arterials (w/in 2-mi buffer of I-680)	2,497	2,393	2,139			
		-4.2%	-14.4%			

<u>Scenario 1 – Fully-Funded, Programmed Mobility Related Projects</u>

Scenario 1 includes the widening of two arterials in Pleasant Hill, the addition of an auxiliary lane between Sycamore Valley and Crow Canyon Roads, and the extension of Express Lanes to Livorna Road. Scenario 1 projects are expected to impact the corridor in the short-term.

In the short-term (using the 2010 Base Case model as a proxy for short-term impacts) and in the long-term (using the 2030 model), Scenario 1 shows promise in moving vehicles off of the I-680 general purpose lanes and nearby arterials onto the Express Lanes.

In the short-term, VMT on the I-680 Express Lanes is expected to increase more than 22 percent. Adjacent lanes, ramps, and arterials experience a one percent reduction in VMT. This reduction in VMT on I-680 results in a 7.4 percent reduction in congestion on the freeway, with small absolute increases in delay on the Express Lanes and ramps. Congestion on the arterials decreases by more than four percent.

By 2030, VMT on the Express lanes will increase by more than 11 percent, which will result in a five percent reduction in congestion on the I-680 CSMP freeway. Arterials will experience a nearly percent reduction in congestion.

Scenario 2 – Express Lanes, Direct Access Ramp, I-680/SR-4 Interchange Improvements

Scenario 2 represents other medium-term projects that include an additional expansion of Express Lanes in the northern portion of the I-680 corridor, as well as direct access ramps in the San Ramon area, and a major capital improvement at the I-680/SR-4 interchange.

Scenario 2 was also evaluated using the 2010 and 2030 models. As may be expected with the expansion of the Express Lanes, VMT on those lanes grows by more than 63 percent compared to the 2010 base case, and 39 percent compared to the 2030 case. These improvements increase VMT on the I-680 freeway by nearly four percent in both the 2010 and 2030 models.

This scenario reduces congestion on the I-680 by more than 17 percent in the 2010 model and by 11 percent in the 2030 model. The scenario also reduces congestion near the I-680/SR-4 interchange and reduces arterial delays by 14 percent in 2010 and by nearly 23 percent by 2030.

Exhibits 9-8 through 9-10 show the VHD by freeway link after Scenario 1 and Scenario 2 have been implemented for each of the three major facility types (mainline, HOV/Express Lanes, arterials/ramps). Exhibits 9-11 through 9-13 show the differences in VHD between the 2010 Base Case and the 2010 Scenario 2 results.

Mainline lanes on the entire I-680 freeway show reductions in congestion, with the largest decreases occurring through Danville and Walnut Creek. Route 4 also experiences large reductions near the I-680 interchange, with congestion virtually being eliminated in the short-term.

The Express Lanes show modest increases in delay, particularly through Walnut Creek, which is likely due to the southbound extension to Livorna Road.

Arterials benefiting the most from the projects implemented in the first two scenarios include: Danville Boulevard, Ygnacio Valley Road, and Willow Pass Road.

Once the TOPL model has been calibrated to the 2013 Base Year, an isolated analysis will be performed as Scenario 2b that will test the impacts of ramp metering on freeway congestion.

Exhibit 9-8: 2010 Scenario 2 Freeway Congestion

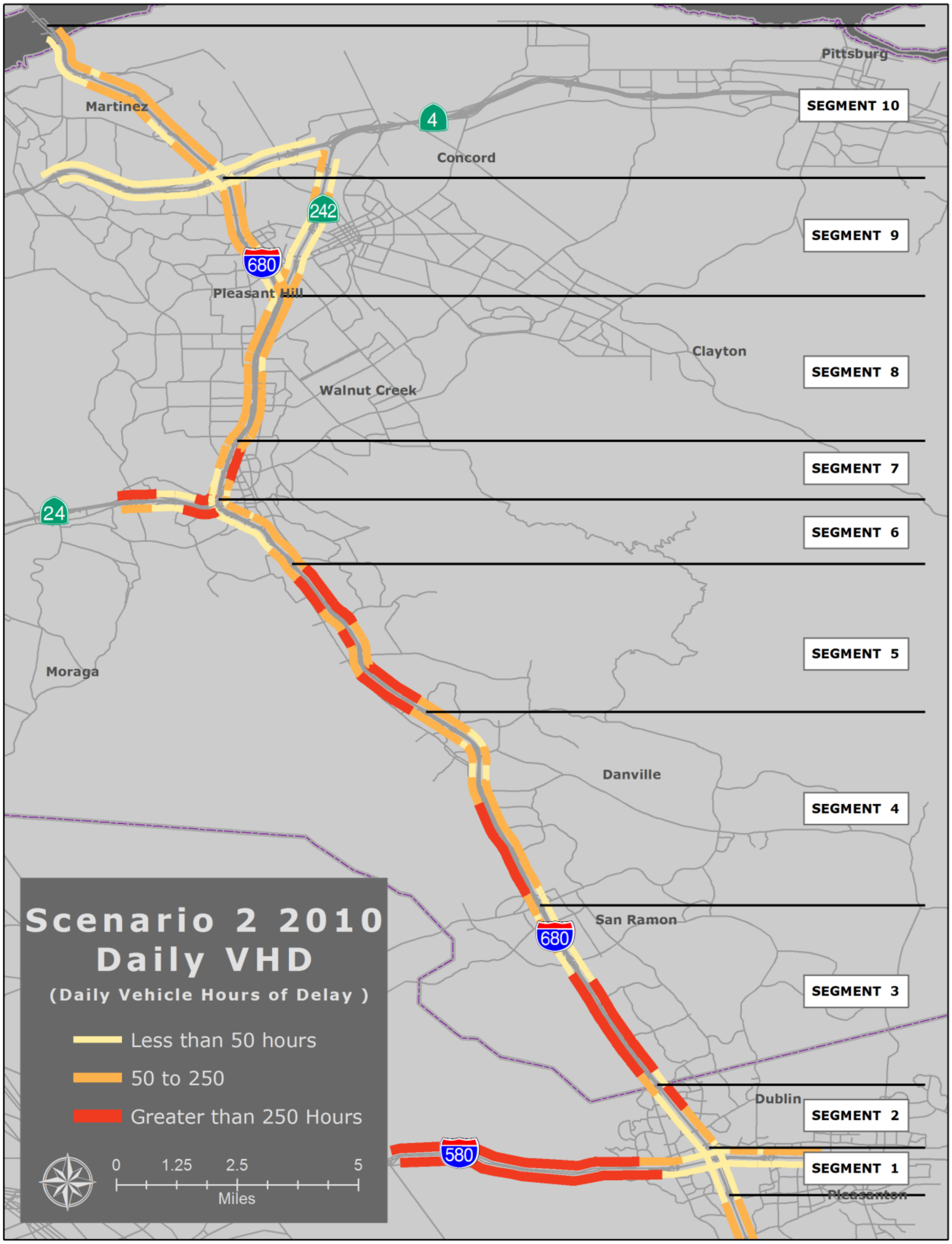


Exhibit 9-9: 2010 Scenario 2 HOV/Express Lane Congestion

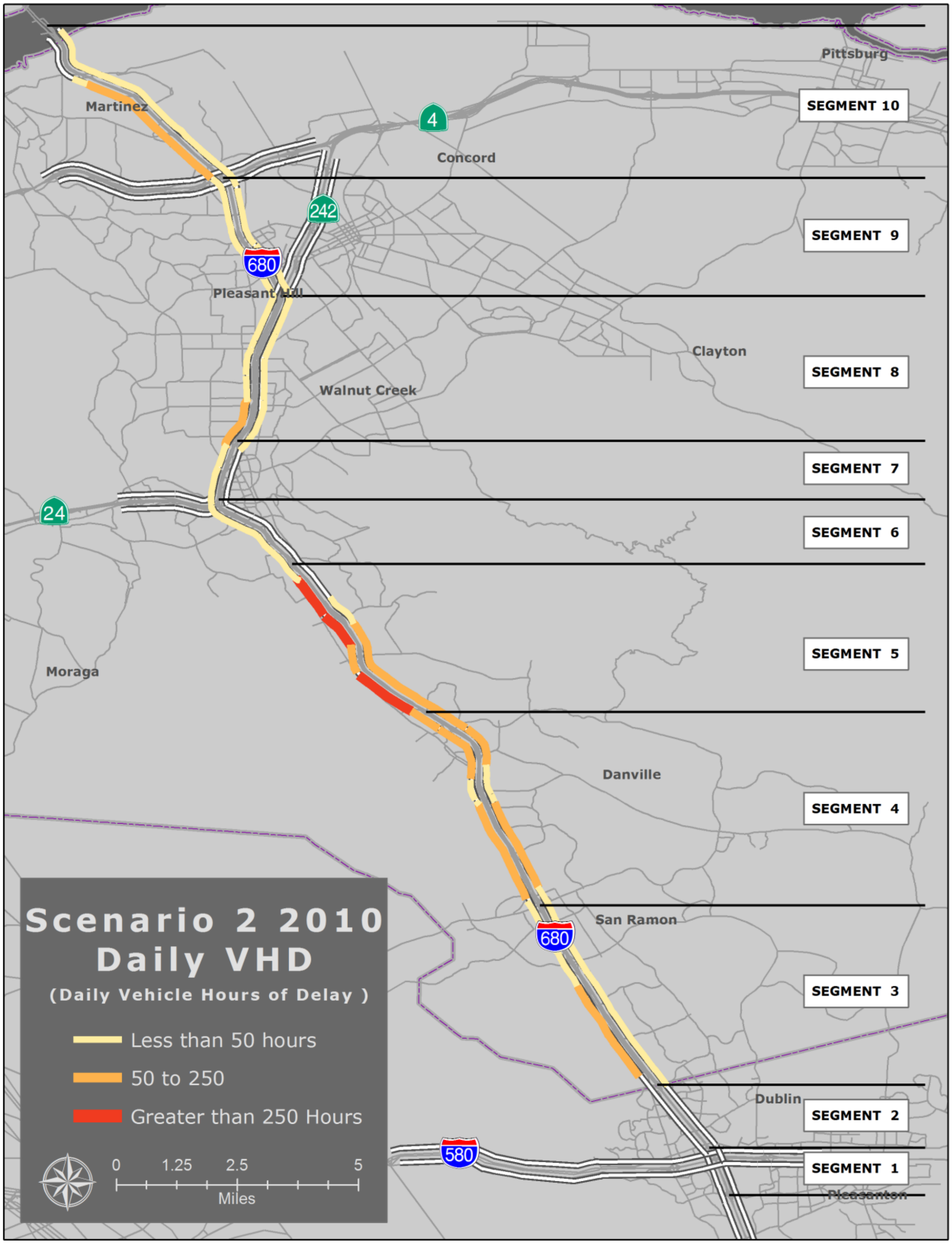


Exhibit 9-10: 2010 Scenario 2 Arterial/Ramp Congestion

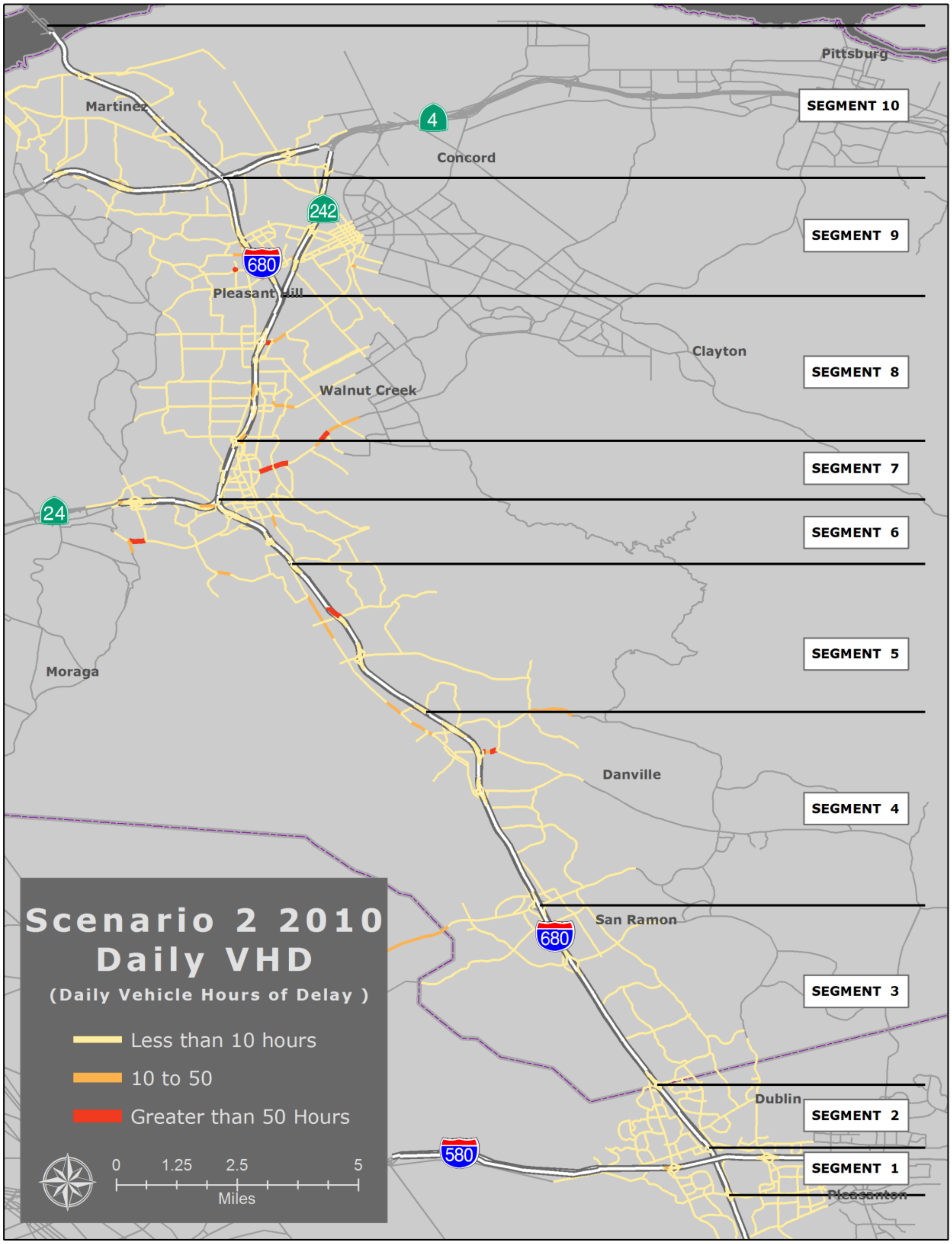


Exhibit 9-11: 2010 Scenario 2 vs. Base Case - Mainline

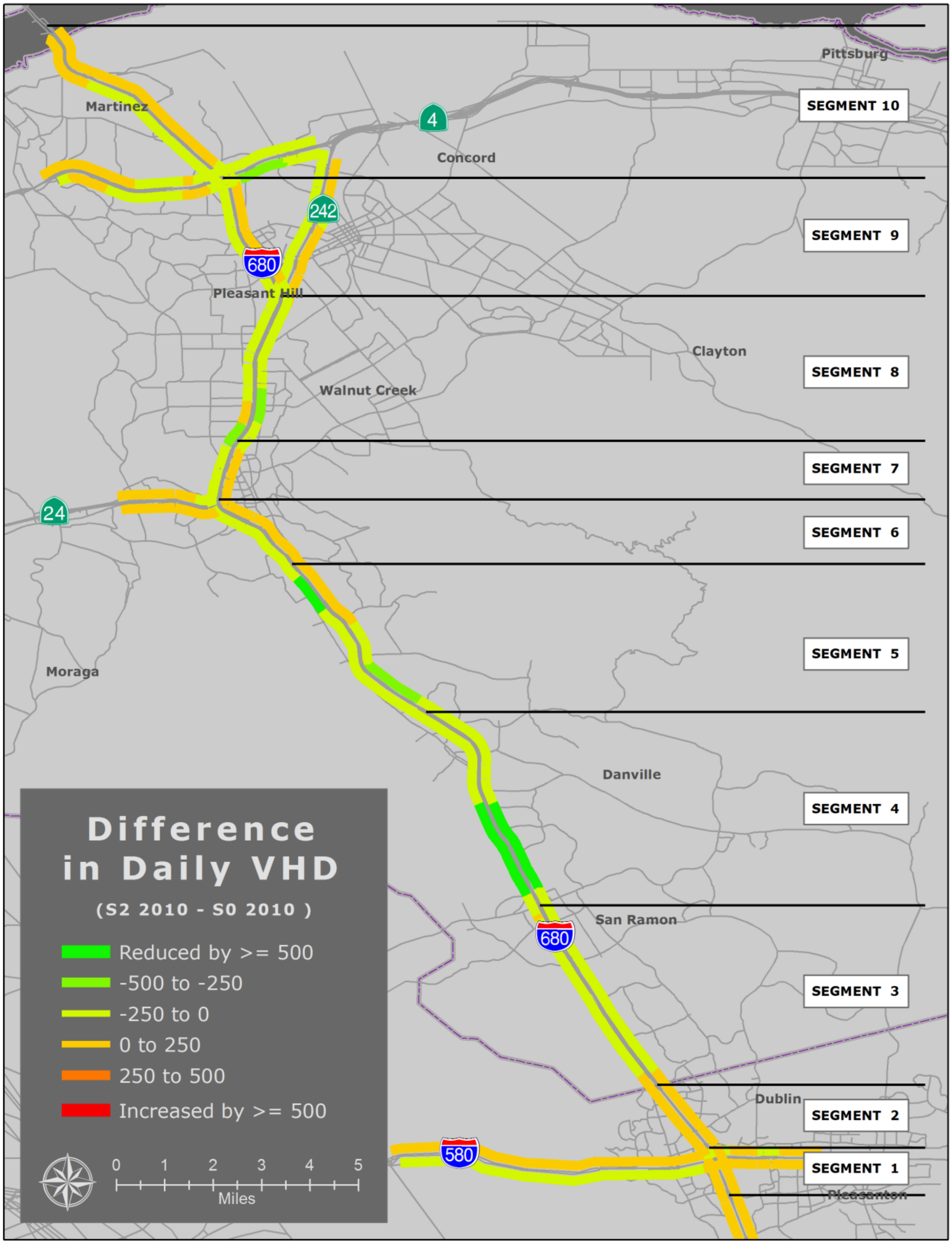


Exhibit 9-12: 2010 Scenario 2 vs. Base Case - HOV/Express Lane Congestion

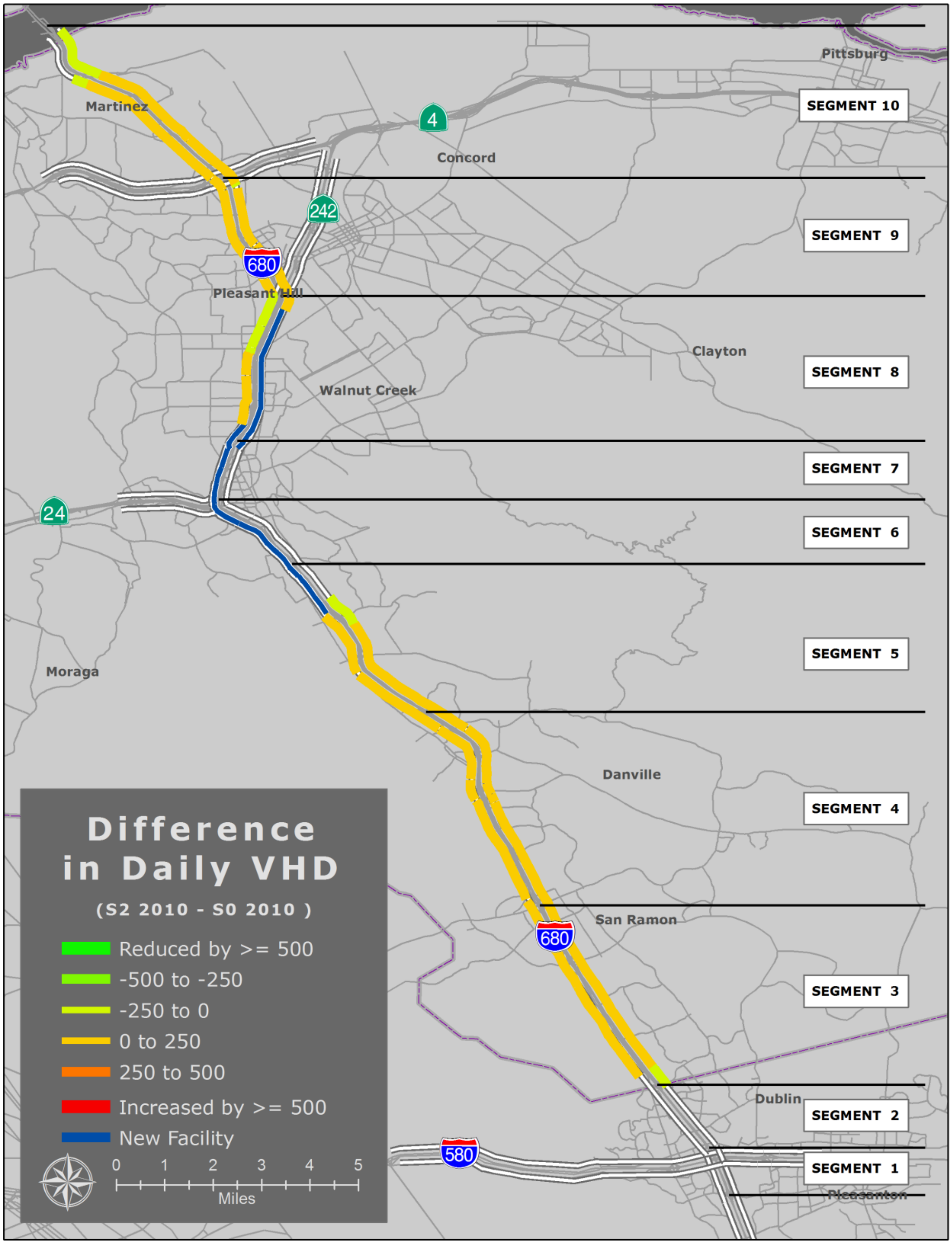
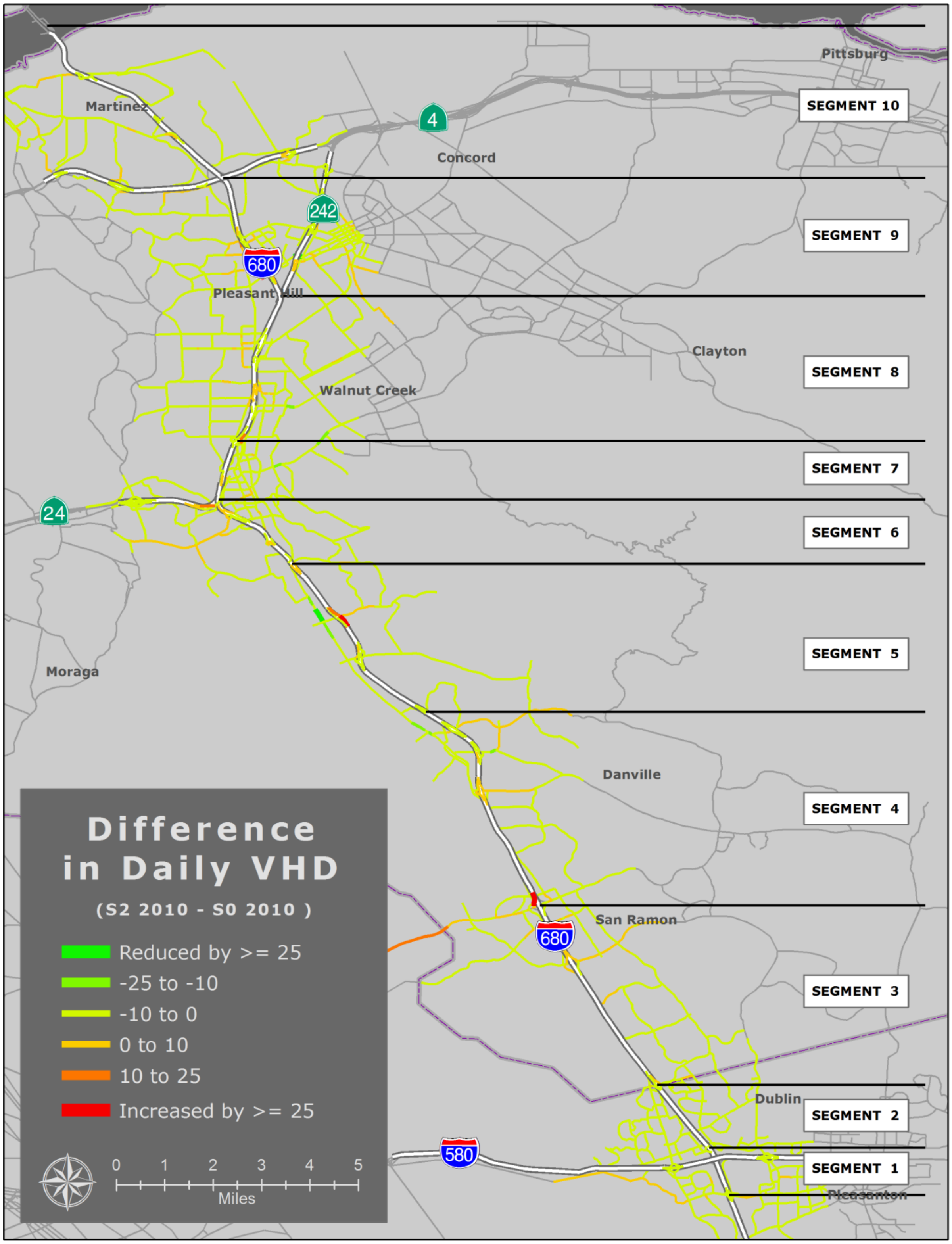


Exhibit 9-13: 2010 Scenario 2 vs. Base Case - Arterial/Ramp Congestion



LONGER-TERM SCENARIOS 3 THROUGH 5

Exhibits 9-14 through 9-16 show the congestion reported by the 2030 constrained horizon year model. As can be expected, the I-680 freeway shows significantly more congestion in the study area due to the growth in travel over the 20-year time period. Communities adjacent to I-680 are also expected to see increases in arterial congestion of more than three times the 2010 Base Case delays. In Contra Costa County, most of this arterial congestion is expected to occur from Walnut Creek south to Danville.

Exhibit 9-17 shows 2030 VMT results, Exhibit 9-18 shows VHT, and Exhibit 9-19 summarizes VHD for all scenarios, 1 through 5. The sections following the exhibits discuss the findings in more detail for Scenarios 3 through 5.

Exhibit 9-14: 2030 Base Freeway Congestion

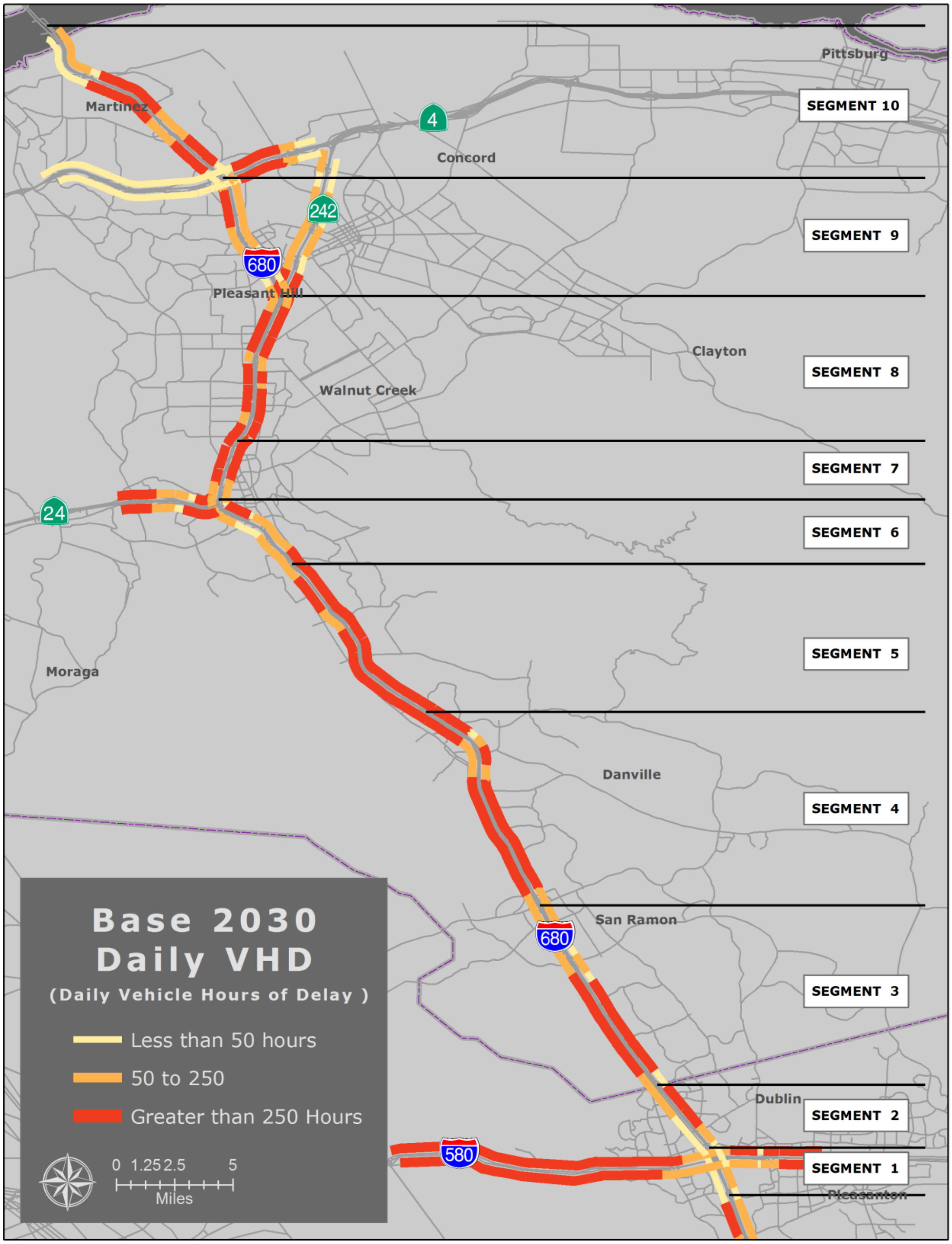


Exhibit 9-15: 2030 Base HOV Lane Congestion

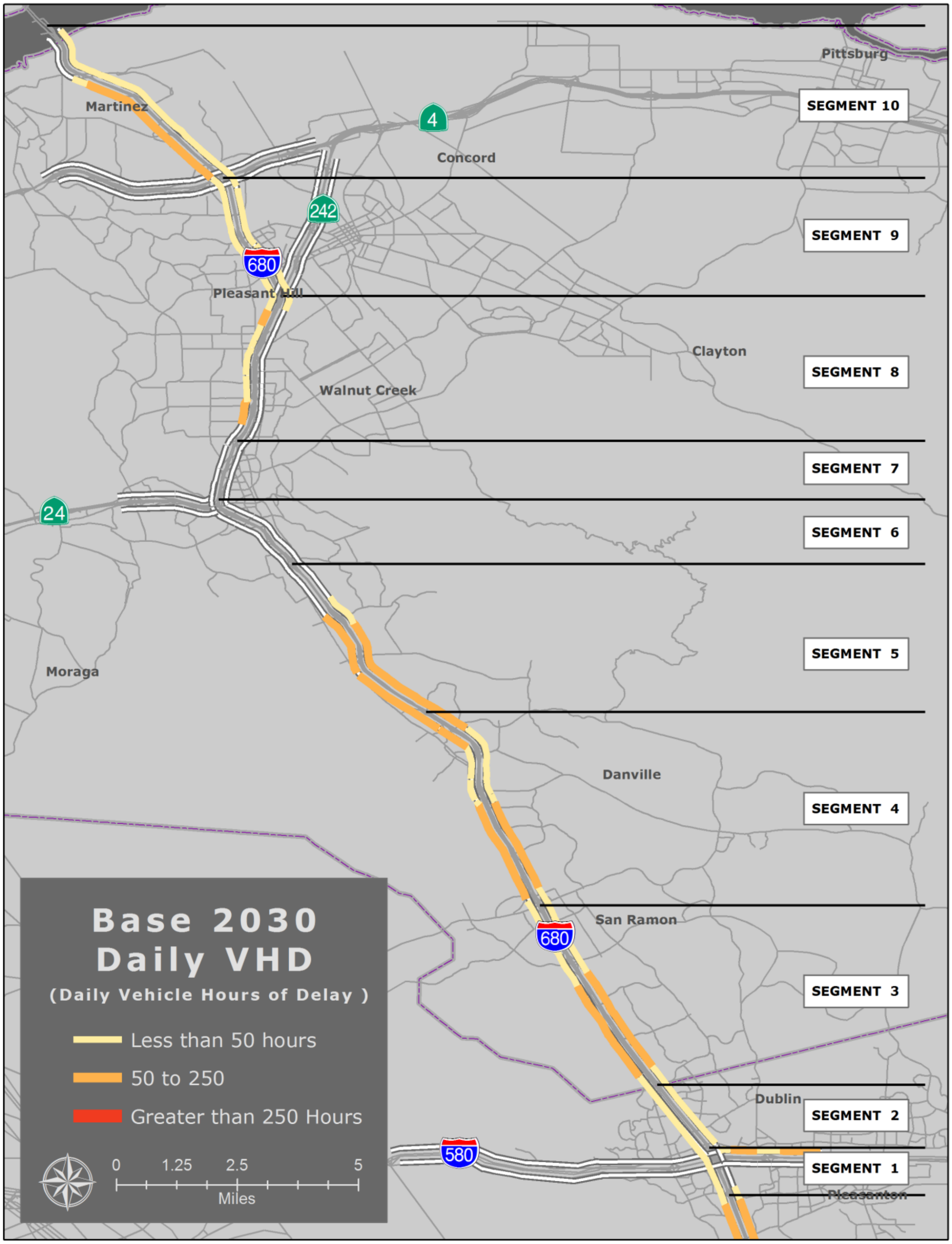


Exhibit 9-16: 2030 Base Arterial/Ramp Congestion

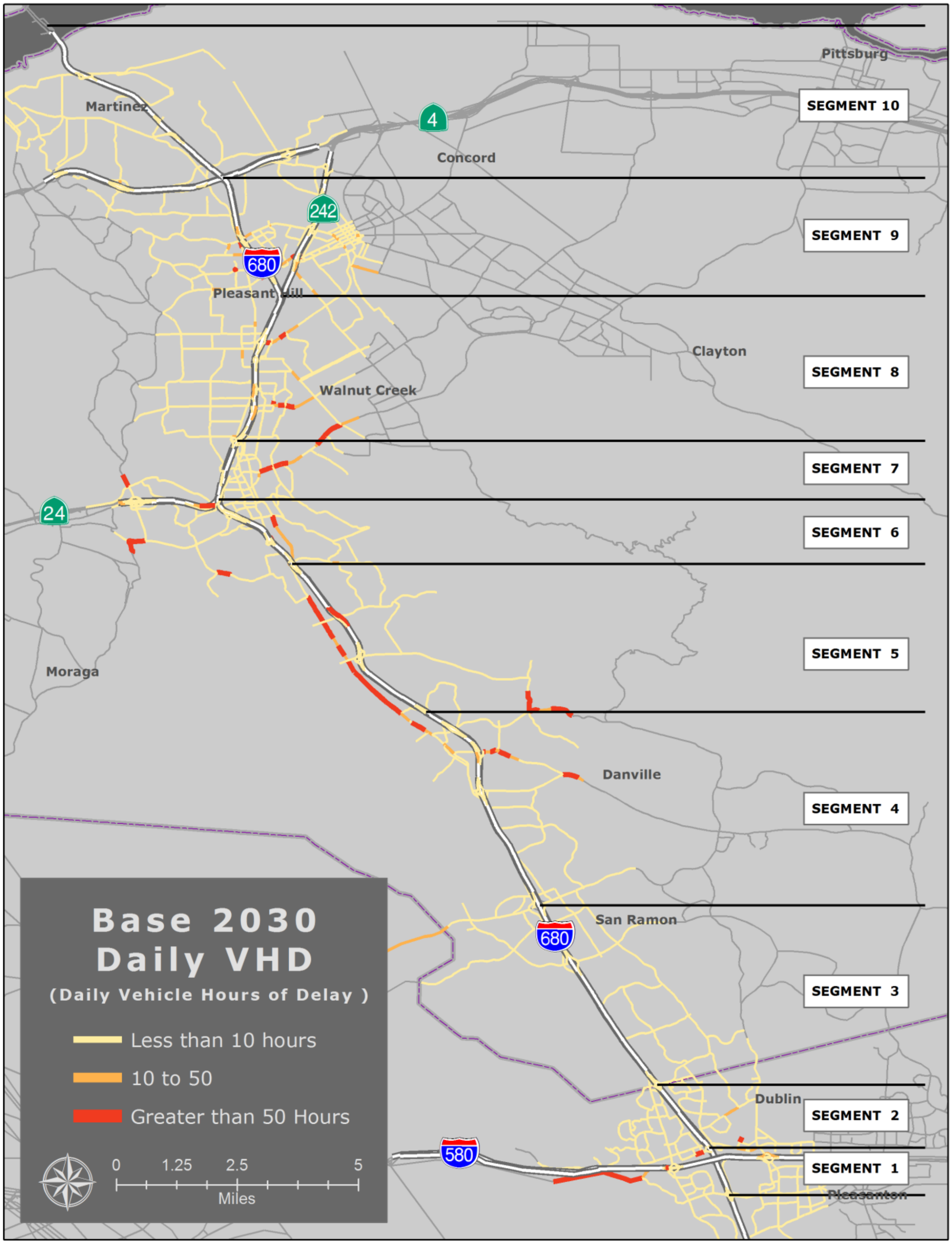


Exhibit 9-17: 2030 VMT by Scenario

Facility	2030 Base Case	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
I-680 Corridor						
I-680 General Purpose & Auxiliary Lanes	5,618,456	5,630,485	5,544,208	5,540,939	5,696,936	5,695,407
		0.2%	-1.3%	-1.4%	1.4%	1.4%
I-680 Ramps & Connectors	401,578	400,722	406,599	421,383	431,922	436,213
		-0.2%	1.3%	4.9%	7.6%	8.6%
I-680 Express Lanes	874,716	972,698	1,219,663	1,222,400	1,197,842	1,191,284
		11.2%	39.4%	39.7%	36.9%	36.2%
Total I-680 Freeway	6,894,750	7,003,905	7,170,470	7,184,722	7,326,700	7,322,905
		1.6%	4.0%	4.2%	6.3%	6.2%
Connecting/Parallel Routes						
I-580 Freeway (w/in 2-mi buffer of I-680)	1,760,698	1,756,624	1,755,260	1,755,526	1,755,485	1,746,686
		-0.2%	-0.3%	-0.3%	-0.3%	-0.8%
SR-4 Freeway (w/in 2-mi buffer of I-680)	340,723	341,276	377,230	363,220	363,882	361,476
		0.2%	10.7%	6.6%	6.8%	6.1%
SR-24 Freeway (w/in 2-mi buffer of I-680)	353,978	353,732	356,574	356,832	355,568	353,727
		-0.1%	0.7%	0.8%	0.4%	-0.1%
SR-242 Freeway	361,567	362,191	360,529	359,886	361,709	361,463
		0.2%	-0.3%	-0.5%	0.0%	0.0%
Other Ramps & Connectors	193,356	193,695	184,179	183,855	184,035	186,076
		0.2%	-4.7%	-4.9%	-4.8%	-3.8%
Arterials (w/in 2-mi buffer of I-680)	3,201,813	3,163,943	3,093,494	3,087,883	3,051,663	3,030,056
		-1.2%	-3.4%	-3.6%	-4.7%	-5.4%

Exhibit 9-18: 2030 VHT by Scenario

Facility	2030 Base Case	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
I-680 Corridor						
I-680 General Purpose & Auxiliary Lanes	136,632	131,326	123,924	123,950	122,690	122,506
		-3.9%	-9.3%	-9.3%	-10.2%	-10.3%
I-680 Ramps & Connectors	10,928	10,961	11,120	11,530	12,261	12,610
		0.3%	1.8%	5.5%	12.2%	15.4%
I-680 Express Lanes	16,262	20,921	26,928	27,041	25,300	25,547
		28.6%	65.6%	66.3%	55.6%	57.1%
Total I-680 Freeway	163,822	163,207	161,972	162,521	160,252	160,663
		-0.4%	-1.1%	-0.8%	-2.2%	-1.9%
Connecting/Parallel Routes						
I-580 Freeway (w/in 2-mi buffer of I-680)	48,298	47,645	47,493	47,532	47,474	46,700
		-1.4%	-1.7%	-1.6%	-1.7%	-3.3%
SR-4 Freeway (w/in 2-mi buffer of I-680)	6,278	6,288	5,944	5,734	5,745	5,697
		0.2%	-5.3%	-8.7%	-8.5%	-9.2%
SR-24 Freeway (w/in 2-mi buffer of I-680)	9,193	9,115	9,349	9,384	9,266	9,094
		-0.9%	1.7%	2.1%	0.8%	-1.1%
SR-242 Freeway	7,753	7,767	7,419	7,363	7,423	7,450
		0.2%	-4.3%	-5.0%	-4.3%	-3.9%
Other Ramps & Connectors	5,135	5,254	5,036	4,961	5,016	5,174
		2.3%	-1.9%	-3.4%	-2.3%	0.8%
Arterials (w/in 2-mi buffer of I-680)	107,339	105,566	102,232	102,032	100,378	99,312
		-1.7%	-4.8%	-4.9%	-6.5%	-7.5%

Exhibit 9-19: 2030 VHD by Scenario

Facility	2030 Base Case	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
I-680 Corridor						
I-680 General Purpose & Auxiliary Lanes	47,571	42,081	36,100	36,178	32,496	32,333
		-11.5%	-24.1%	-24.0%	-31.7%	-32.0%
I-680 Ramps & Connectors	1,230	1,247	1,329	1,426	1,908	2,115
		1.4%	8.0%	15.9%	55.1%	71.9%
I-680 Express Lanes	2,354	5,482	7,569	7,638	6,270	6,627
		132.9%	221.6%	224.5%	166.4%	181.5%
Total I-680 Freeway	51,155	48,811	44,999	45,241	40,674	41,076
		-4.6%	-12.0%	-11.6%	-20.5%	-19.7%
Connecting/Parallel Routes						
I-580 Freeway (w/in 2-mi buffer of I-680)	21,211	20,620	20,489	20,524	20,466	19,828
		-2.8%	-3.4%	-3.2%	-3.5%	-6.5%
SR-4 Freeway (w/in 2-mi buffer of I-680)	1,036	1,038	141	146	146	136
		0.2%	-86.4%	-85.9%	-85.9%	-86.9%
SR-24 Freeway (w/in 2-mi buffer of I-680)	2,988	2,914	3,099	3,130	3,035	2,896
		-2.5%	3.7%	4.8%	1.6%	-3.1%
SR-242 Freeway	1,727	1,730	1,410	1,365	1,395	1,425
		0.2%	-18.4%	-21.0%	-19.3%	-17.5%
Other Ramps & Connectors	493	605	542	475	526	646
		22.7%	9.9%	-3.7%	6.6%	31.0%
Arterials (w/in 2-mi buffer of I-680)	7,672	6,985	5,948	5,935	5,323	4,922
		-8.9%	-22.5%	-22.6%	-30.6%	-35.9%

Scenario 3 – I-680/SR-4 Interchange Improvements, Arterial Improvements

Scenario 3 completes the improvements at the I-680/SR-4 interchange (the first phases were included in Scenario 2 described above). It also includes some arterial improvements on Contra Costa Boulevard in Pleasant Hill.

Scenario 3 was only evaluated using the 2030 model since these projects are to be implemented in the 2015-2025 timeframe. This scenario shows very minor changes for all facilities on the corridor, shown in Exhibits 9-17 through 9-19 above. Neither VMT nor VHD changes much due to these improvements. Most of the impacts from the I-680/SR-4 interchange occurred in the first phases of the project in Scenario 2.

Scenario 4 – Auxiliary Lanes

Scenario 4 is a long-term scenario to test auxiliary lane additions identified as potential projects in various planning documents along the southern portion of I-680, from Alcosta Boulevard north to Rudgear Road.

Scenario 4 was only evaluated using the 2030 model since these projects are planning-level projects that would be implemented in the future. This scenario shows an increase in VMT on auxiliary lanes and ramps on I-680. This is to be expected for this scenario, but overall there is a modest increase in travel on I-680. Arterial VMT continues to decline with this scenario, as shown in Exhibit 9-17 above.

The minor reductions in VMT, however, translate into significant reductions in congestion on I-680. As shown in Exhibit 9-19, congestion on the entire I-680 freeway has been reduced by more than 20 percent over the 2030 base case. Congestion on arterials declines by more than 30 percent.

Scenario 5 – Bicycle/Pedestrian Improvements

Scenario 5 is a long-term scenario testing the impact of bicycle and pedestrian improvements by assuming a 1.5 percent reduction in travel due to a full build out of the bicycle network in Contra Costa County. This is based on estimates in bicycle demand from Bicycle Demand Forecasting of the 2009 Contra Costa Countywide Bicycle and Pedestrian Plan.

Scenario 5 was only evaluated using the 2030 model since these planning-level projects would be implemented in the future. This scenario shows reductions in VMT for all facilities with the exception of connectors and miscellaneous facilities as shown in Exhibit 9-17. As can be expected, this scenario shows dramatic reductions in congestion on arterials, but more modest improvements on freeway facilities.

Exhibits 9-20 through 9-22 are maps showing the VHD by link after Scenario 5 has been implemented (Scenario 5 includes all previous scenarios). Exhibit 9-20 shows mainline freeway delay, Exhibit 9-21 HOV/Express Lane VHD, and Exhibit 9-22 shows arterial delay. Exhibits 9-23 through 9-25 show the differences in VHD between the 2030 Base Case and the 2030 Scenario 5 results for each of the same facility types as described above. The areas experiencing reductions in the 2010 analysis are also those that experience improvements in congestion using the 2030 year model.

Exhibit 9-20: 2030 Scenario 5 Freeway Mainline Congestion

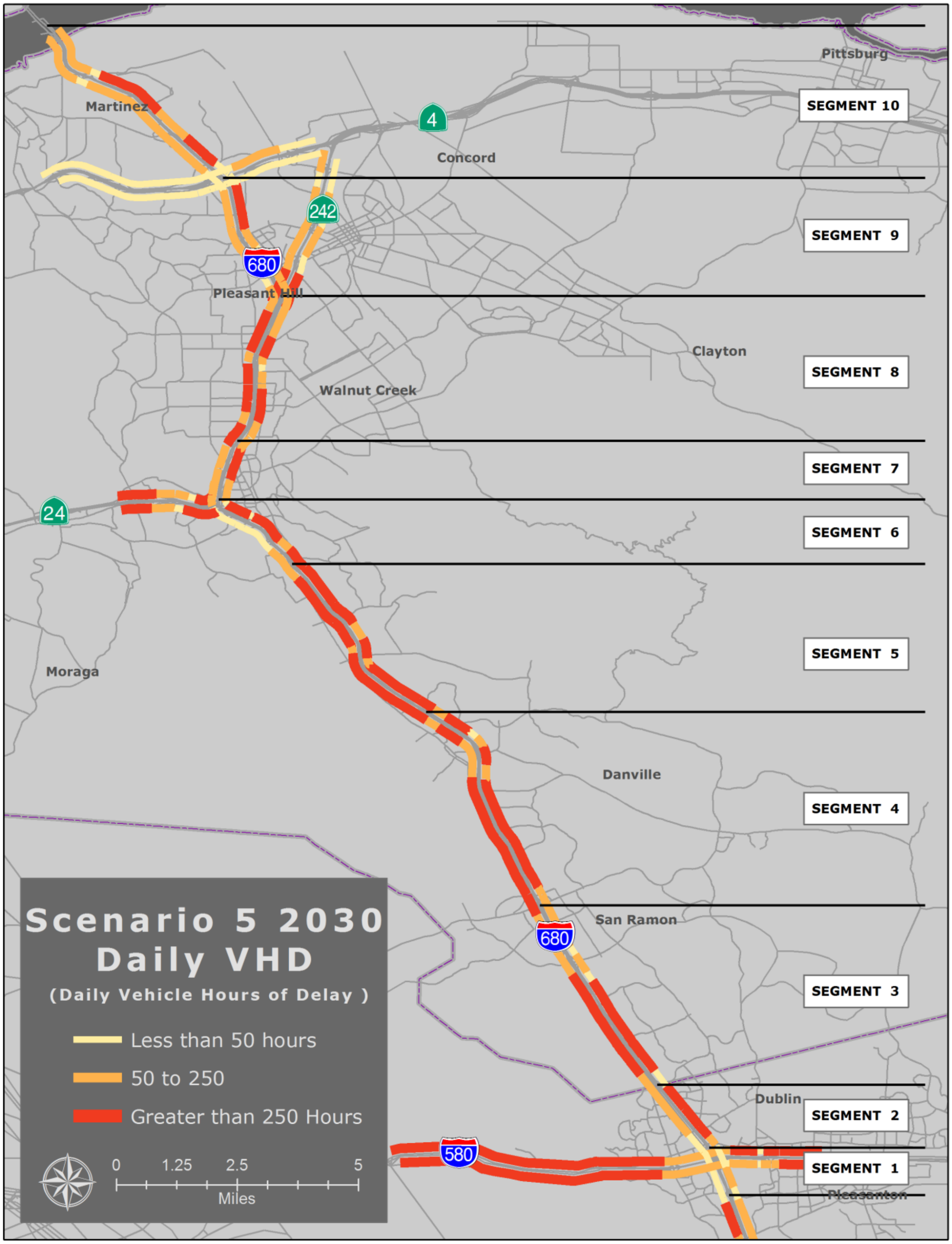


Exhibit 9-21: 2030 Scenario 5 HOV/Express Lane Congestion

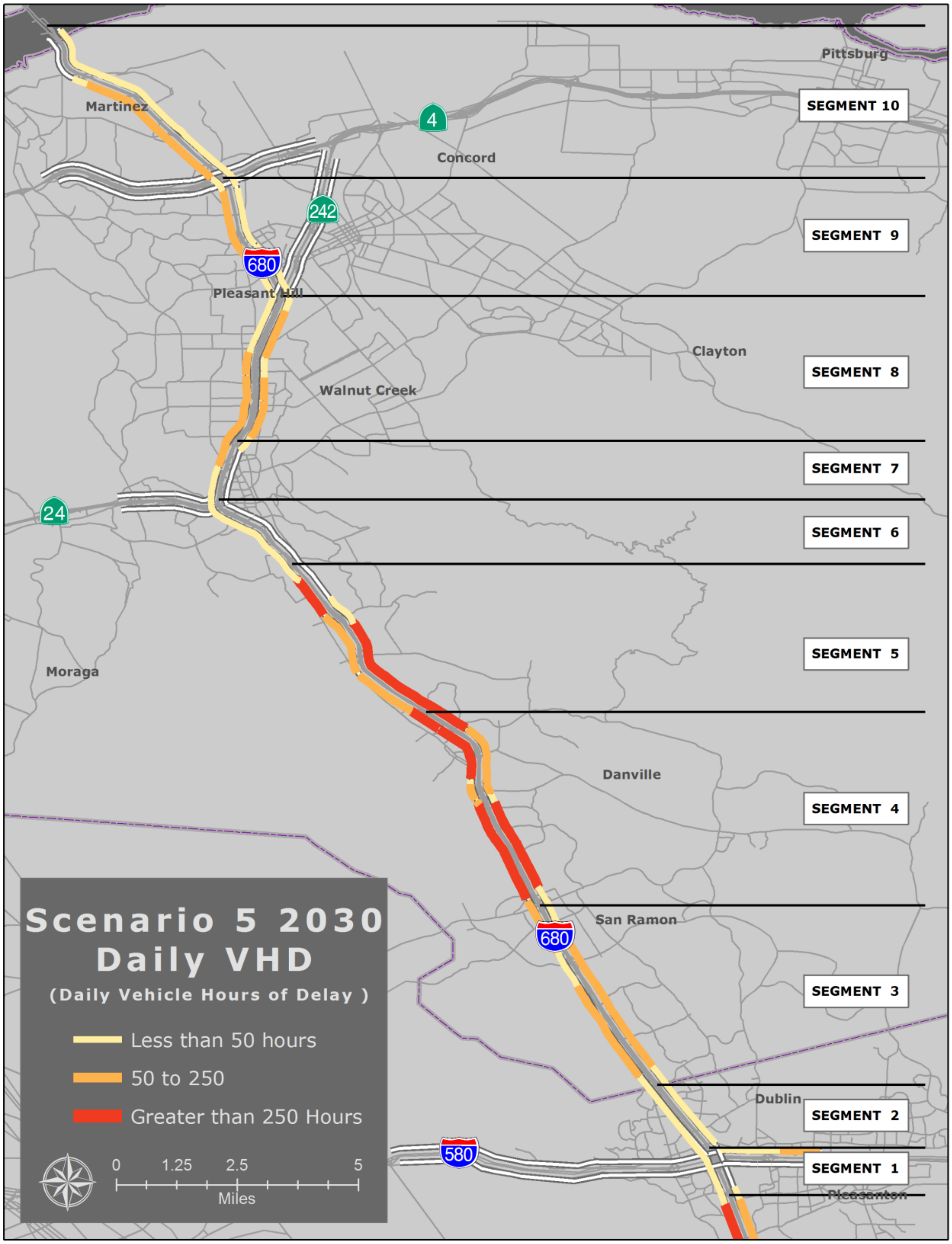


Exhibit 9-22: 2030 Scenario 5 Arterial/Ramp Congestion

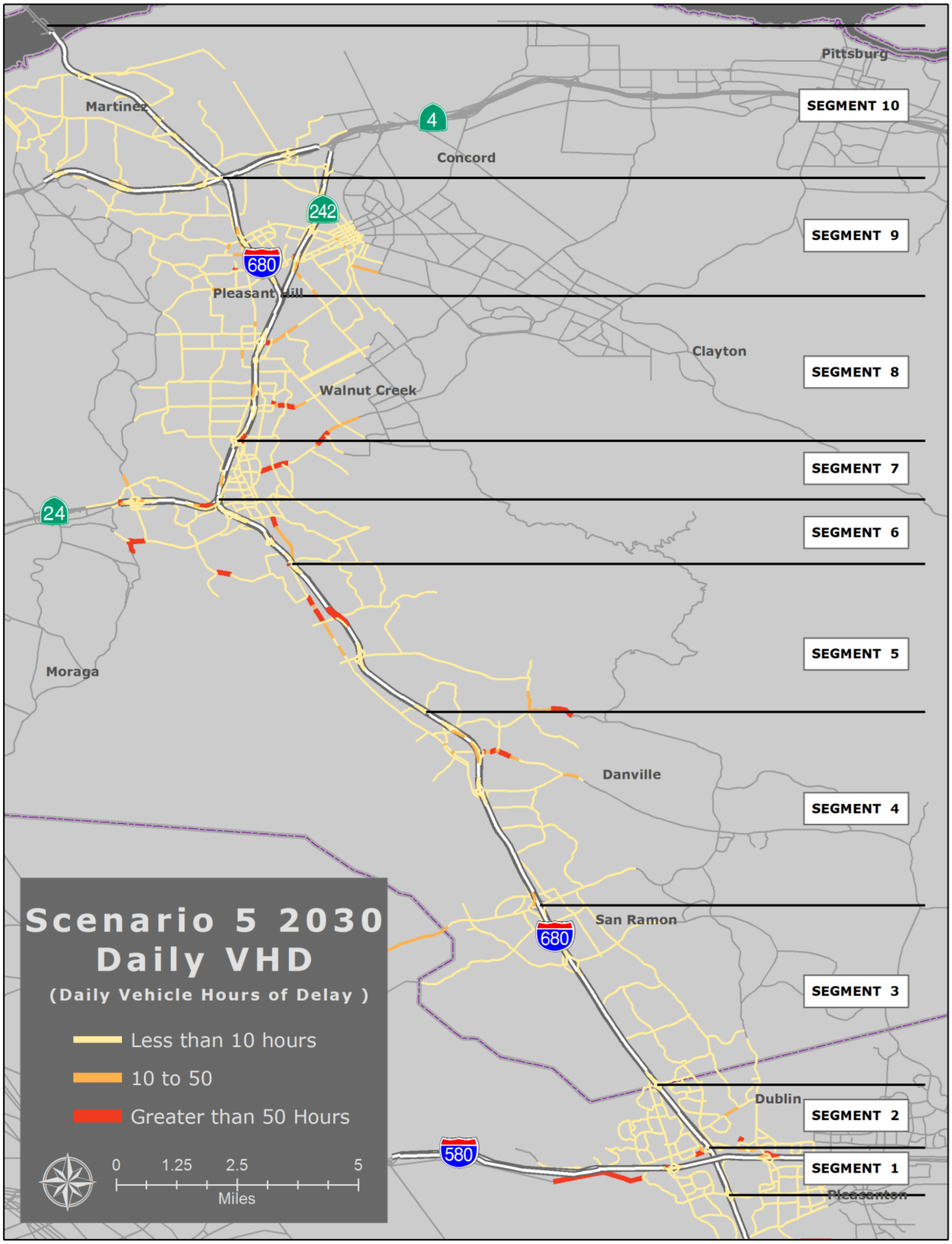


Exhibit 9-23: 2030 Scenario 5 vs. Base Case - Mainline

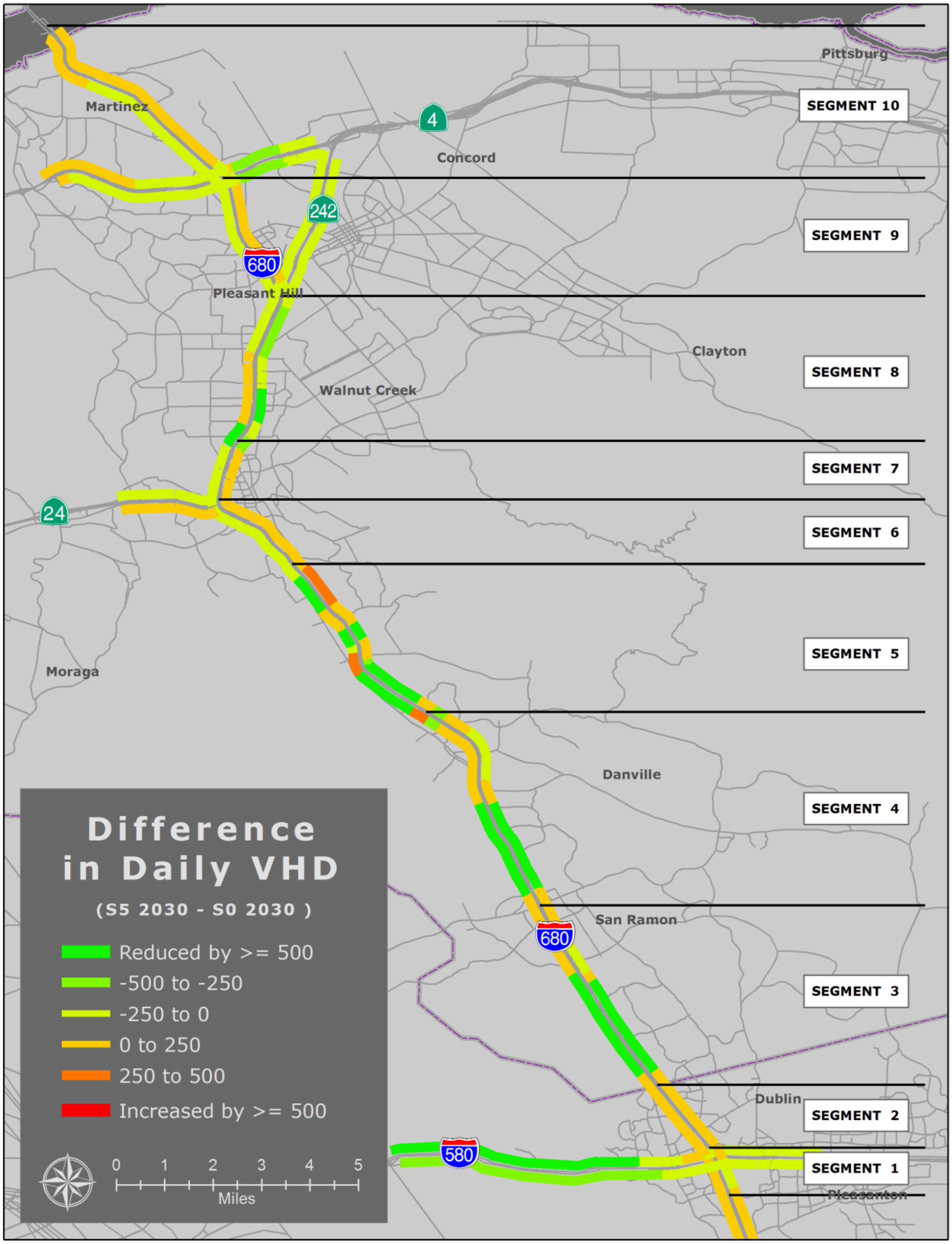


Exhibit 9-24: 2030 Scenario 5 vs. Base Case - HOV/Express Lane Congestion

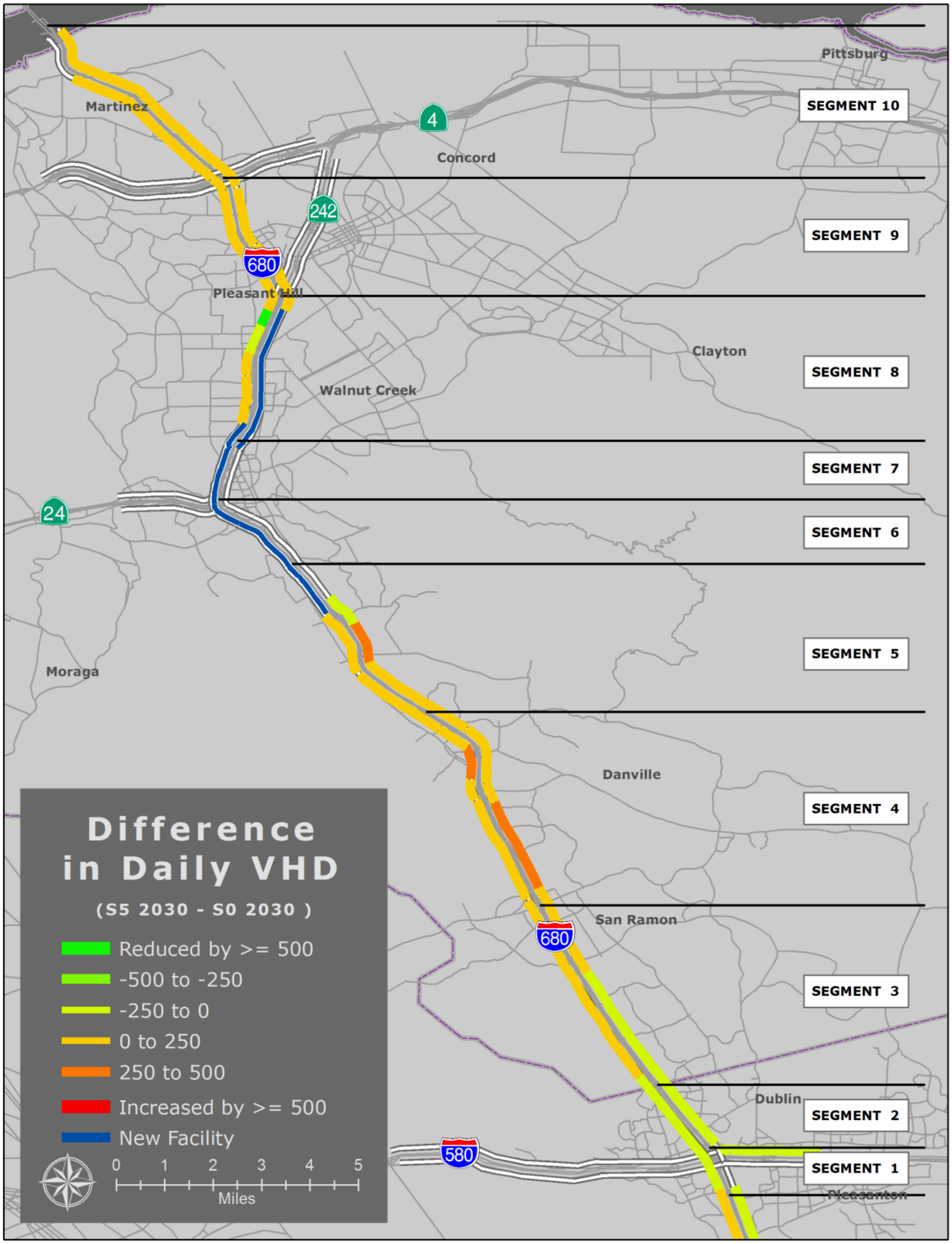
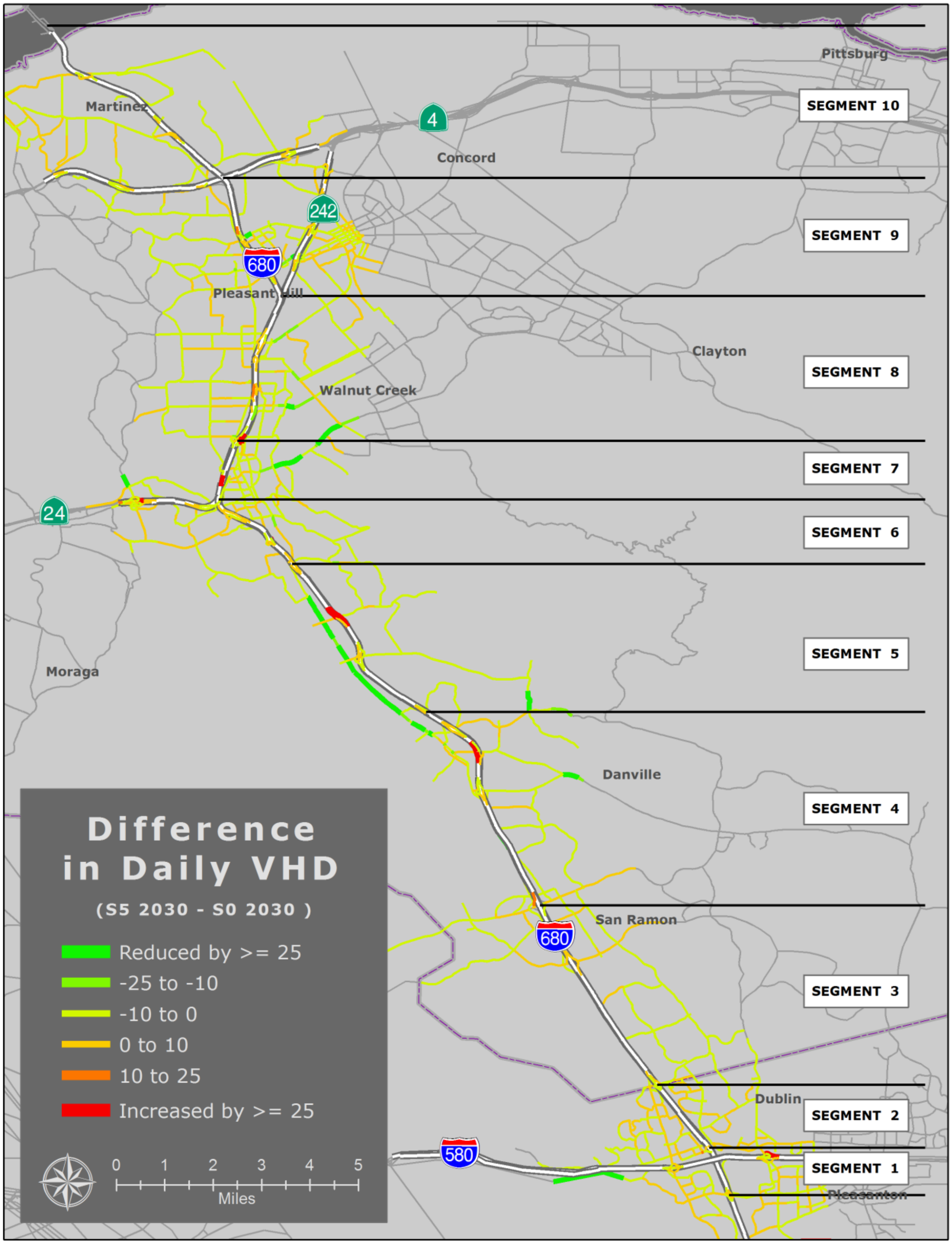


Exhibit 9-25: 2030 Scenario 5 vs. Base Case - Arterial/Ramp Congestion

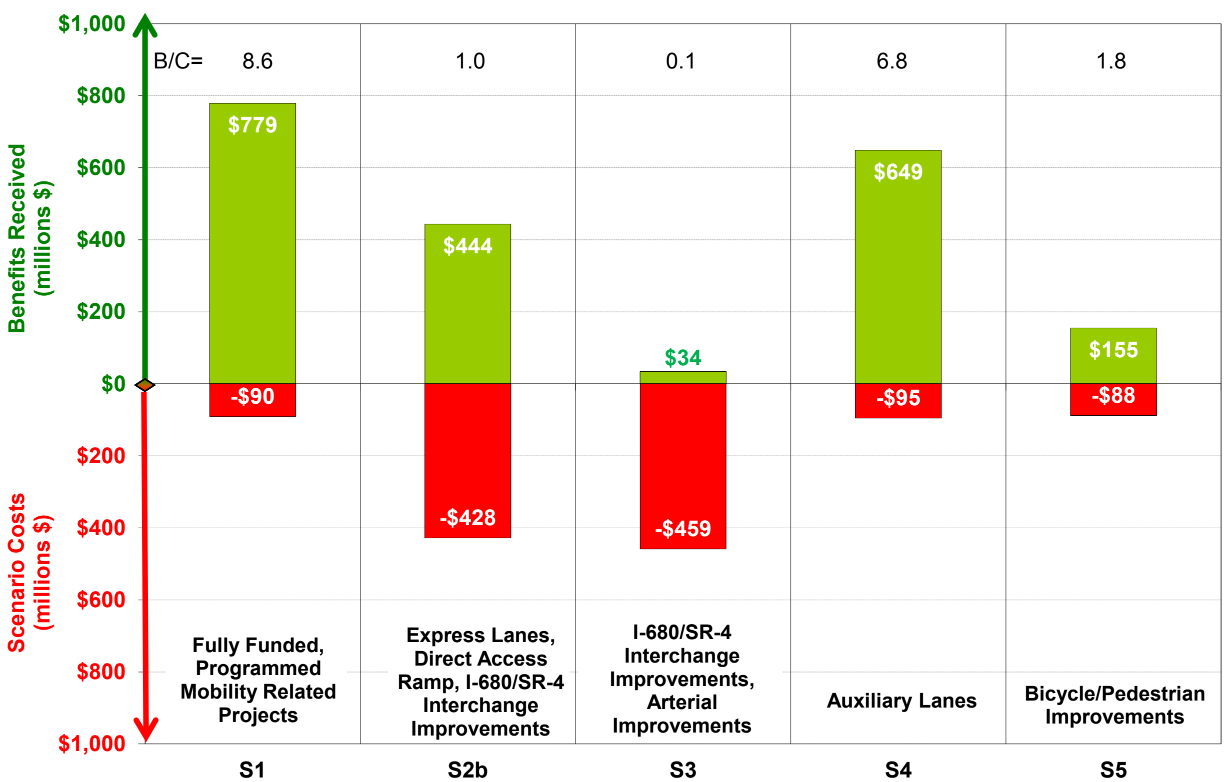


BENEFIT-COST ANALYSIS

Following an in-depth review of the CCTA model results, the team performed a BCA for each scenario. The BCA results represent the incremental benefits over the incremental costs of a given scenario. The TOPL model is currently being calibrated to run these scenarios. Once the TOPL model runs have been successfully completed, the updated results will be used to revise the benefit-cost analysis. Cal-B/C was used to estimate benefits in three key areas: travel time savings, vehicle operating cost savings, and emission reduction savings. The results are conservative since this analysis does not capture the benefits after the 20-year lifecycle, the reduction in congestion outside the peak periods, the safety benefits, and the improvements in transit travel times.

Project costs were obtained from various sources, including the CCTA 2009 County Transportation Plan (CTP), the MTC Regional Transportation Plan/Sustainable Communities Strategy (MTC RTP/SCS), the Caltrans Transportation System Development Plan (TSDP). A B/C greater than 1.0 means that a scenario's projects return has greater benefits than they cost to construct or implement. It is important to consider the total benefits that a project brings. For example, a large, capital capacity project, such as widening the southbound I-680 for express lanes, has a high capital, construction cost, which reduces the B/C ratio, but brings much higher absolute benefits to I-680 users. The benefit-cost analysis for the I-680 corridor is summarized in Exhibit 9-26 below.

Exhibit 9-26: Scenario Benefit/Cost (B/C) Results



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

- Scenario 1 (Fully-Funded, Programmed Mobility Related Projects) produces a very high benefit-cost ratio of about 8.6.
- Scenario 2 (Express Lanes, Direct Access Ramp, I-680/SR-4 Interchange Improvements) produces an average benefit-cost ratio of 1.0, with a high cost of almost $430 million. Note that benefits on SR-4 are not included in the analysis. Combined with Scenario 1, these scenarios produce an aggregate benefit-cost ratio of 2.4.
- Scenario 3 (I-680/SR-4 Interchange Improvements, Arterial Improvements) produces an average benefit-cost ratio of 0.1. This project scenario also has a high cost of almost $460 million. Again, this low ratio reflects the fact that most benefits related to this scenario will occur on SR-4 which is not included.
- Scenario 4 (Auxiliary Lanes) produces a high benefit-cost ratio of 6.8 reflecting the benefits of relatively low cost operational improvements.
- Scenario 5 (Bicycle/Pedestrian Improvements) produces a very high benefit-cost ratio of about 1.8. The benefit-cost ratio will change depending on the type of bike facilities implemented.
- The combined benefit-cost ratio of Scenarios 1, 2, 3, 4, and 5 is 2.8, which is a reasonable investment result despite the remaining congestion on the corridor and despite not taking SR-4 benefits into account. If all the projects are delivered at current cost estimates, the public will get almost two dollars of benefits for each dollar expended. In current dollars, costs add to almost $1.2 billion, whereas the benefits are estimated to be almost $2.1 billion.
- The projects also alleviate CO_2 greenhouse gas emissions by almost 1.2 billion tons over 20 years, avoiding almost 59,000 tons per year. These emission impacts are estimated in Cal-B/C using data from the California Air Resources Board (CARB) EMFAC model.

Detailed benefit-cost results can be found in Appendix H.

TOPL Freeway Traffic Evaluation

The previous results do not address operational improvements such as ramp metering and incident management, nor do they show how bottlenecks are impacted as a result of the various scenarios. To conduct such an analysis, simulation models are needed. This section presents the simulation model results for the various scenarios organized again by shorter term scenarios and longer term scenarios. Shorter term scenarios were analyzed using a base year simulation model representing 2012/2013 conditions as well as a forecast year of 2025. Longer term scenarios were only analyzed using the 2025 simulation model. This section also includes an analysis conducted to evaluate the impacts of incident management improvements.

SHORTER TERM SCENARIOS 1 AND 2

Scenarios (1) and (2) were further divided into sub-scenarios to better understand the impacts of individual projects and delineate the impacts of ramp metering in more detail. Scenario 1A only includes the auxiliary lane from Sycamore Valley Road to Crow Canyon, which recently completed. Scenario 1B includes all the other improvements in Scenario (1), including the first extension of the Express Lanes. Scenario 2A includes all Scenario (1) projects and adds ramp metering. Finally, Scenario 2B the remaining Scenario (2) project such as the direct connector and the first phase of the SR-4 interchange.

Exhibits 9-27 through 9-31 depict the speed contour plots for the northbound direction during the PM peak period. Speed contour plots show color-coded speeds by time of day and direction. Green speeds represent free-flow or close to free-flow conditions (50 miles per hour or faster). Red speeds represent congested speeds (lower than 35 miles per hour). Orange and yellow speeds represent speeds between green and red (between 35 and 50 miles per hour).

For reference purposes, Exhibit 9-27 is the calibrated base (i.e., without any projects) previously discussed in the Methodology section. Subsequent exhibits depict the speed contour maps for Scenarios 1A, 1B, 2A, and 2B respectively.

Exhibits 9-32 through 9-36 depict the speed contour plots for the southbound direction during the AM peak period. Again, for reference purposes, Exhibit 9-32 is the calibrated base (i.e., without any projects) previously discussed in the Methodology section. Subsequent exhibits depict the speed contour maps for Scenarios 1A, 1B, 2A and 2B respectively.

The results of each of these scenarios are briefly discussed below:

<u>Scenario 1A – Auxiliary Lane from Sycamore Valley Road to Crow Canyon</u>

In the northbound direction during the PM peak period, this project almost eliminates the Crow Canyon bottleneck. However, due to increased flows, the El Cerro/El Pintado bottleneck queue gets longer. This is to be expected and in fact has been observed in the field since the implementation of the auxiliary lane. Whenever an upstream bottleneck is alleviated, downstream bottleneck usually worsen. However, overall, delay in the northbound direction does improve. In the southbound direction, the project did not have any impact.

<u>Scenario 1B – First Phase of the Express Lane</u>

In the northbound direction during the PM peak period, the El Cerro/El Pintado bottleneck is significantly reduced. As some single occupant vehicles elect to use the Express lanes, demand on the mixed flow lanes is reduced accordingly, thereby relieving congestion. The North Main/Lawrence bottleneck worsens slightly due to increased traffic flows.

In the southbound direction during the AM peak period, the Livorna and Stone Valley bottlenecks are also reduced. The North Main bottleneck in not impacted since it is upstream of the Express lane.

Scenario 2A – Ramp Metering

Ramp metering modeling was iterative in nature. TOPL simulated ramp metering. Then, the modeling team reviewed ramp backups. Whenever backups exceeded the capacity of the ramp, the model was revised to expand the ramps. Local stakeholders voiced their concerns regarding ramp backups that can extend to local streets. Also, Caltrans ramp metering approach is to ensure backups do not extend to the local streets. The highest ramp flows when metered is around 900 vehicles per hour per lane. When ramps get expanded to 2 lanes, they can effectively allow flows of up to 1,800 vehicles per hour per lane.

The following ramps are likely to need expansion based on the TOPL analysis:

Northbound:
- Additional ramp HOV lane to the Lawrence Way on-ramp
- Additional ramp mixed flow lane to the Buskirk on-ramp
- Additional ramp mixed flow lane to the Crow Canyon EB on-ramp
- Additional ramp mixed flow lane to the El Cerro on-ramp

Southbound:
- Additional ramp HOV lane to the Geary Road on-ramp
- Additional ramp mixed flow lane to the N. Main on-ramp
- Additional ramp mixed flow lane to the Bollinger Canyon WB on-ramp
- Additional ramp mixed flow lane to the Willow Pass WB on-ramp
- Additional ramp mixed flow lane to the Monument on-ramp
- Additional ramp mixed flow lane to the El Cerro on-ramp

Once these additions were coded and TOPL was rerun, the speed contour plots show how traffic flows improve significantly on the freeway in both directions. Vehicles will experience delays on the ramps, but the cumulative ramp delays are significantly lower than the improvement of congestion on the freeway (incremental vehicle delays on the ramps are around one tenth of the incremental reduction of congestion on the freeway). This is primarily due to the fact that platoons of vehicles from the ramps will be eliminated. These platoons cause bottlenecks to occur earlier and often more create much larger bottlenecks.

Scenario 2B – Second Phase of Express Lanes

After the Express lane is extended to cover the entire corridor, bottlenecks are removed in both directions. Note though that for all these scenarios, only recurrent delays are considered. Studies have estimated that non-recurrent delay due to collisions, incidents (e.g., stalls), special events and other unpredictable circumstances can account for as much as 50 percent of all delays on congested corridors. These delays are not included in the TOPL results so far. Later in this section, improved incident management testing will be presented to illustrate how reducing the duration of a collision can have significant benefits.

Exhibit 9-27: Northbound PM Peak Period Base Year TOPL Speed Contour Plot

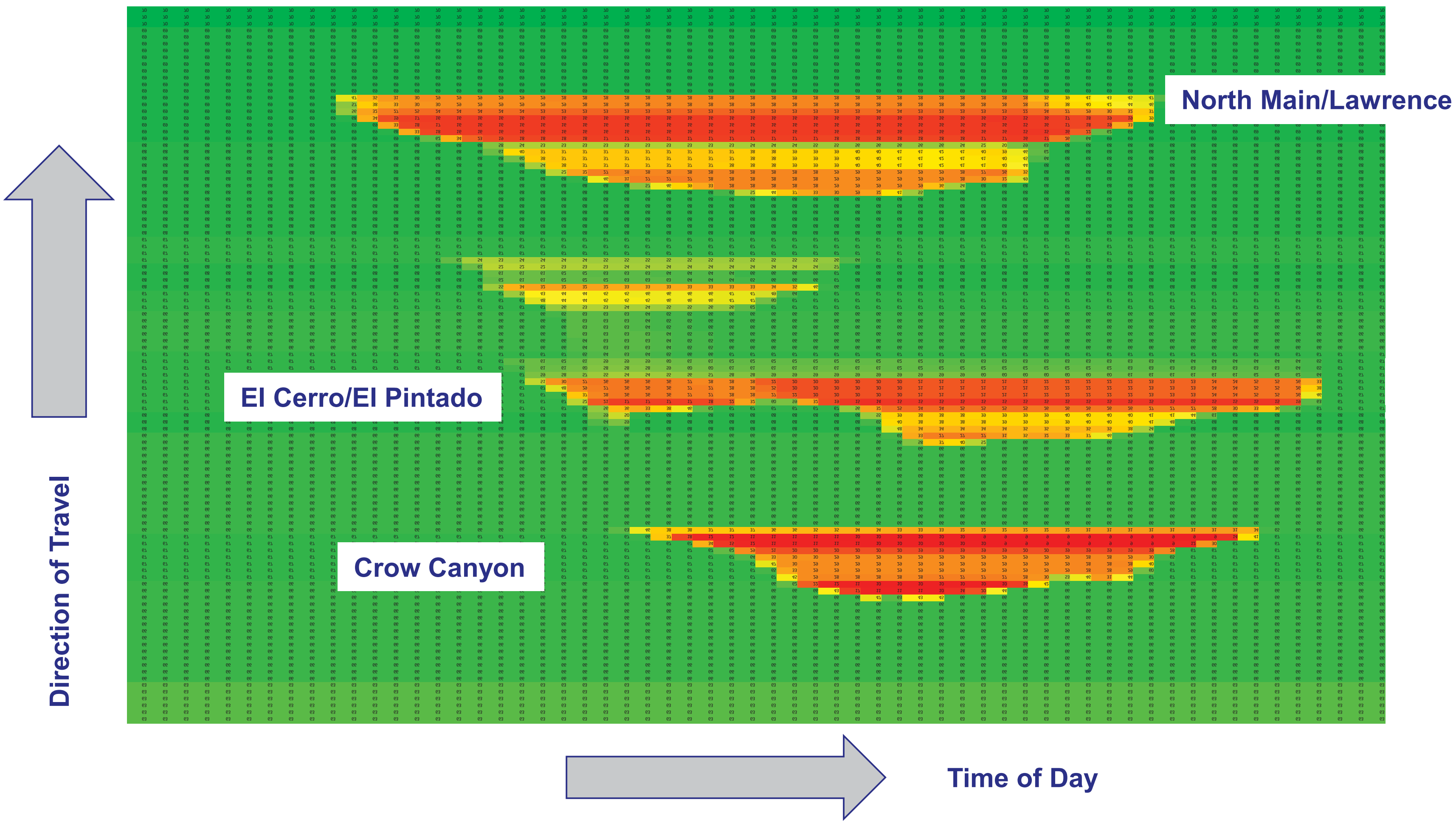


Exhibit 9-28: Northbound PM Peak Period Scenario 1A TOPL Speed Contour Plot

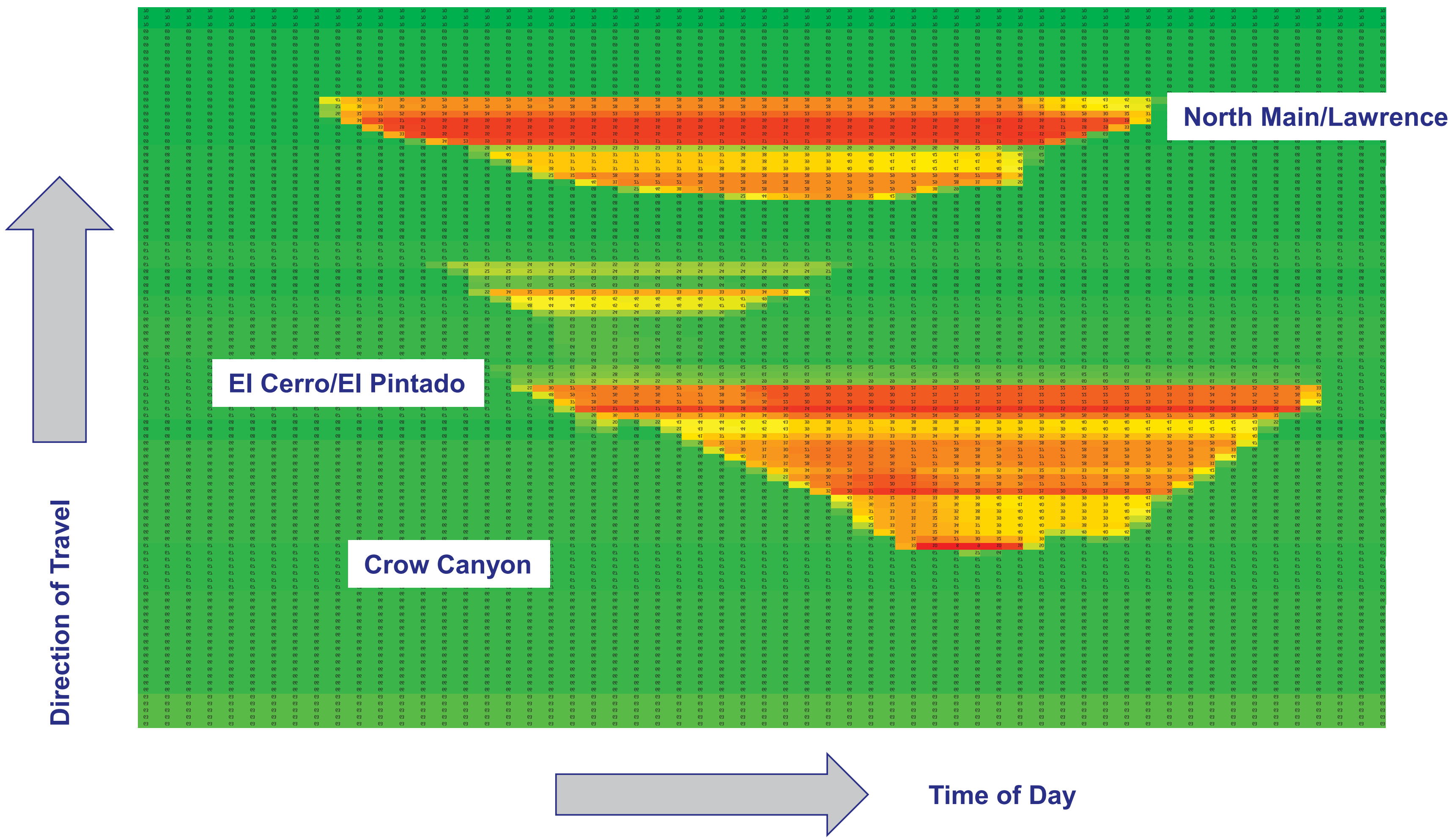


Exhibit 9-29: Northbound PM Peak Period Scenario 1B TOPL Speed Contour Plot

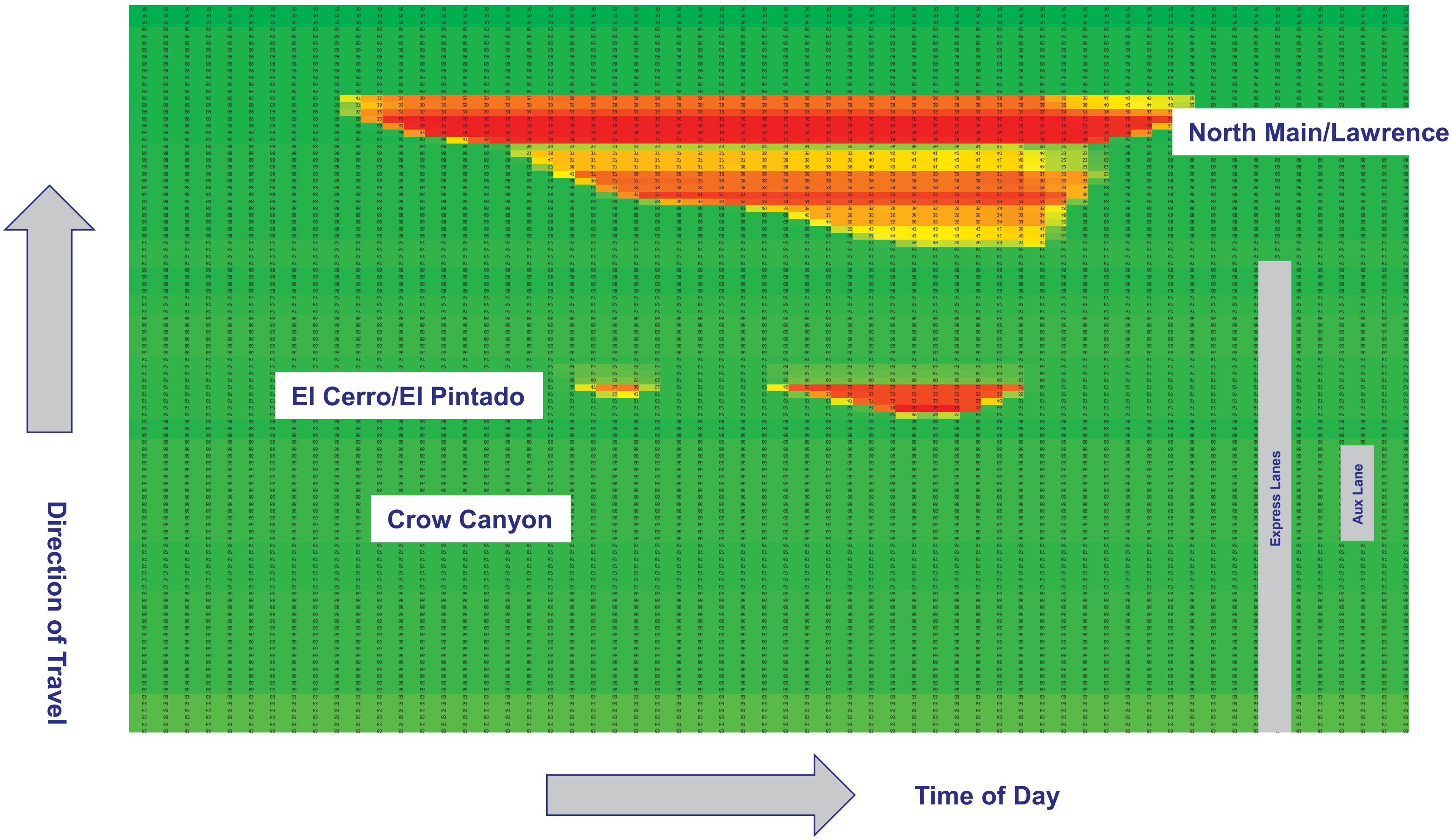


Exhibit 9-30: Northbound PM Peak Period Scenario 2A TOPL Speed Contour Plot

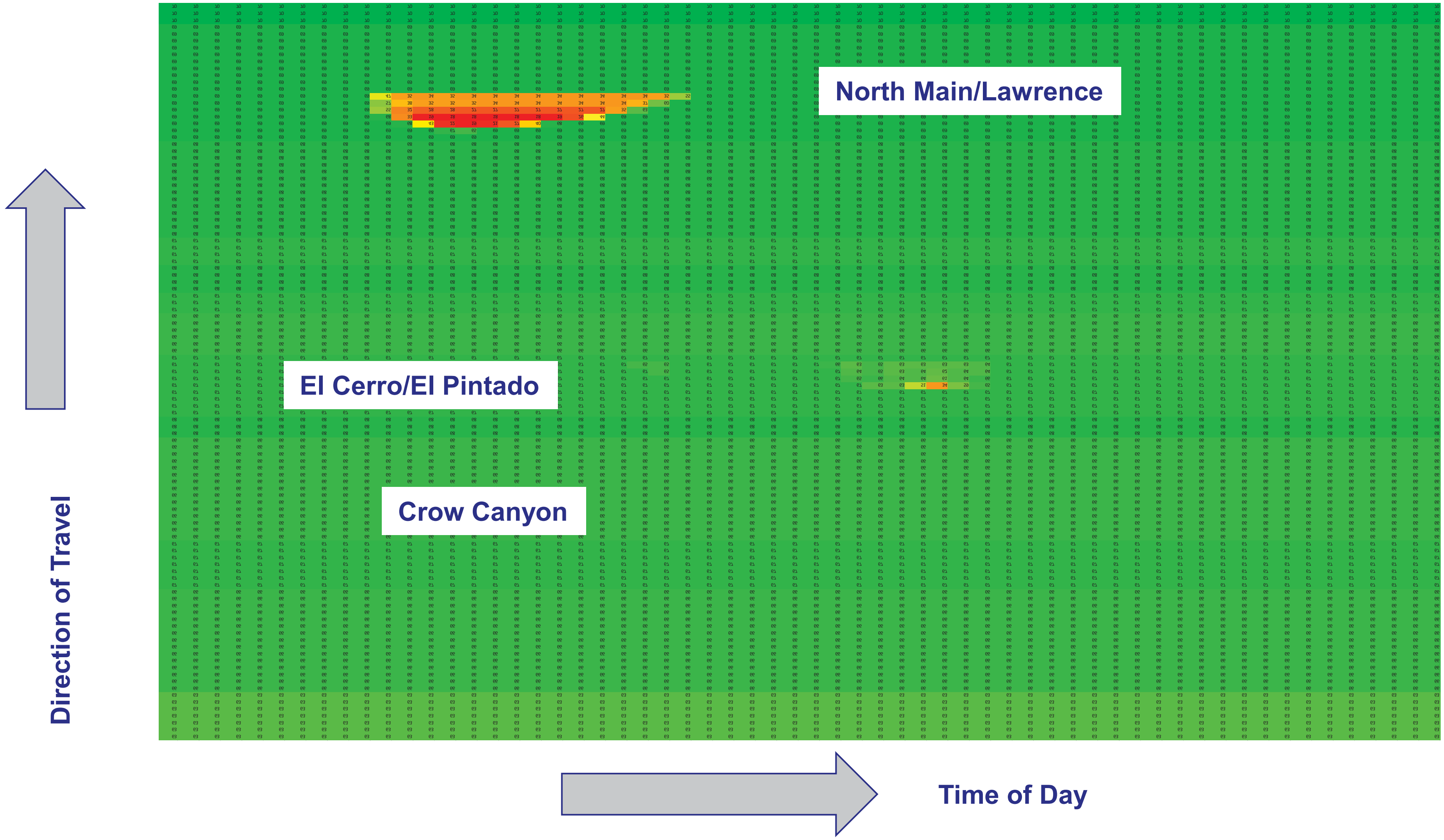


Exhibit 9-31: Northbound PM Peak Period Scenario 2B TOPL Speed Contour Plot

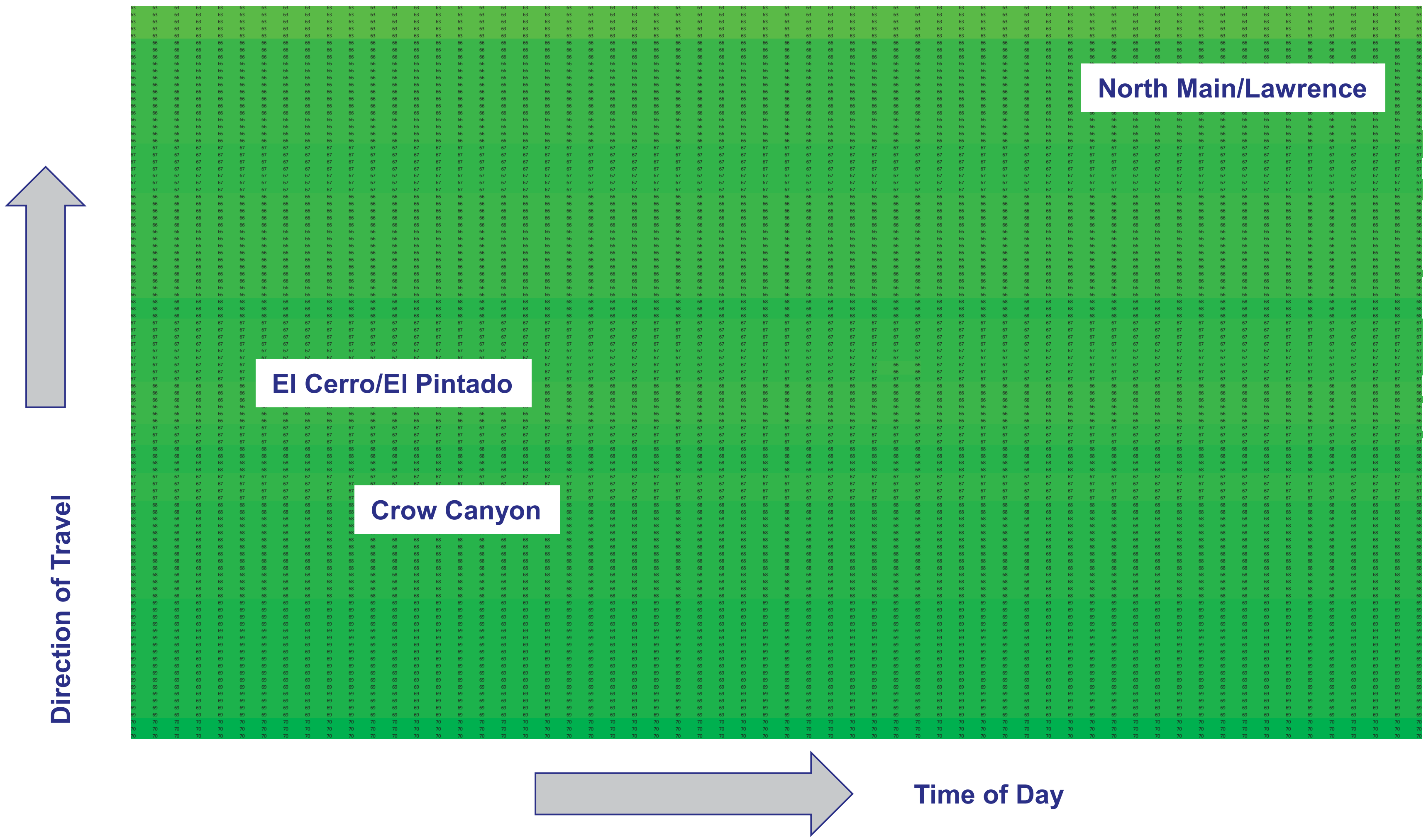


Exhibit 9-32: Southbound AM Peak Period Base Year TOPL Speed Contour Plot

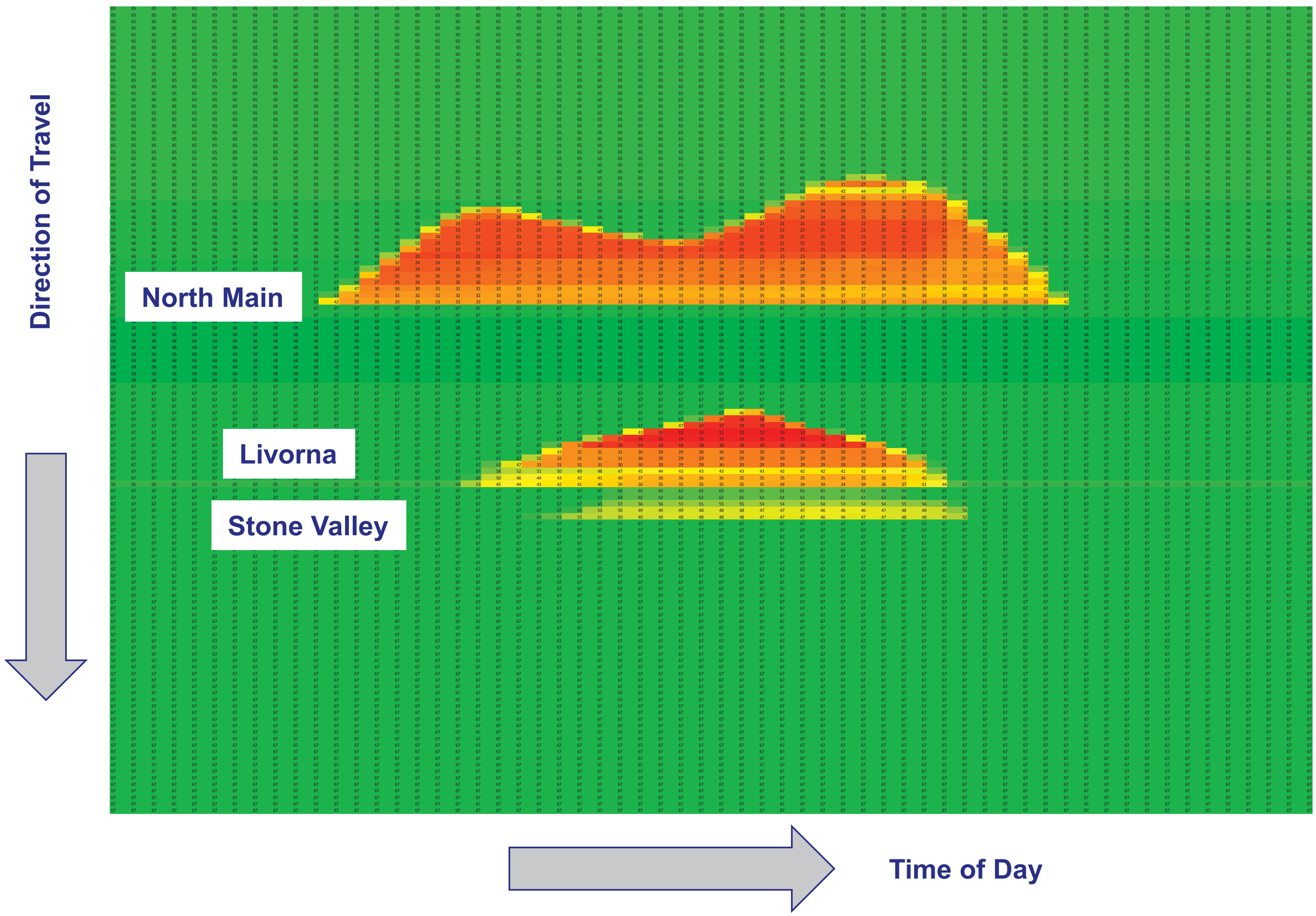


Exhibit 9-33: Southbound AM Peak Period Scenario 1A TOPL Speed Contour Plot

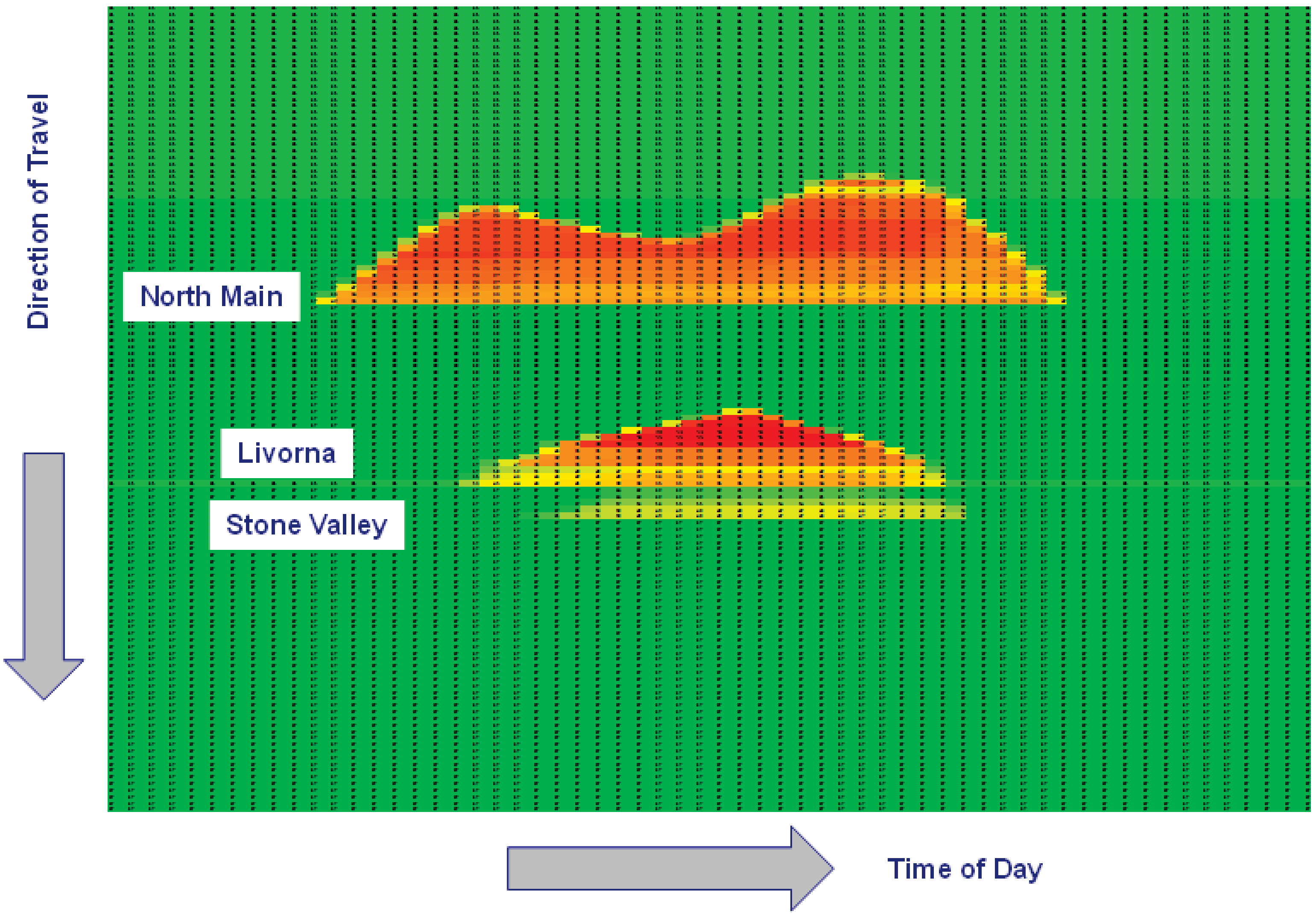


Exhibit 9-34: Southbound AM Peak Period Scenario 1B TOPL Speed Contour Plot

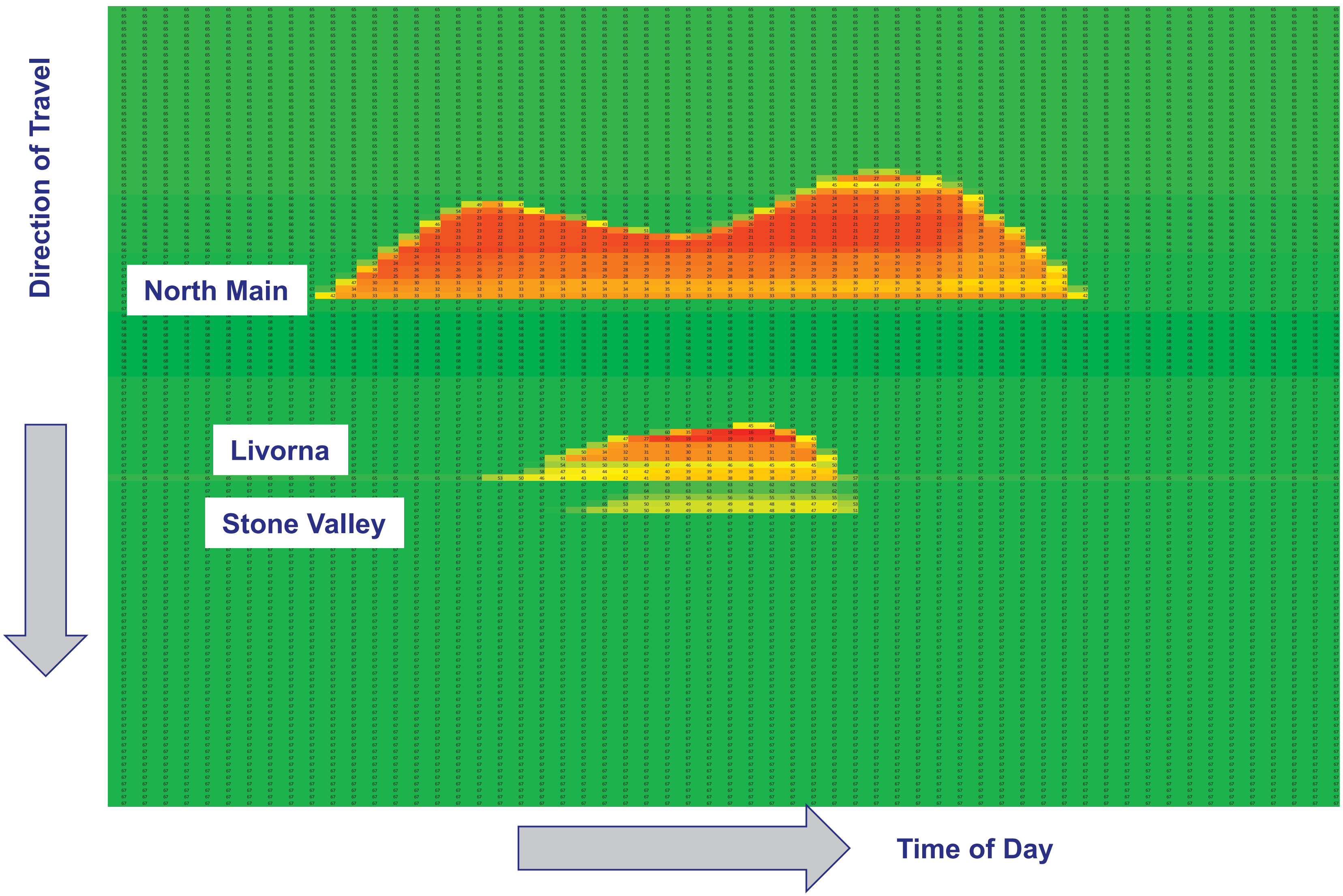
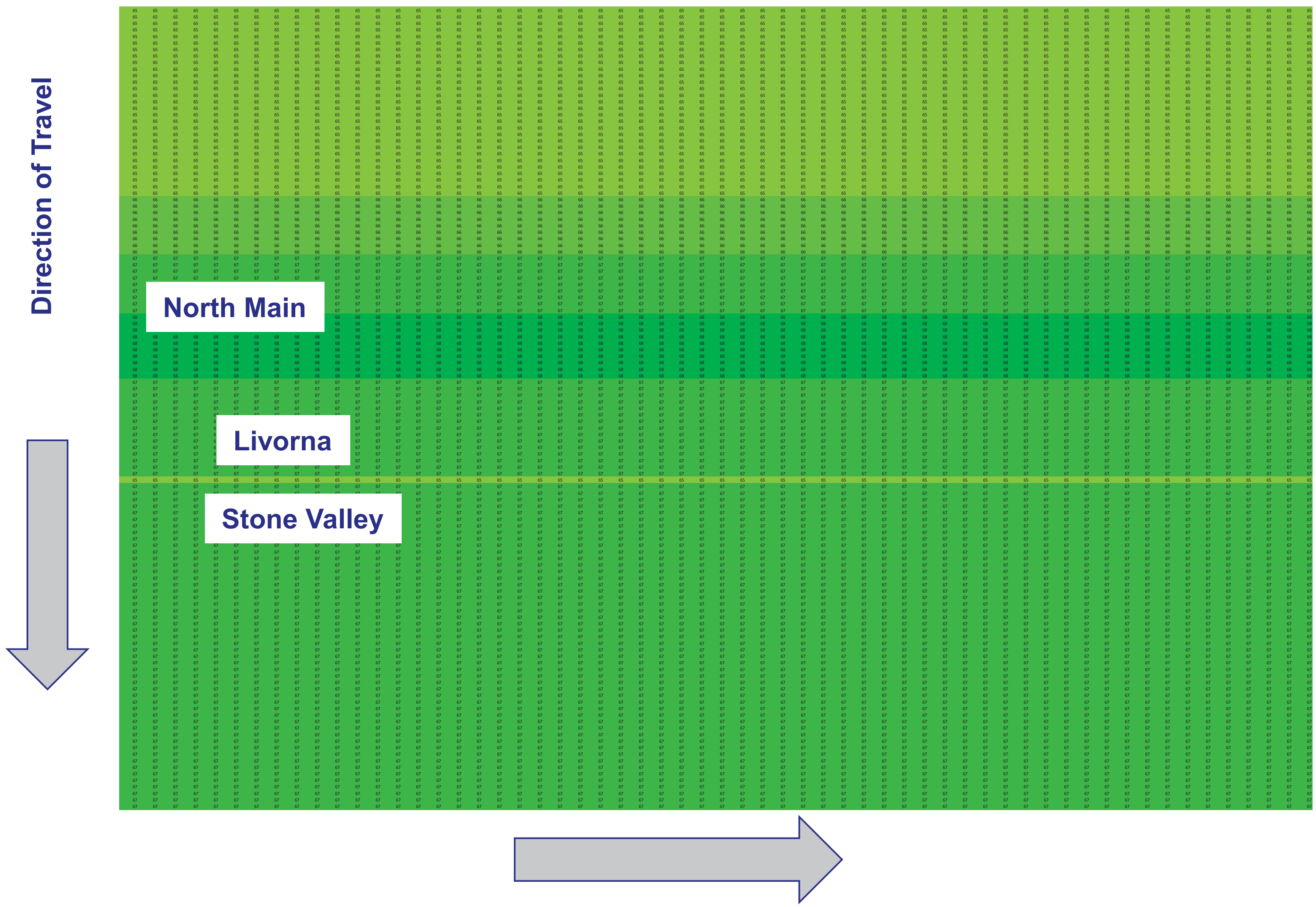


Exhibit 9-35: Southbound AM Peak Period Scenario 2A TOPL Speed Contour Plot

Exhibit 9-36: Southbound AM Peak Period Scenario 2B TOPL Speed Contour Plot



LONGER-TERM SCENARIOS 3 THROUGH 5

Longer term scenarios were compared to the 2025 baseline which was developed using the travel demand model demand increases projected.

Exhibit 9-37 is a speed contour plot that depicts this northbound baseline conditions during the peak PM peak period and represents traffic flows if none of the shorter or longer term projects are implemented. Exhibit 9-38 is the speed contour plot that reflects the implementation of all short term projects (Scenario 2B). Exhibits 9-39 and 9-40 are speed contour plots that depict conditions for scenarios 3 and 4 respectively.

Note that scenario 5 did not have an impact on overall freeway traffic flow and is therefore not included in this section. Its benefits were presented previously in the travel demand model evaluation section.

Exhibit 9-41 presents the speed contour plots for 2025 baseline conditions in the southbound direction during the AM peak period. Exhibit 9-42 is the speed contour plot that reflects the implementation of all short term projects (Scenario 2B). Exhibits 9-43 and 9-44 present the speed contour plots that represent scenarios 3 and 4 respectively.

Scenario results are discussed briefly below:

2025 Baseline (Do Nothing) Scenario

The baseline scenario represents the conditions that would occur if none if the improvements are implemented (even the ones already delivered). The speed contour plots in both directions show significant increases in congestion.

- Northbound (Exhibit 9-37), the Crow Canyon and the El Cerro/El Pintado bottlenecks extend and almost become one large bottleneck. The North Main bottleneck does not worsen due to reduced flows from upstream bottlenecks.
- Southbound (Exhibit 9-41), the North Main bottleneck expands significantly with much larger queues, starting earlier, and lasting longer. The Livorna bottleneck expands less.

Scenario 2B (all short term projects)

Scenario 2B speed contour plots show a significant reduction in congestion in both directions. Even though bottleneck queues and durations are reduced, overall congestion in 2025 would still exceed today's conditions. Also not that this scenario includes ramp metering and using the same iterative process previously discussed, additional ramp expansions will likely be needed as follows:

Northbound:
- Adding ramp mixed flow lane at Diablo Road westbound and eastbound
- Adding ramp mixed flow lane at Sycamore Valley Road
- Adding ramp mixed flow lane at Danville Boulevard
- Adding ramp mixed flow lane at Bollinger Canyon Road eastbound and westbound

- Adding ramp mixed flow lane at Olympic Boulevard
- Adding lane at Alcosta Boulevard

Southbound:

- Adding ramp mixed flow lane at Willow Pass Road westbound
- Adding ramp mixed flow lane at Stone Valley Road
- Adding ramp mixed flow lane at Rudgear Road
- Adding ramp mixed flow lane at Pacheco Boulevard
- Adding ramp mixed flow lane at Contra Costa Boulevard

Scenario 3 (other planned projects)

Scenario 3 only includes the second phase of the SR-4 interchange improvements and some arterial improvements. As such, it had no impacts on freeway traffic flows. The speed contour plots are the same as with Scenario 2. Note that most of the interchange benefits would be on SR-4.

Scenario 4 (additional auxiliary lanes)

As a reminder, Scenario 4 is a long-term scenario that tests potential auxiliary lane additions that have been presented in other long-range planning reports:

- Alcosta Road to Bollinger Canyon Road
- El Cerro Road to El Pintado Road
- El Pintado Road to Stone Valley Road
- Stone Valley Road to Livorna Road
- Livorna Road to Rudgear Road

This scenario improves flow significantly in both directions. Some congestion remains in the northbound PM peak direction (Exhibit 9-40), but less than current conditions. Very few locations would experience speeds below 35 miles per hour. In the southbound direction during the AM Peak period (Exhibit 9-44), congestion would almost be eliminated.

Exhibit 9-37: Northbound PM Peak Period Scenario 2025 Baseline TOPL Speed Contour Plot

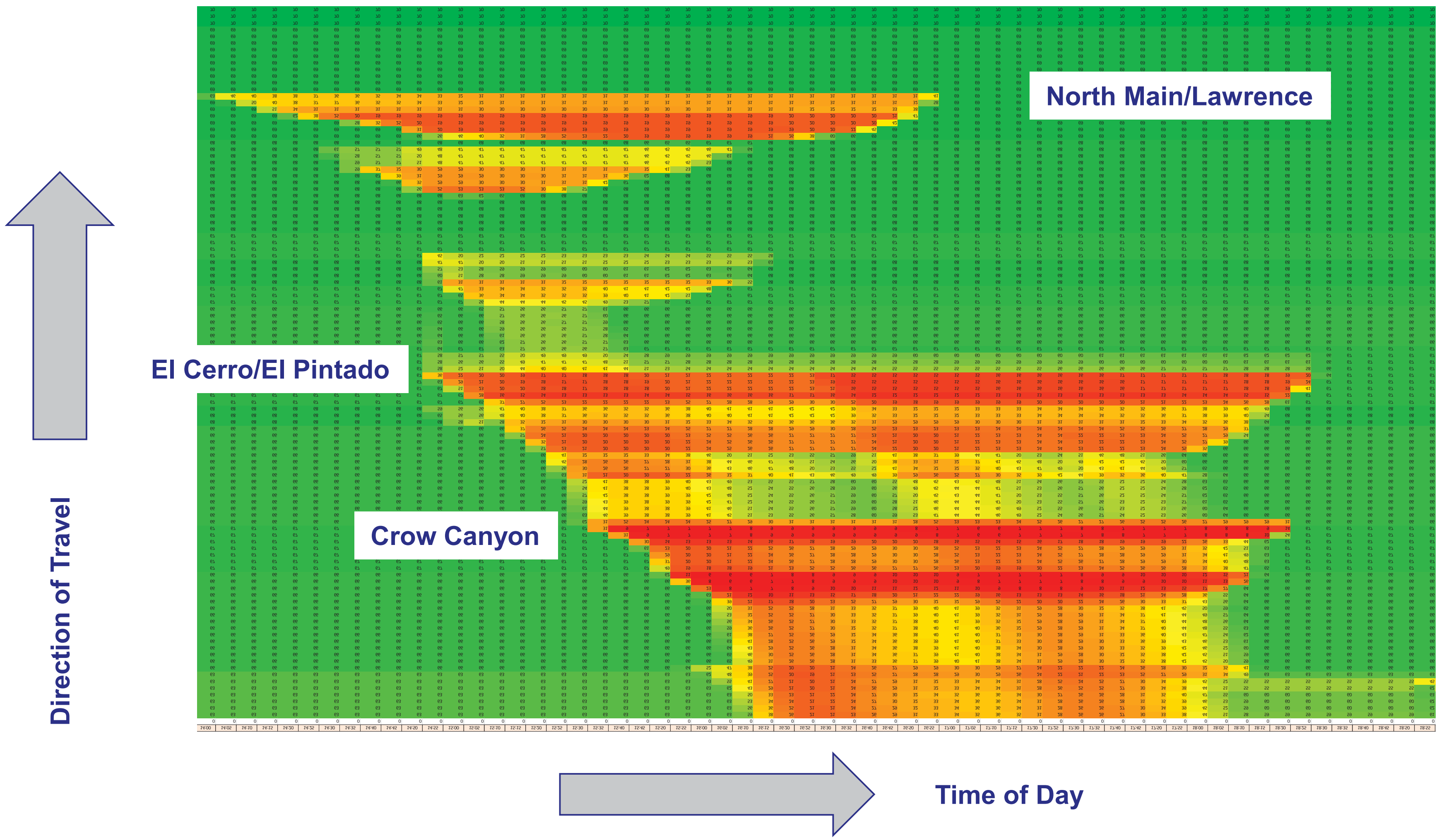


Exhibit 9-38: Northbound PM Peak Period Scenario 2025 Scenario 2B TOPL Speed Contour Plot

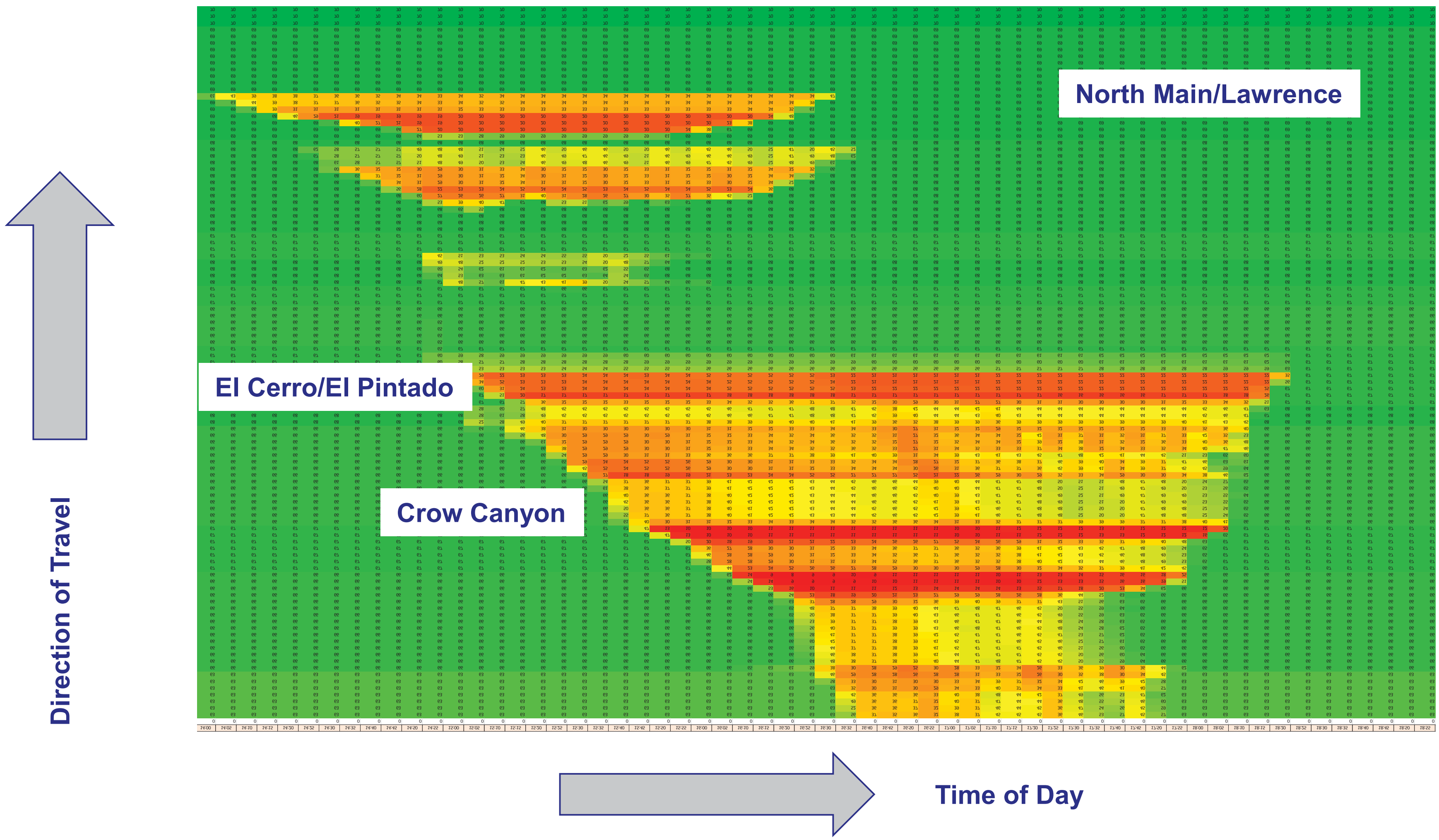


Exhibit 9-39: Northbound PM Peak Period Scenario 2025 Scenario 3 TOPL Speed Contour Plot

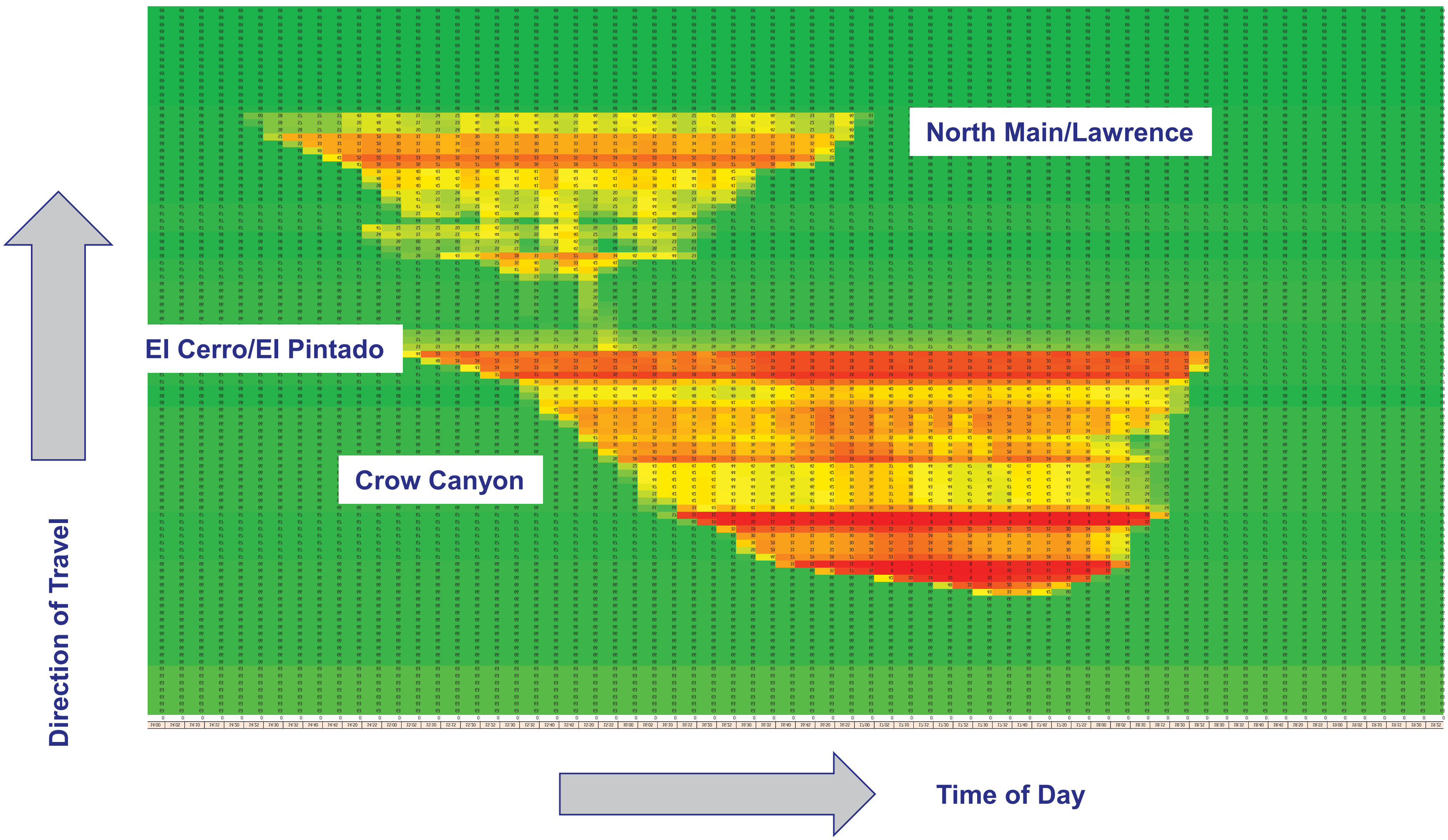


Exhibit 9-40: Northbound PM Peak Period Scenario 2025 Scenario 4 TOPL Speed Contour Plot

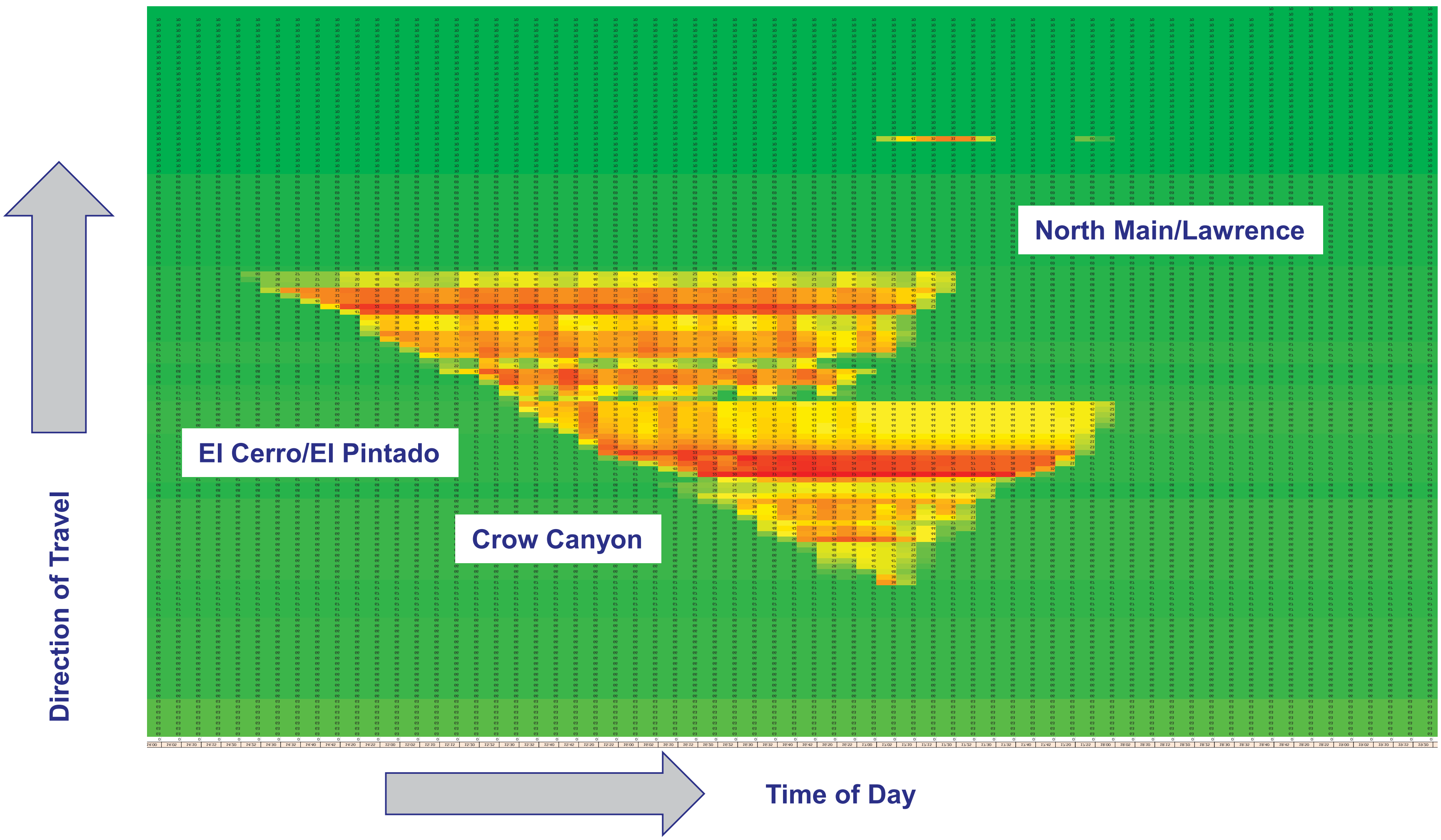


Exhibit 9-41: Southbound AM Peak Period Scenario 2025 Baseline Scenario TOPL Speed Contour Plot

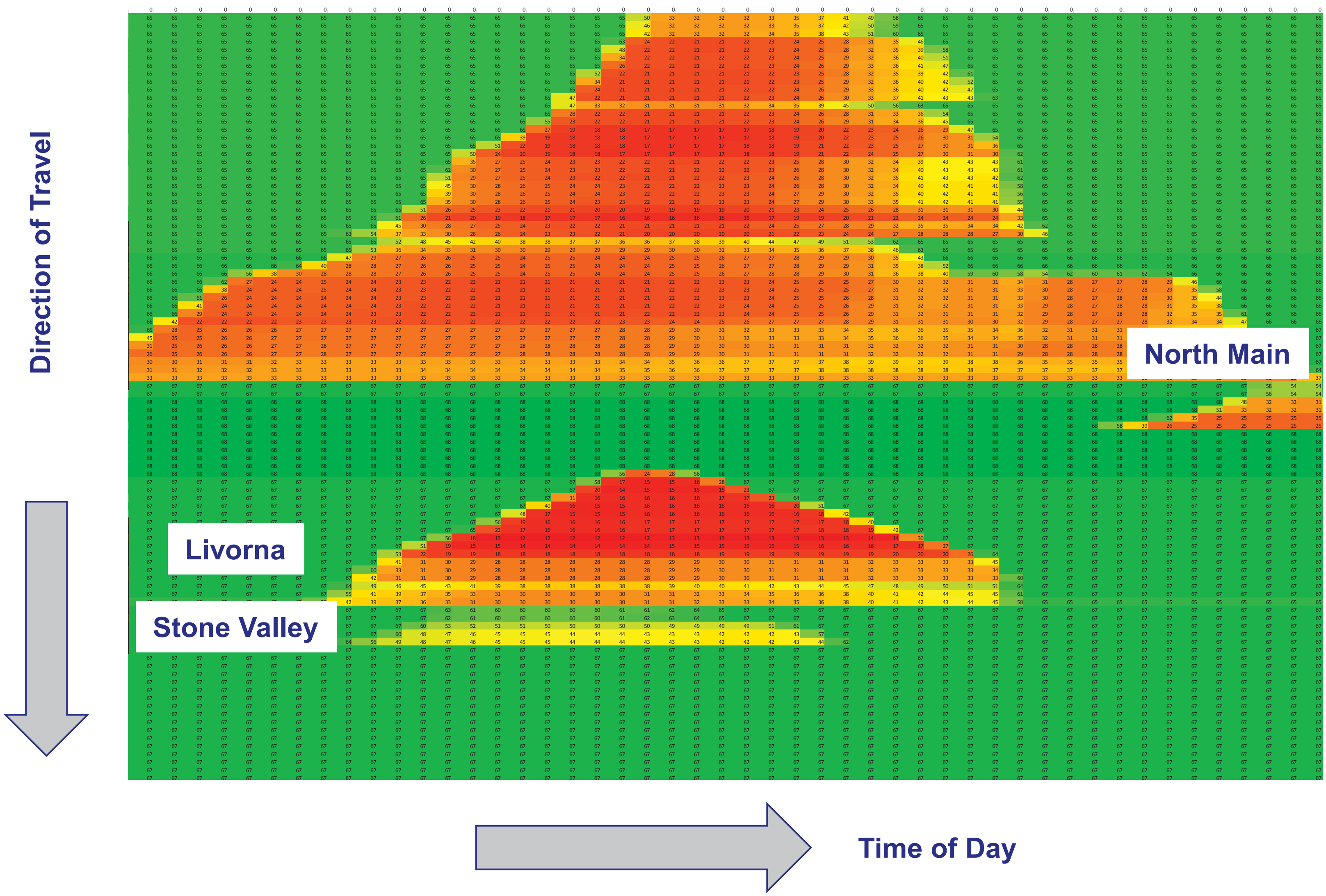


Exhibit 9-42: Southbound AM Peak Period Scenario 2025 Scenario 2B TOPL Speed Contour Plot

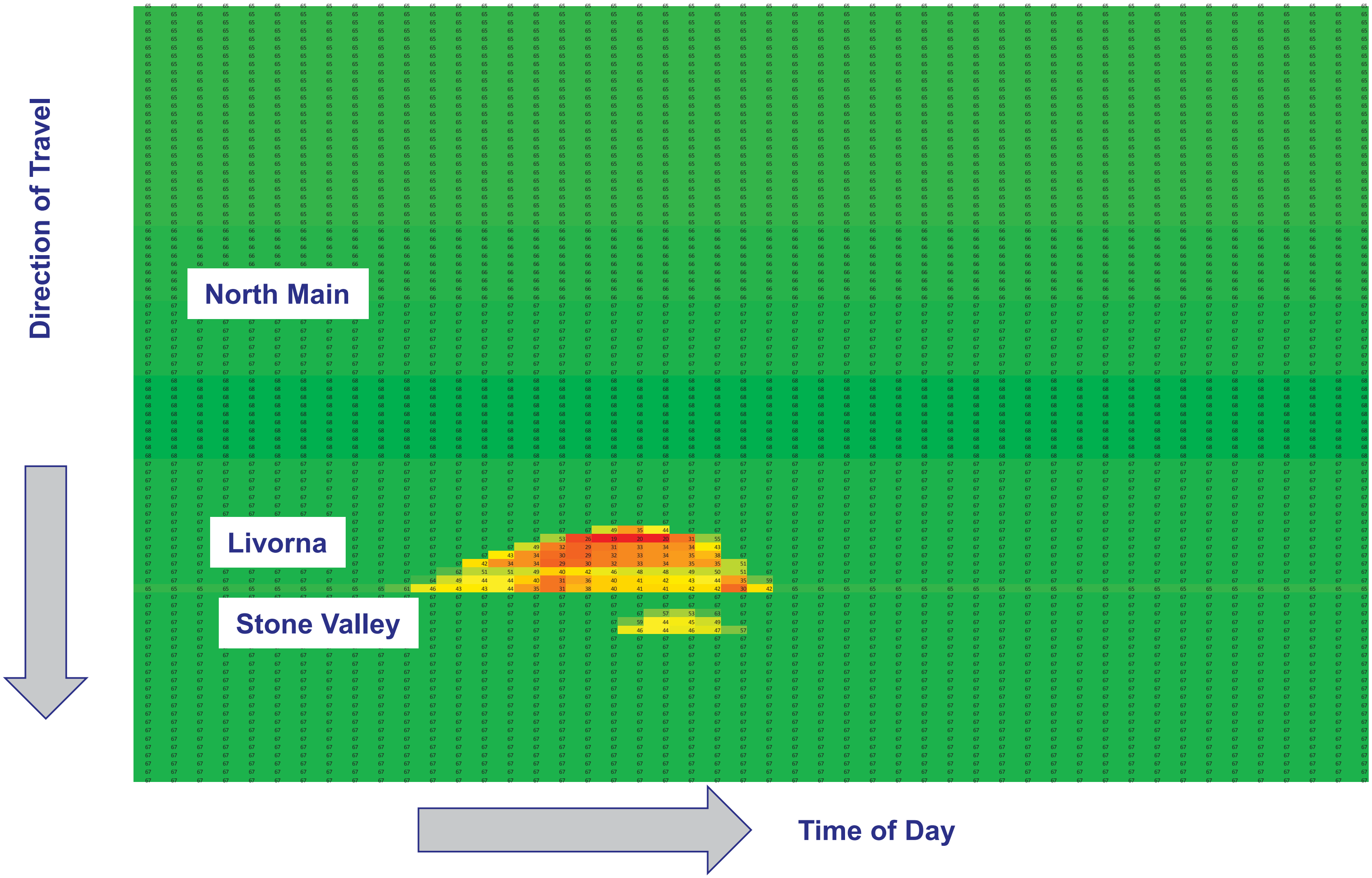


Exhibit 9-43: Southbound AM Peak Period Scenario 2025 Scenario 3 TOPL Speed Contour Plot

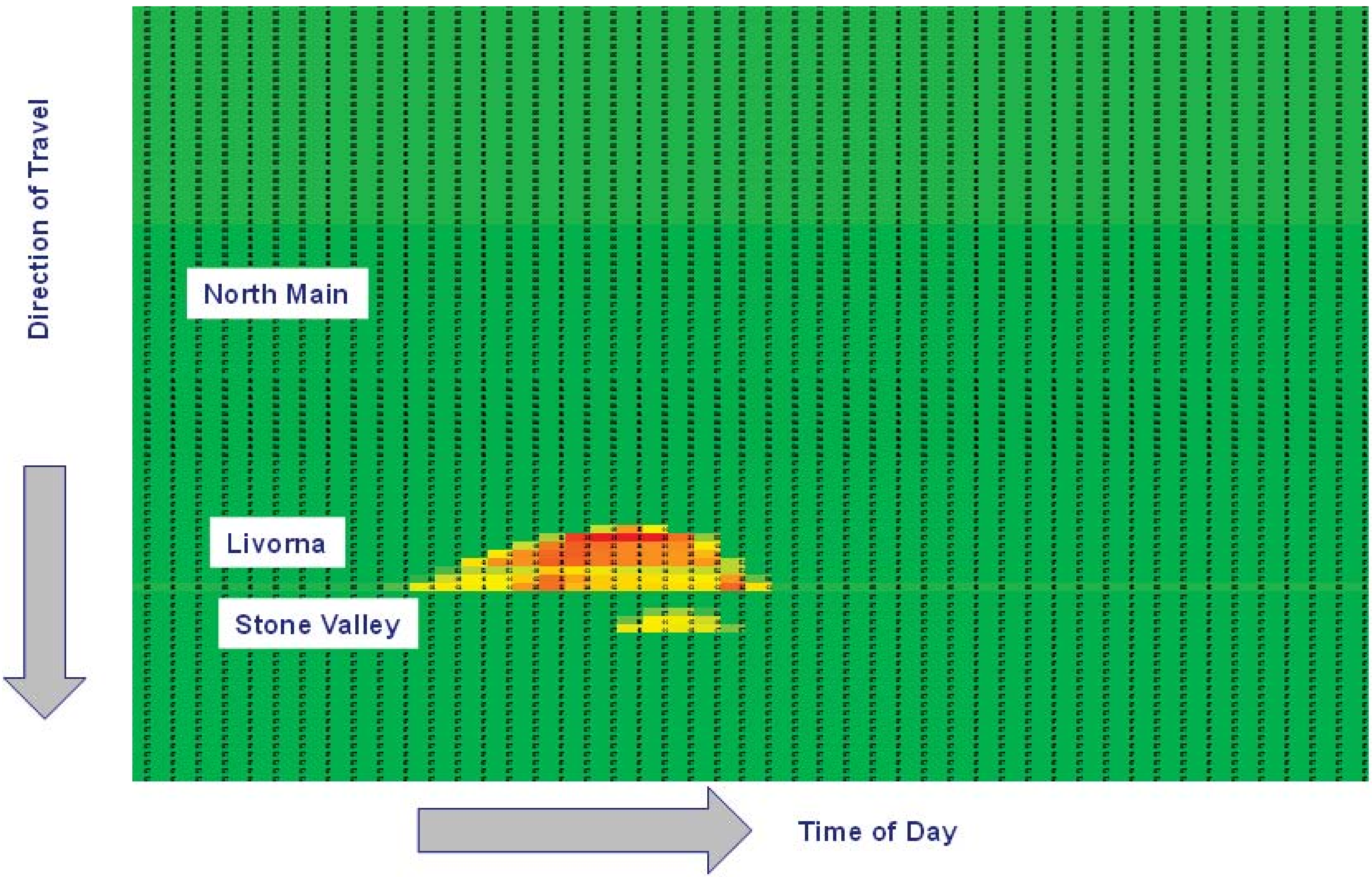
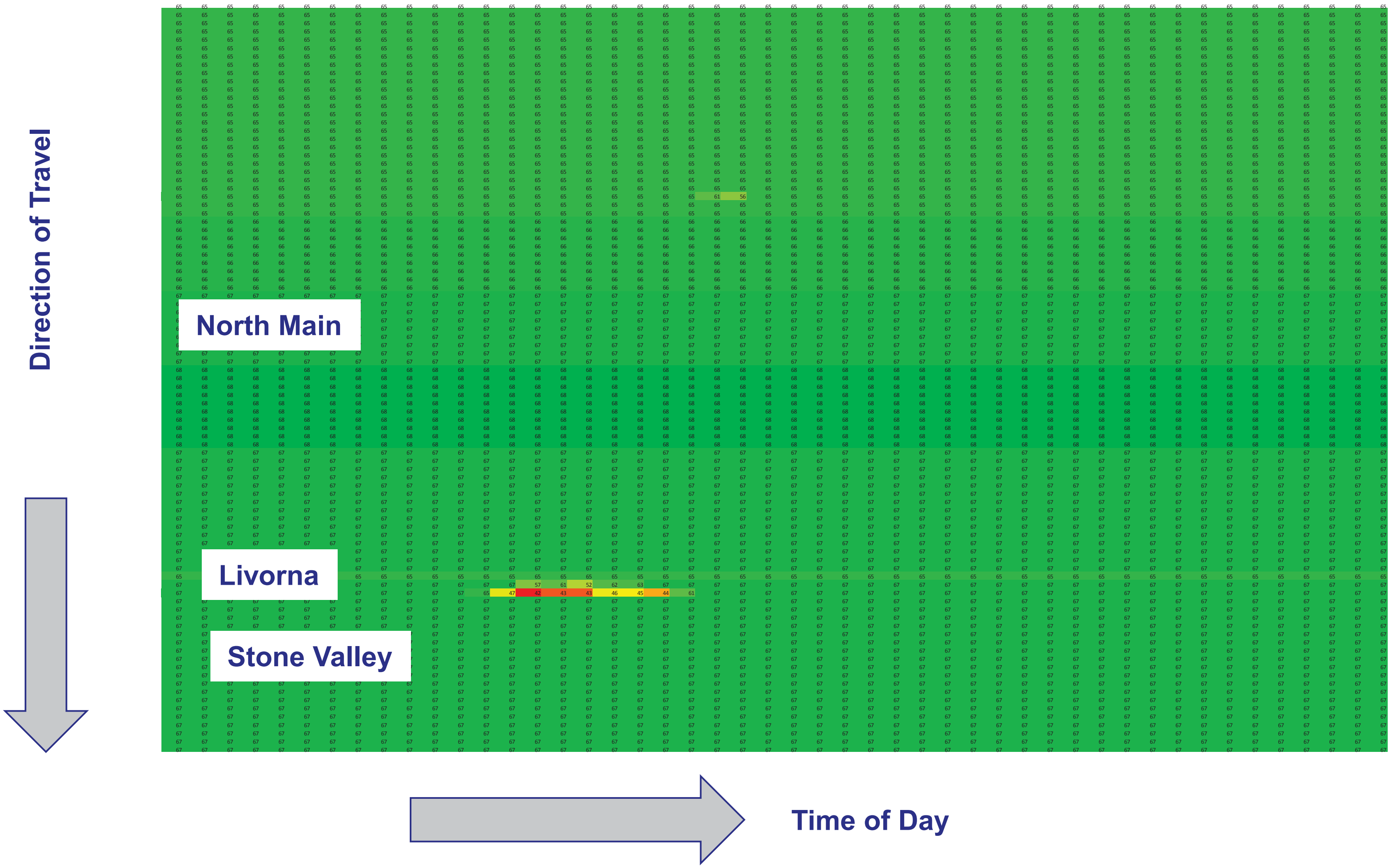


Exhibit 9-44: Southbound AM Peak Period Scenario 2025 Scenario 4 TOPL Speed Contour Plot



INCIDENT MANAGEMENT IMPROVEMENT SCENARIO

As previously mentioned, non-recurrent delay due to incidents and other special circumstances can account for as much as 50 percent of congestion in urban corridors. Improved incident management can alleviate some of that congestion. TOPL was used to evaluate the impact of improved incident management.

The model was used to simulate an accident that leads to a lane closure. The accident was placed around Rudgear Road in the northbound direction during the PM peak period. It was assumed that the lane closure would last 45 minutes. Then, the same accident was simulated with only a 20-minute lane closure. The difference between these two scenarios reflects the potential of improved incident management.

Exhibit 9-45 shows the results of this analysis. Improvement in clearing this single accident would reduce delay by almost 70 percent (147 hours versus 475 hours). If such improvements can be achieved for many or most of the collisions on the I-680, the aggregate reductions would be significant. Such improvements can be achieved through better incident verification, clearance, and re-routing.

Exhibit 9-45: TOPL Incident Management Improvement Results

	GP_Delay	HOV_VMT	HOV_VHT	HOV_Delay	Ramp_Delay	Total_Delay
20 minute lane closure	41	299,767	4,388	0	106	147
45 minute lane closure	344	299,772	4,401	10	122	475
Difference	(303)	(4)	(13)	(10)	(16)	(328)

10. CONCLUSIONS ON STRATEGIES

This section summarizes the conclusions and recommendations of the I-680 CSMP based on the analysis presented in this report. Note that many of these conclusions are based primarily on the results of benefit-cost analyses using the CCTA travel demand model. Caution should always be used when making decisions based on modeling alone since project selection and programming are based on a combination of regional and inter-regional plans and needs. Regional and local acceptance for a project, availability of funding, and the planning and engineering requirements are all critical for the successful implementation of a project. Exhibit 10-1 summarizes the concept facility following the completion of Scenario 5 for each segment on the corridor.

Exhibit 10-1: Concept Facility

Segment #		1	2	3	4	5	6	7	8	9	10
Post 25 Year Facility											
Facility Type		F	F	F	F	F	F	F	F	F	F
General Purpose Lanes		7 - 10	6 - 11	8 - 10	8 - 10	7 - 8	8 - 11	7 - 10	9 - 12	8 - 11	7 - 11
Lane Miles		8.0	15.6	37.9	31.9	33.4	17.2	9.4	35.4	23.2	38.0
Centerline Miles		0.9	1.7	4.6	3.9	4.2	1.7	1.1	3.2	2.7	4.3
HOV Lanes		0	0	0	0	0	0	0	0	0	0
HOT/Express Lanes		0	1	2	2	2	1	1	2	2	2
BRT Lanes		0	0	0	0	0	0	0	0	0	0
Toll Lanes		0	0	0	0	0	0	0	0	0	10
Auxiliary Lanes		65%	84%	100%	89%	100%	32%	26%	23%	63%	28%
Passing Lanes		0	0	0	0	0	0	0	0	0	0
Truck Climbing Lanes		0	0	0	0	0	0	0	0	0	0

The I-680 CSMP represents the second generation of CSMPs and includes the testing of Caltrans' SMF principles, the integration of Complete Streets into corridor planning, and an evaluation of a new traffic simulation tool in TOPL. Conclusions related to the new aspects of this CSMP include:

- It is premature to make specific conclusions related to TOPL since the tool is still being developed and improved as a result of this study. It is anticipated that this report will be updated once TOPL results have been produced and vetted. The TOPL results will also include the evaluation of ramp metering impacts on the corridor.
- The SMF principles, place types, and performance measures were incorporated into this CSMP planning process. The SMF principles were reflected in the corridor objectives as well as the performance metrics. The SMF Place Types were applied. However, given that Priority Development Areas (PDAs) were recently defined by the Regional Transportation Plan (RTP)/Sustainable Community Strategy (SCS) adopted by MTC, subsequent corridor studies, like this I-680 CSMP, can document PDAs around the corridor rather than apply the SMF Place Types. The MMLOS analysis demonstrated that the HCM 2010 methodology can be applied with limited data collection to capture the interaction among modes on parallel arterials. However, additional

resources would be needed to conduct a more detailed MMLOS analysis for the entire corridor, and such an analysis should include stakeholders to select locations for study.

- The Complete Streets analysis was very useful and identified specific areas for potential improvements that were not included in previous CSMPs. In fact, it is strongly recommended to include similar or even more detailed analysis for corridor studies in the future.

The following specific conclusions and recommendations are based on the results of the analyses presented herein:

- To ensure that traffic conditions on the corridor are continually monitored to track changes in performance, it is recommended that Caltrans continues to expand freeway detection along the corridor and to identify additional opportunities for expanding traffic operating systems (TOS) along I-680.
- All scenarios tested show benefit-cost ratios greater than or equal to 1.0, except for Scenario 3 (which primarily benefits the SR-4). This indicates that most bundles of projects appear to have positive impacts on the corridor.
- Scenarios 1 and 2 are short-term scenarios that are planned to be implemented in the next few years. Of these two scenarios, Scenario 1, the extension of the Express Lanes to Livorna Road and the construction of the Crow Canyon Road/Sycamore Valley Road auxiliary (which was recently completed), are expected to produce significant travel time savings on both the freeway facility and on local arterials in the San Ramon and Danville areas.
- Scenario 2B (ramp metering), which was only tested with TOPL relieves almost all remaining congestion after the first phase of the Express Lanes project is completed. However, several ramps will need to be expanded to avoid spillage into local roads.
- Even with Scenarios 1 and 2 (including 2B), congestion will return in the future and will be greater than it is today without additional improvements.
  Scenario 3 produces the lowest expected benefit-cost ratio (0.1), but the SR-4 interchange improvements may provide benefits along SR-4 that could be higher than estimated in the 2-mile buffer around the I-680 freeway interchange. The direct access ramp may produce increases in local, arterial traffic adjacent to the proposed ramp, but will reduce traffic volumes at other locations.
- Scenario 4 shows a high benefit-cost ratio of 6.8 to 1.0. This scenario constructs relatively low-cost, auxiliary lanes in the southern part of the corridor extending to the Alamo area, where they currently do not exist. This draws traffic off of local arterials and improves flows on the I-680.
- Scenario 5 is a sketch-level, 1.5 percent VMT reduction strategy using the 605-mile bicycle and pedestrian development, outlined in the 2009 Contra Costa County Comprehensive Bicycle Plan, as the basis for the analysis. This high-level assessment should be further refined in the future, using more updated cost data based on more detailed planning. It can also be used as a proxy for other VMT reduction strategies.
- TOPL evolved significantly over the study period and still requires work related to its user interface, documentation, training, and some technical areas such as the split-ratios assumed and the improvement of its merging and weaving analysis. A user group has been assembled to assist in completing this work. In the end, it will be imperative for Caltrans and its stakeholder agencies to be able to use this tool independently.

Future improvements for other parallel or connecting routes as well as supporting transit, bicycle/ pedestrian, and land use strategies that had been incorporated into the CCTA 2030 constrained travel demand model have been captured in the I-680 CSMP traffic analysis. The CSMPs and Transportation Concept Reports (TCRs) for other connecting corridors have outlined strategies for future improvements that should be considered when implementing the I-680 scenarios. These other identified strategies are summarized in Exhibit 10-2.

Exhibit 10-2: Connecting Corridor Strategies

CSMP/ TCR	Short-Term	Long-Term
I-580 East CSMP (2010)	-Increase ramp meter capacity at San Ramon/Foothill Road on ramp -Increase storage capacity for metered on-ramp at Hacienda to EB I-580 -Install ITS Improvements in corridor including implementation corridor including freeway to freeway connectors at I-680/I-580 interchange -Improve EB and WB HOT lane operations between Santa Rita/Tassajara and First Street -Construct separate off-ramp WB I-580 to access SB I-680 SB loop ramp	-Extend Single HOT lanes: -WB between I-680 and Redwood Road -EB between Redwood Road and Hacienda -Improve operations of HOT lanes WB between Santa Rita and I-680 -Construct Direct Ramp I-580 WB to I-680 SB - w/mixed flow lanes plus 1 HOT lane -Add HOT lanes both directions to SR-84 between I-580 and I-680 -Reconstruct interchanges: -San Ramon/Foothill Road Hacienda Drive Interchange -Widen SR-84 to 4 lanes divided expressway I-680 to Isabel Avenue to Stanley (off loads I-680/I-580 Interchange) -Restrict I-580 over Altamont pass to 8 mixed-flow lanes (4 each direction)
SR-4 CSMP (2010)	- Implement ramp metering WB between SR-160 and I-680 - Implement ramp metering EB between Alhambra Blvd and Willow Pass Rd - EB/WB Activate existing ITS installations that currently are not fully operational - EB/WB Fill gaps in the current and programmed ITS installations as needed	
SR-24 CSMP (2010)	-Activate existing ITS installations that currently are not fully operational -Fill gaps in the current and programmed ITS installations as needed -Implement ramp metering EB/WB between Caldecott Tunnel and I-680 -Add EB HOV lane from St. Stephens Drive interchange to the I-680 interchange -Add WB HOV lane from I-680 to the Caldecott Tunnel	
SR-242 TCR (2011)	-Improve TOS coverage	

The Contra Costa I-680 CSMP corridor will evolve operationally by incorporating ramp metering, priced managed lanes, and auxiliary lanes in the short-term that will continue to provide long-term benefits including reducing pressure on local arterials and streets. The Contra Costa I-680 CSMP also identified opportunities for implementation of Complete Streets along the corridor, whenever feasible.

It is important to stress that CSMPs should be updated on a regular basis, and these new efforts should be advanced in future efforts. The continual updating of the CSMP is particularly important since traffic conditions and patterns can change over time and differ from current projections. After projects are delivered, it is also useful to compare actual results with ones estimated in this document so that models can be further improved.

Appendix A: Pilot Area 1: Complete Streets Assessment using HCM 2010

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MEMORANDUM

Date: May 8, 2013 Project #: 12383

To: Chris Ratekin
Caltrans - Planning
P.O. Box 942874, MS #32
Sacramento, CA 94274

From: Alice Chen / Amy Lopez

Project: Caltrans Smart Mobility Framework - PO# 2660-2212000748-2

Subject: Pilot Area 1: Complete Streets Assessment using HCM 2010 – Analysis Results

INTRODUCTION

This memo presents the results of our Complete Streets Assessment of level of service (LOS) for transit, bike, and pedestrian modes as part of the implementation of the Smart Mobility Framework (SMF). Our approach for the Complete Streets Assessment was presented in a memo dated January 23, 2013, and our method to select segments for analysis was presented in a memo dated March 10, 2013. In addition to discussing the results of our analysis, this memo provides a preliminary discussion of issues confronted as part of the analytical process.

DATA NEEDS AND AVAILABILITY

2010 Highway Capacity Manual Methodology Data Needs

As discussed in earlier memos, the application of the 2010 *Highway Capacity Manual* (HCM) multimodal level of service (MMLOS) methodology requires additional data when compared to traditional vehicle LOS methodologies. Table 1 outlines data necessary for an MMLOS analysis. Analysis of MMLOS using HCM 2010 methodology can be achieved through data collection in the field, recommended default values, and online resources such as Google Earth or Maps.

Table 1: Data necessary for multimodal LOS analysis

Physical Characteristics and Geometry
• Number of lanes, access points, right turn islands, curb presence, and continuous barriers
• Lengths and/or widths of: median, lanes, parking, sidewalk, buffer, etc.
• Bus stops, shelters, benches, near-side
• Speed limits
• Pavement conditions
Traffic and Signal Data
• AADT's or peak hour turning movements
• Number of RTOR and permitted lefts
• Left/Right Turn Percentage
• Parking occupancy percentage
• Pedestrian volume
• Heavy vehicle percentage
• Number of RTOR and permitted lefts
• K, D, and peak hour factors
• Through adjusted saturation flow rate
• Cycle lengths
• g/C ratio for the through movement
• Pedestrian walk time
• Arrival types
Transit Data
• Frequency (headways)
• Load factor (crowdedness)
• Bus on-time performance (reliability)
• Scheduled speed
• Average passenger trip length

Available data utilized

Several types of data were collected as part of the CSMP Complete Streets effort. Those data utilized by KAI were intersection peak-hour counts for the downstream signalized intersection of each study segment. In some cases, the CSMP data collection effort provided intersection peak-hour counts for additional signalized intersections along the study segment. In those cases, the provided counts were incorporated into the analysis. In addition, the fact sheets prepared by Nelson/Nygaard were used for identifying segments for HCM analysis as well as a starting point for the geometric design data.

Additional data collected

Several additional data were necessary in order to conduct MMLOS analysis along the proposed segment. With sensitivity to the available budget for this data collection and greater analysis effort, and based on experience applying the 2010 HCM MMLOS methodology, KAI identified certain data to collect and other data to address with professional assumptions.

KAI collected the following data:

- Number of lanes
- Number of access points
- Number of right turn islands
- Curb presence
- Presence of continuous barrier
- Lengths and/or widths of: median, vehicle lanes, bicycle lane, on-street parking, sidewalk, and buffer area
- Bus stops, shelters, benches, presence on near side of intersection
- Speed limits
- Scheduled speed of transit
- Frequency of bus arrival (headway)

Assumptions for select data inputs

- Auto speed: half posted speed limit – This negates the need for signal timing data as the mean speed is assumed rather than calculated. In previous studies, we found that the mean speed of autos along a segment is approximately half the posted speed limit.
- Transit speed: calculated based on distance and time between scheduled stops
- Of all right turns, percent made on red: 10% (only where no channelized right turn lane exists)
- Of all left turns, percent as permitted lefts: 10% (only where left turns are permitted)
- On-street parking occupancy: 20%
- PHF: 0.90
- Bus on time percentage: 90%
- Bus Load Factor (crowdedness): 80%
- Heavy vehicle percentage: 2%
- Pavement condition: type "3" was used to reflect a smooth ride for autos and exhibit few, if any, visible signs of surface deterioration.
- K and D factors: no assumptions were made because peak-hour volumes were available.
- Pedestrian walk time was based a walking speed of 3.5 feet/second.
- Pedestrian volume was omitted from the analysis.

RESULTS

The 2010 HCM MMLOS methodology evaluates roadways in several parts. They are named and defined as follows:

- Intersection – the intersection of two or more roadways; diameter of intersection is the distance between the stopbar for the direction of analysis approach and either the nearest side of the opposing crosswalk or the opposing stopbar in the absence of a crosswalk.
- Link – the portion of roadway between two consecutive signalized intersections
- Segment – a link and its downstream intersection
- Facility – two or more consecutive segments

Segment LOS combines the intersection and link LOS scores and includes some additional factors, such as the number of access points along the right side of the road. The methodology does not analyze transit service at the intersection or link levels; it only analyzes transit LOS at the segment level.

The results of KAI's analysis show a range of levels of service for alternative modes along the study segments. Table 2 below lists the segments included in the analysis.

Table 2: Analysis Segments

Arterial	Community	From/To	Analysis Period	Analysis Direction
Alcosta Blvd	San Ramon	Norris Canyon Terr/ Crow Canyon Rd	PM	Northbound
Buskirk Ave	Pleasant Hill	Hookston Rd/ Oak Park Blvd	AM	Southbound
California Blvd	Walnut Creek	Lacassie Ave/ Ygnacio Valley Rd	PM	Northbound
Danville Blvd	County	Cedar Ln/ Stone Valley Rd	PM	Southbound
Diamond Blvd	Concord	Willows Shopping Center/ Willow Pass Rd	PM	Southbound
Pacheco Blvd	Martinez	S Buchanan Cir/ Center Dr	AM	Southbound
Railroad Ave	Danville	Church St/ Hartz Ave	AM	Northbound

Alcosta Boulevard, PM peak, Northbound Direction

Alcosta Boulevard forms a T-intersection with Crow Canyon Road. It does not have a through movement, but it does have a through crosswalk. Bicycle LOS at the intersection level cannot be directly analyzed in the absence of a through movement; however, the presence of a through crosswalk permits pedestrian LOS analysis at the intersection level. This segment does not have transit service in the direction of analysis, so transit automatically has LOS F.

Table 3: LOS results for Alcosta Boulevard – Norris Canyon Terrace to Crow Canyon Road

	Intersection		Link		Segment	
	Score	LOS	Score	LOS	Score	LOS
Transit						F
Bike			2.48	B		
Ped	3.34	C	4.00	D	4.33	E

Buskirk Avenue, AM peak, Southbound Direction

Buskirk Avenue does not have a sidewalk along the west side of the street, which is adjacent to a chain-link fence that prevents access to I-680. The west side of the street is the side analyzed for the southbound movement because this direction carried more traffic during the peak hour. The methodology assumes pedestrians will walk in the street when no sidewalk is present. This condition has a negative impact on pedestrian LOS at the link and segment level. The transit headway is one (1) bus per hour, which negatively affects the transit LOS on this segment.

Table 4: LOS results for Buskirk Avenue – Hookston Road to Oakpark Boulevard (Coggins Drive)

	Intersection		Link		Segment	
	Score	LOS	Score	LOS	Score	LOS
Transit					5.59	F
Bike	3.94	D	4.89	E	4.20	D
Ped	2.65	B	6.00	F	4.92	E

California Boulevard, PM peak, Northbound Direction

The results for California Boulevard indicate a desirable LOS for all alternative modes along the segment. This is due to the presence of a bike lane, a sidewalk with an effective width of six feet, low speed limit (25 MPH) and therefore low mean speed of vehicles, zero access points along the right side of the road for the direction of analysis, and high frequency transit service (four buses per hour).

Table 5: LOS results for California Boulevard – Lacassie Avenue to Ygnacio Valley Road

	Intersection		Link		Segment	
	Score	LOS	Score	LOS	Score	LOS
Transit					2.25	B
Bike	3.01	C	2.29	B	3.44	C
Ped	2.81	C	3.18	C	2.59	B

Danville Boulevard, PM peak, Southbound direction

Danville Boulevard between Cedar Lane and Stone Valley Road has a northern portion without a sidewalk and curbs for the southbound direction. The southern portion of the study section of the road has a sidewalk and curbs in the southbound direction. The study segment was divided into two analysis segments to capture the difference between absence and presence of sidewalk and curb along the road. Intersection LOS cannot be provided for the northern segment because it does not have a downstream intersection. In essence, that segment terminates mid-block approximately where the sidewalk and curb begin.

Table 6: LOS results for Danville Boulevard – Cedar Lane to Stone Valley Road

	Intersection		Link		Segment	
	Score	LOS	Score	LOS	Score	LOS
Transit					3.79	D
Bike			3.02	C	3.56	D
Ped			5.25	F	3.93	D
Transit					3.59	D
Bike	3.21	C	2.74	B	4.49	E
Ped	2.04	B	4.03	D	2.67	B

Diamond Boulevard, PM peak, Southbound Direction

The analysis shows that all pedestrians are well-accommodated along the study segment of Diamond Boulevard. This is due to the presence of a buffer between the sidewalk and road, only one access point on the right side of the road for the direction of analysis, and a moderately low speed limit (35 MPH) that leads to a low mean speed (approximately 17 MPH). Bicycle LOS is poor because no bike lane is present. Transit LOS is poor as a result of low bus arrival frequency (1.33 buses per hour or one bus every 40 minutes).

Table 7: LOS results for Diamond Boulevard – from Willows Shopping Center to Willow Pass Road

	Intersection		Link		Segment	
	Score	LOS	Score	LOS	Score	LOS
Transit					4.15	D
Bike	4.15	D	4.44	E	4.43	E
Ped	3.18	C	3.11	C	3.16	C

Pacheco Boulevard, AM peak, Southbound Direction

The LOS for each mode along Pacheco Boulevard indicates that each mode is accommodated on the segment. The unusual shift from LOS A and B for bicycles at the intersection and link levels, respectively, to LOS D for the segment can be attributed to the number of commercial driveways per mile along this short segment. The factor for number of access points per mile is not introduced into the LOS calculation until the segment level. This segment has five (5) access points within less than half of a mile (0.4 mi.).

Table 8: LOS results for Pacheco Boulevard – S. Buchanan Circle to Center Drive

	Intersection		Link		Segment	
	Score	LOS	Score	LOS	Score	LOS
Transit					4.06	D
Bike	1.92	A	2.13	B	3.70	D
Ped	2.45	B	2.66	B	2.47	B

Railroad Avenue, AM peak, Northbound Direction

The results for Railroad Avenue indicate that pedestrian amenities and conditions are adequate along the study segment. A bicycle LOS for the intersection, and therefore the segment, cannot be provided because the downstream intersection does not have a through movement. Transit LOS is low primarily due to the frequency of transit service: only one (1) bus per hour. Like Pacheco Blvd., the Railroad Avenue segment experiences a drop in pedestrian LOS at the segment level because the segment has 14 access points along just under half of a mile (0.45 mi.). Were the methodology able to analyze the downstream intersection for bicycle LOS and then calculate the bicycle LOS for the segment, that mode likely would also experience a drop in LOS at the segment level as a result of the high number of access points.

Table 9: LOS results for Railroad Avenue – Church Street to San Ramon Valley Boulevard

	Intersection		Link		Segment	
	Score	LOS	Score	LOS	Score	LOS
Transit					4.86	E
Bike			1.83	A		
Ped	2.13	B	2.08	B	2.35	B

LESSONS LEARNED

Some of the challenges in using the HCM 2010 methodology as a performance measure and possible ways to address in future applications of the 2010 HCM MMLOS methodologies include the following:

- MMLOS is more data intensive than the traditional vehicular LOS analysis, even with making assumptions for some of the less critical inputs. Application of MMLOS methodologies to planning-level analyses, such as this effort, would benefit from standard defaults or assumptions to off-set the data requirements.
- The methodology does not handle T-intersections. Professional judgment must be used to accommodate conditions of T-intersections.
- The individual segments selected from the study facilities are of varying lengths, which may diminish the validity of across-the-board comparison of MMLOS from one parallel arterial to another.
- Because the MMLOS analysis using available count data and did not have funds to collect additional traffic counts, the analysis was limited to select links tangent to the intersections for which count data was available. This may have limited our ability to select the best segments to represent the longer facility. For example, tour analysis covered a segment that happens to have a disproportionately high number of access points on the right side, which has a strong effect on bicycle LOS.
- Some of the parallel arterials identified by the CSMP team have notably different features in the northbound and southbound directions. For example, Buskirk Avenue has a sidewalk along only one side of the road, and Alcosta Boulevard only has transit service in one direction. By selecting only one direction of analysis, the results may not be as well representative of the level of service along the facility as we had hoped when planning our approach to conduct our analysis. Future efforts for parallel arterials should consider analysis of both directions, which would not necessarily double the costs, but would be more representative of the facility.
- As is commonly understood, the results of one's analysis can only be as good as the data used. For at least one location, the available count data was incomplete, eliminating the possibility to analyze certain directions along certain segments connected to that intersection.

Appendix B: Caltrans District 4 Complete Streets Guidelines

DRAFT (3/28/11)

Preliminary Guidance on Incorporation of Complete Streets Issues in Caltrans System Planning Documents

Inventory of Infrastructure

Bicycle Infrastructure

Conventional Highways:

The collection of data on the location of class 2 bicycle lanes, designation of class 3 bicycle routes[1], shoulder width on shared roadways, and the presence of shoulder rumble strips on state highways, including the estimated postmile and/or crossroad for the starting and ending points, needs to be required. The shoulder width on shared roadways should be categorized as a) more than 4 feet, b) less than 4 feet, c) varying. This inventory can be done using the photolog, which shows postmiles, or by driving the route and using the vehicle's trip odometer to estimate the distance from the last known postmile.

If a continuous bicycle path (class 1) parallels the state highway within a quarter mile, then its approximate location, width and starting and ending points should also be recorded.

Freeways and Expressways:

Freeway and expressway segments where bicycling is prohibited need to be recorded with postmiles and on- and off-ramps indicating the beginning and end of the segment. In addition, the location of the *major parallel through-route*, and whether it is a shared roadway, is designated as a class 3 bicycle route, has class 2 bicycle lanes, or is a class 1 bicycle path, needs to be recorded. This should include the starting and ending point of the parallel route and the locations where its classification changes or, on a shared roadway, where the shoulder width changes significantly, expressed in terms of the estimated distance from the nearest crossroad.

In order to assess whether an interchange with local roads/conventional highways meets the needs of bicyclists, some basic information needs to first be recorded. This includes information on the role/importance of the over-/undercrossings in the overall local/regional bicycle network, the location of shoulders and bicycle lanes, and the location of dedicated bicycle/pedestrian over-/undercrossings. Additional information to record includes the location of freeway ramp entrances and exits with large corner radii, where free entries and exits are located, and whether bike pockets have been provided to designate the space for cyclists between the rightmost through-lane and right-turn only lanes at freeway entries. To make the recording of corner radii more manageable, the radii could be broken down into ranges, such as <25 feet, 25-35 feet, 35-50 feet, 50-75 feet, >75 feet. If this is too technical for staff to

[1] The problem with the class 3 designation is that is does not say anything about the physical condition of the roadway as there are no minimum requirements for designating a class 3.

do in-house, then a qualitative assessment could be made, with corner radii categorized as being small, medium or large. Also, the interchange type, as shown in Chapter 500 of the California Highway Design Manual, could be recorded as a way of indicating the size of radii and speed of traffic entering and exiting the freeway. For instance, interchange types L-3 through L-6 and L-9 through L-13 would tend to have large corner radii and free entries and exits.

Pedestrian Infrastructure

Conventional Highways:

The location of sidewalks, including the starting and ending points to the nearest cross street or estimated postmile, needs to be recorded. Sidewalk width information would also be useful, but could be optional. To make this task more manageable, the corridor could be broken down into segments, with widths within a segment expressed in terms of a single range, such as <5 feet (substandard), 5 feet, 6-8 feet, 8-10 feet, >10 feet. Also, blocks or segments could be identified where the sidewalks have obstructions leaving less than 4 feet of clear width or have been uplifted by tree roots or where the curb ramps need to be upgraded to current standards (not the specific location of each problem but simply identifying whether these problems exist within the block or segment). However, this data collection could be optional.

The location of marked crosswalks needs to be recorded. If an intersection has crosswalks marked on only certain legs, then this information should be recorded as well.

The location of shoulders where there are no sidewalks within cities, towns and on pedestrian routes to schools, including the starting and ending points to the nearest crossroad or estimated postmile, needs to be recorded. This should include the estimated postmile and/or crossroad where the shoulder width changes significantly (by 2 feet or more as estimated with a visual scan).

Freeways and Expressways:

In order to assess whether an interchange with local roads/conventional highways meets the needs of pedestrians, some basic information needs to first be recorded. This includes information on the role/importance of the over-/undercrossings in the overall local pedestrian network, the location of sidewalks and shoulders on roadway over-/undercrossings, and the location of dedicated pedestrian and pedestrian/bicycle over-/undercrossings. Additional information to record includes the location of freeway ramp entrances and exits with large corner radii, where free entries and exits are located, including if these have dual turn lanes, and where marked crosswalks are located. To make the recording of corner radii more manageable, the radii could be broken down into ranges, such as <25 feet, 25-35 feet, 35-50 feet, 50-75 feet, >75 feet. If this is too technical for staff to do in-house, then a qualitative assessment could be made, with corner radii categorized as being small, medium or large. Also, the interchange type, as shown in Chapter 500 of the California Highway Design Manual, could be recorded as a way of indicating the size of radii and speed of traffic entering and exiting the freeway. For instance, interchange types L-3 through L-6 and L-9 through L-13 would tend to have large corner radii and free entries and exits.

If the route parallel to the freeway is not a state highway, then information on pedestrian facilities on this route could be recorded, but should be optional. Instead, resources should be focused on the segments in State right-of-way where pedestrians are legal roadway users, including overcrossings and undercrossings.

Transit Infrastructure

Conventional Highways:

Transit Infrastructure comprises of three main categories which all need to be recorded. First, running way, such as transit only lanes and passenger light rail, should be recorded in terms of starting and ending point within the State Highway System. Also include whether the transit lane/rail track is located in the median or side lane. In mixed flow traffic situations, record location of transit specific features such as transit queue jump lanes.

Second, stations and bus stops need to be documented with information pertaining to location and transit stop features (should include if there is shelter and lighting, could also note items such as platform vs. sidewalk boarding, concrete buspad, sidewalk bulbout, real time transit arrival information, bike racks). Documentation should also note major transit hubs and transfer points.

Third, intelligent transport systems (ITS) and technology need to be recorded. Note if any traffic signals in corridor have Transit Signal Priority. Also document locations where automated guidance features have been installed.

Freeways and Expressways:

Regional transit service will typically travel on freeways and/or expressways for their commute routes. These regional transit routes are supported by park-and-ride facilities, transit centers, and bus stops within, or nearby, the freeway right-of-way. Transit centers and park-and-ride facilities need to be recorded in terms of owner/operator of the facility, location, transit service, and number of parking spaces (if any). A park-and-ride facility may also be considered a transit center if multiple transit routes serve the location. Bus stops need to be recorded by postmile and specific ramp location. Also record amenities such as shelter, lighting, and bike rack. Significant for bus stops within the highway right-of-way, provide description of the type of path (such as width, distance) between the bus stop and closest street sidewalk.

Operational Analysis: Identifying Deficiencies

Once this basic inventory has been completed, then deficiencies can be identified. Since the districts will likely not have the resources to do this quantitatively, a qualitative assessment could suffice. The assessment should include the following deficiency measures:

Urban/Suburban Conventional Highways and Main Street Segments of Highway:

- Bicycle lanes missing
- Sidewalks missing
- Crosswalks not marked on all 4 legs of signalized intersections
- Crosswalks not marked at unsignalized and T-intersections and mid-block locations with transit stops
- Deficiencies identified in local transit plan(s)
- Transit routes that must travel through conventional highway routes with significant travel delays.

Rural Conventional Highways:

- Lack of shoulders or presence of shoulders with sub-standard width
- Deficiencies identified in local transit plan(s)

Freeways and Expressways:

- Deficiencies identified in local and regional transit plan(s)
- Regional transit routes that must travel through freeways and expressways with significant travel delays.
- Transit centers and park-and-ride facilities where demand for parking is 90% of capacity or over.
- Lack of bicycle lanes, or presence of shoulders with sub-standard width, on overcrossings and undercrossings
- If urban/suburban or in town, or in a location planned for future development: lack of sidewalks on overcrossings and undercrossings and/or presence of large curb radii and/or free entries and exits

Freeway and Expressway Segments where cycling is permitted:

- Lack of right shoulder or presence of sub-standard shoulder width on freeway segment
- Lack of parallel through-route for cyclists

Freeway and Expressway Segments where cycling is not permitted:

- If a class 1 path is not provided or is circuitous or inconveniently located, the lack of bicycle lanes or shoulders, or presence of substandard shoulder widths, on the major parallel route.

Operational Analysis: Developing Recommendations

Once the deficiencies have been identified and listed by location, then recommendations for improvements can be made.

Conventional Highways:

Bicycle Infrastructure. Recommendations should be developed based on the identified deficiencies, nearby land uses, and the highway's designation in the local/regional bicycle transportation network. In rural locations, the need to provide shoulders or widen shoulders to improve access and safety for bicyclists should be identified. In urban and suburban locations, the need for enhanced bicycle infrastructure such as bike lanes or separated bikeways should be evaluated. Special attention should be given to intersections with right-turn only lanes where pocket bike lanes are the preferred design treatment to reduce conflicts between right-turning vehicles and bicyclists traveling straight through the intersection.

Pedestrian Infrastructure. Recommendations should be developed based on the identified deficiencies relative to the nearby land uses. In rural locations, the need to provide shoulders or widen shoulders to improve pedestrian safety should be identified. Locations in need of improved pedestrian crossing treatments, such as between rural communities and schools or other trip generators, should also be identified. Recommended treatments may include signage and high-visibility crosswalks. In urban and suburban locations, recommendations should be developed for needed improvements to infrastructure and crossing treatments. These could include recommending that sidewalks be provided where they are missing in urban and suburban locations along the corridor; that sidewalks be widened to serve land uses and pedestrian activity in key segments identified based on the intensity of lane use and observed pedestrian activity; and that treatments to shorten the pedestrian crossing distance and calm traffic, such as curb extensions, pedestrian refuge islands, and pedestrian countdown signals be provided at intersections where the pedestrian demand is high or crossing is difficult or intimidating due to the speed and volume of traffic. Uncontrolled locations (without a signal or stop control, or midblock) where pedestrian crossing improvements may be warranted can be identified based on the location of trip generators directly across from each other and the distance to the nearest signal. Recommended treatments may include curb extensions, raised medians with a channel for pedestrians, and high-visibility crosswalks. For busy, multi-lane arterials, the installation of a pedestrian hybrid beacon may be warranted.

Transit Infrastructure. All conventional highways with recurring congestion segments should be recorded in terms of what transit routes are affected. Significant intersections with the greatest delays should be examined for potential transit infrastructure enhancements. Enhancements may include transit signal priority, transit queue jump lanes, or peak period transit lanes in place of parking spaces. Such enhancements will require cooperation and coordination with transit service providers and local jurisdictions.

Freeways and Expressways:

Given the complexity of freeway interchanges with local roads/conventional highways, below are specific recommendations regarding their analysis.

Bicycle Infrastructure. All freeway interchanges with local roads/conventional highways should be recorded and categorized in terms of their need for safety and accessibility improvements to bicycle travel. One way to do this is to classify/assess interchanges in terms of their bicycle infrastructure: a.) Addresses the needs of bicyclists; b.) Requires restriping/signage; and c.) Requires reconstruction. These categories are in accordance with the "Complete Intersection" guide that could also be used a resource by system planners (but is yet to be officially released).

Pedestrian Infrastructure. All freeway interchanges with local roads/conventional highways located within urban/suburban areas or rural towns, or areas slated for development within the timeframe of the system plan, should be recorded and categorized in terms of their need for safety and accessibility improvements for pedestrians. One way to do this is to classify/assess interchanges in terms of their pedestrian infrastructure: a.) Addresses the needs of pedestrians; b.) Requires restriping and/or signage and/or corner treatments, such as curb extensions or pedestrian refuges (without determining which treatment would be employed); and c.) Requires reconstruction.

Transit Infrastructure. Similar as above, freeway and expressways with significant recurring congestion should be examined for potential transit infrastructure enhancements. Freeway and expressway transit infrastructure enhancements may include transit use of shoulders, transit ramp meter jump lanes, or commute period transit only on/off ramps.[2] Transit Centers and Park-and-Ride close to maximum capacity should be examined for expansion opportunities.

[2] D11 completed a successful demonstration project for transit use of freeway shoulders. There is currently little guidance on transit infrastructure enhancements; many of these types of improvements may need to be implemented on a trial basis.

Appendix C: Complete Streets Evaluation

1 INTRODUCTION

The following report describes a preliminary methodological approach to evaluating Complete Streets (CS) as part of a Corridor System Management Plan (CSMP) for a freeway corridor. This is followed by a reporting of the results of a pilot application of the methodology to evaluate Contra Costa County's I-680 freeway corridor. The preliminary methodology will almost certainly undergo considerable revisions by the California Department of Transportation (Caltrans) prior to using it more broadly. On the other hand, the evaluation of the I-680 corridor in this report will be incorporated into the concurrent CSMP being developed for I-680. The goal of this evaluation is to ensure that improvements to congestion issues in the corridor resulting from the CSMP also address the ability for users on foot, bicycle, and transit to safely move across and along the corridor.

BACKGROUND

As part of a limited access highway CSMP, the term "Complete Street" needs to be more broadly considered because limited access highways are by definition not "complete" streets nor will regulations allow the transformation of the freeway facility into a complete street.

Caltrans defines a "Complete Street" as:

> *A transportation facility that is planned, designed, operated, and maintained to provide safe mobility for all users, including bicyclists, pedestrians, transit riders, and motorists appropriate to the function and context of the facility.*[1]

California Vehicle Code 21960 permits Caltrans and local authorities to prohibit or restrict the use of freeways, expressways, or any portion thereof by pedestrians, bicycles or other non-motorized traffic. This prohibition must be stated in a sign at the on-ramp to the restricted roadway. There are areas where some or all of these users are permitted on a controlled-use roadway, such as areas where the road network does not provide any alternative travel routes, due to topographical, land use, or other constraints, or where these users can be safely accommodated on wide shoulders with limited off-ramps.

Source: http://www.dslretorts.com/Paladin/archives/002931.html

[1] Caltrans Deputy Directive DD-64-R1, October 2008.

According to the Highway Design Manual (Topic 116.1- Bicyclists and Pedestrians on Freeways):

> *If a freeway segment has no suitable non-freeway alternative and is closed because certain features are considered incompatible, the feasibility of eliminating or reducing the incompatible features should be evaluated. This evaluation may include removal, redesign, replacement, relocation or retrofitting of the incompatible feature, or installation of signing, pavement markings, or other traffic control devices.*
>
> *Where no reasonable, convenient and safe non-freeway alternative exists within a freeway corridor, the Department should coordinate with local agencies to develop new routes, improve existing routes or provide parallel bicycle and pedestrian facilities within or adjacent to the freeway right of way.*

2 METHODOLOGY

The following chapter describes a detailed approach to evaluating Complete Streets as part of a CSMP. This includes defining what a Complete Street freeway corridor must achieve to be considered complete as well as describing all of the elements of the streets that are to be evaluated and how to conduct the evaluation.

BACKGROUND

In recognition that most limited access highways will not allow all users to access the facility and per the guidance in the Caltrans Deputy Directive DD-64-R1, *Complete Streets- Integrating the Transportation System*; the definition of a Complete Streets *Freeway Corridor* was needed to guide the formation of an evaluation methodology. This began by developing principles that would frame what a Complete Streets freeway corridor must achieve.

Complete Streets Freeway Corridor Principles

> *A Complete Streets Freeway Corridor must allow all users access to services along the entire corridor.*
>
> *A Complete Streets Freeway Corridor must provide all users with the ability to safely and efficiently move from one end of the corridor to the other.*

Based on the guiding principles, a standard definition of a Complete Streets Freeway Corridor was developed. The standard definition of a Complete Street in the context of a limited access highway corridor developed for this methodology will include, at a minimum:

- Frequent pedestrian, bicycle, and transit accessible crossings over/under the freeway, preferably connecting to the parallel alternatives.
    - At the corridor level, the freeway can present an obstacle that prevents bicyclists or pedestrians from getting across the barrier, to reach destinations on one side of the freeway when originating on the other side.
- Parallel alternative arterial routes (or shared-use paths) on either side of the freeway with sufficient walking, biking and transit facilities.
    - The existence of a contiguous alternative route, preferably on each side of the freeway, is important for providing equitable access to facilities to non-motorized travelers traveling along the corridor. The importance of an alternate on each side is dependent on the frequency of crossings; more frequent crossings render the dual alternates less important.
- Limited obstructions to safe and convenient passage of pedestrians and cyclists at freeway ramps.
    - Freeway ramp intersections can be an obstacle for pedestrians and cyclists and they most often occur on streets crossing the freeway. The design and operation of the freeway ramp is also usually directly within Caltrans jurisdiction.
- Limited obstructions to safe and convenient access to transit centers providing alternatives to the freeway.

    - Regional transit centers provide alternatives to the freeway corridor and Caltrans can work with transit agencies and local municipalities to help ensure safe and convenient access for non-motorized users.

A selection methodology was developed to select freeway ramp intersections, transverse routes, and parallel alternatives to the freeway corridor for evaluation based on this definition for a Complete Streets Freeway Corridor. These facilities could potentially meet the needs of non-motorized users if they are safe, connected, signed, and designed to minimize conflict with vehicular traffic. The segment evaluation methodology is designed specifically to prioritize ease of moving through and across the corridor by identifying and prioritizing specific locations where improvement is needed to achieve a Complete Streets Freeway Corridor.

Following the application of the selection methodology, the study parameters are established and ready for evaluation. The evaluation methodology is primarily concerned with cataloguing important infrastructure details to identify improvement opportunities and to derive recommendations for improvements to achieve corridor Complete Streets "completeness."

SELECTION METHODOLOGY[2]

The facilities to be evaluated are selected with the goal of identifying ways for non-motorized travelers to get from one side of the freeway to the other and from one end of the freeway to the other. To break the large area of a freeway corridor into manageable units of analysis, the corridor should be divided into individual segments using exit ramps as the bounding ends. Using the exit ramps as the segment breaks, each segment is assessed independently to determine what facilities would be evaluated in greater detail. Within each segment, all of the elements identified as the minimum features for a Complete Streets Freeway Corridor must be present.

The following outlines the methodology used to select the facilities for detailed evaluation.

Crossings or Transverse Routes

For the purposes of identifying the transverse routes for evaluation, they are defined as those facilities that are:

- Transverse streets with or without a freeway ramp (over- and under-passes)
  - With a freeway ramp
    - Ramp intersection areas, specifically
      - Crossings at freeway ramps, both because they are owned by Caltrans and experience high vehicle volumes and speed zone transitions
      - Where there are potential turning conflicts with ramp traffic
  - Without a freeway interchange (over- and under-passes)
- Non-motorized crossings allowing only bicycles or pedestrians (over- and under-passes)

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[2] It is important to note that the level of analysis of this study does not permit a comprehensive Complete Street analysis as such would be done as an element of a roadway construction or reconstruction project. Data such as adjacent land uses, traffic volumes, existing use by bicyclists and pedestrians, community plans, and collisions have not been collected for this effort. This is an overview assessment of a highway corridor, where the intent is to identify roadway segments and intersections for further analysis and improvement on a broad scale while minimizing staff time and data collection efforts. Specific projects in the I-680 corridor should refer to the MTC Complete Streets Checklist at http://completestreets.mtc.ca.gov.

Parallel Routes or Alternatives

For the purposes of identifying the parallel alternatives for evaluation, they are defined as those facilities that are:

- Freeway from study end point to study end point
- Parallel streets within a half-mile of the freeway corridor that connect two transverse routes
  - The ideal being at least one on each side of the freeway
- Non-motorized paths within one mile of the freeway corridor that connect two transverse routes
  - The path can be substituted for one of the parallel streets in the case that one does not exist
- Transit centers and park and ride lots within a half-mile of the freeway corridor
  - Including the intersections connecting the transit station or park and ride lot to a freeway ramp or freeway ramp-adjacent arterial

SEGMENT EVALUATION METHODOLOGY

Once the list of facilities to be evaluated is established, the methodology for evaluating the most important Complete Streets elements of each facility type must be applied. The focus of this evaluation methodology is to identify the presence or absence of some of the most essential features that help create a more complete street. The following sections describe the features evaluated for each facility type.

Freeway Facility

The freeway is evaluated between the two segment boundary exit ramps. In rare cases, the freeway may allow bicycle use, but in most cases the freeway is simply an obstruction to the free movement along and through the corridor of non-motorized users. Within each freeway segment, the following characteristics are to be recorded as part of the evaluation:

- <u>Route designation:</u> Freeway name.
- <u>Exit 1:</u> Exit number at beginning of the segment.
- <u>Exit 2:</u> Exit number at the end of the segment.
- <u>Length</u>: The length of each segment along the highway centerline from exit to exit, measured at the center lines of the over-/under-pass streets at each bounding exit.
- <u>Vehicle over-/under-passes:</u> The number of vehicular crossings that transverse the highway in the segment, including the ramp interchange crossings.
- <u>Non-motorized over-/under-passes:</u> The number of non-motorized crossings that pass over or under the highway segment where vehicles are prohibited.
- <u>Bicycles</u>: Whether bicycles are permitted on the freeway segment, determined by looking for posted signage at on-ramp locations.

Freeway Ramp Intersections

The bounding exits each have at least one ramp intersection with the local streets or arterials. The ramp intersections pose significant potential obstacles for the safe and convenient movement of non-motorized travelers. To determine the adequacy of the ramp intersection design for serving non-motorized users, the following characteristics were evaluated:

- Exit: Exit name and number.
- Ramps: Count of all on- and off-ramps in the interchange area. In some cases, ramps may be on several adjacent streets.
- Free-flow ramps[3]: Number of free-flow ramps in the interchange area.
- Crosswalks: Count of the number of marked crosswalks at the intersections where the ramps intersect with the surface street network. Marked crosswalks are generally painted with high-visibility or traditional markings, but can also include paving treatments that stand out from the roadway surface.
- Unmarked crosswalks: Count of the number of permitted crossings without markings that lead to a sidewalk or walkway in the ramp intersection.
- Unserved crossings: Count of the number of crossings prohibiting pedestrian crossing with a sign and/or physical barricade.
- Median or refuge islands: Count of the medians and pedestrian refuge islands in crosswalks in the ramp intersection.
- Whether exit is connected to a freeway over/under-pass: Yes or no response.
- Overpass: Yes or no if the crossing is a bridge over the freeways.
- Park & ride: Whether there is a Park & Ride station within ¼ mile[4] of freeway access.

Crosswalks

The following details were collected for every permitted crosswalk in the ramp intersection, whether it was marked or unmarked. Prohibited crossings were excluded.

- Location description: Street name and ramp direction.
- Crossing length: Measured along centerline of the crosswalk, from curb-to-curb.
- Crossing lanes: The number of moving lanes the crosswalk traverses from curb-to-curb.
- Effective turn radius: Measurement of the maximum turn radius of right turns across the crosswalk.
  - Options are small (typical of walkable urban environments), medium, large, and extra large (a large truck could turn at a reasonable speed). Examples of these turning radii curb arrangements are shown below, and should only be used for approximate reference.

[3] A ramp is considered free-flow if there are no intersection controls, including a traffic signal, or a stop or yield sign for at least one traffic lane of the ramp traffic.

[4] Distances are measured using a straight line from a ramp intersection.

- Controls: Vehicle control at crosswalk.
  - Categories are traffic signal, stop sign, yield sign, and free-flow/no control.
- Conflicts: A conflict exists when a vehicle is allowed to move through the crossing while pedestrian traffic has a walk signal or green light. This includes: left turns, right-on-red turns, free-flow ramps, and yield signs. Stop signs and signals that unambiguously prohibit all vehicle movement through the crosswalk during the pedestrian phase are considered to have no conflict.
  - Whether the crosswalk has a possible or definite vehicle-pedestrian conflict; either yes, no, or maybe. “Maybe” is included as an option because signal phasing cycles were not obtained for this data collection effort.
- Markings: Type of crosswalk marking.
  - High-visibility crosswalks are striped perpendicular to the direction that the pedestrian is walking and are commonly referred to as zebra crossings.
  - Traditional crosswalks only have two parallel lines that delineate the pedestrian crossing and are perpendicular to the direction of traffic.
  - “None” is an option for unmarked crossings.
- Pedestrian signals[5]: Whether there is a pedestrian signal for that crossing, at a signalized intersection.
- Pedestrian lighting: Whether there is lighting that is directed at the crosswalk and covers its whole length. Roadway lights can serve this purpose when located directly over the crosswalk.

[5] Whether there are pedestrian actuation controls was not collected in this study.

Roadways

Roadways are linear facilities that could be parallel routes or serve as the connections over the freeway.

- Street: Segment street name.
- Overpass: Whether the crossing is a bridge over the freeway; either yes or no.
- Cross street 1: Name of the cross-street at the beginning of the segment.
- Cross street 2: Name of the cross-street at the end of the segment.
- Length: The centerline length of the street section.
- Shoulders: A non-moving lane that is not a bike lane, in which parking is prohibited, but is wide enough to pull over a vehicle without wholly blocking the adjacent moving lane.
- Parking: A lane designated for parking that is not used as a moving lane (while it is possible for a lane to function as both a parking lane and driving lane during certain hours, for the purpose of this analysis, the two are separated).

Pedestrian Facilities

The focus of this measure is to gather information that can be easily collected and yet adequately captures the degree of safety and comfort experienced by the average pedestrian. To that end, the measures combine a broad stroke width definition and the likely proximity of vehicular traffic and pedestrians.

- Sidewalks: Facility is best characterized by one of the following:
  - *Buffered*: When a planted buffer of varying width exists between the sidewalk and curbline, such as landscaping, walls, furniture, etc.
  - *Wide curbside*: Presence of a curbside sidewalk that is at least six feet wide for the length of the segment.
  - *Narrow curbside*: Presence of a curbside sidewalk that is less than six feet wide for the length of the segment.
  - *Substandard*: Presence of a sidewalk that is less than four feet wide for the length of the segment.
  - *None*: No sidewalk is present.
- Completeness: Facility is best characterized by one of the following:
  - *Both*: There is a contiguous sidewalk on both sides of the street for the length of the segment.
  - *One*: There is a contiguous sidewalk on only one side of the street for the length of the segment.
  - *None*: There is either no sidewalk on either side of the street for the length of the segment, or the existing sidewalk is not contiguous.

Bicycle Facilities

This measure is intended to record information that is easily collected while still adequately capturing the degree of safety and comfort experienced by the average bicyclist.

- Bicycle facility: Facility is best characterized by one of the following:

  - *Cycletrack*: A bicycle facility that is separated from vehicular traffic with some sort of buffer (parking, road markings, plantings) but is not on its own fully separated right-of-way (i.e. not a greenway) present on the roadway.
  - *Lane*: A curbside lane is present that is exclusively meant for bicycles and is marked with paint.
  - *Route*: A signed bicycle route is present.
  - *Other*: Any other bicycle facility is present (shared lane markings, etc).
  - *None*: No bicycle facility is present.
- Completeness: Facility is best characterized by one of the following:
  - *Both*: There is a contiguous facility on both sides of the street for the length of the segment.
  - *One*: There is a contiguous facility on only one side of the street for the length of the segment.
  - *None*: There is either no facility on either side of the street for the length of the segment, or the existing facility is not contiguous.

Transit Service

Transit service along the parallel routes, including the presence of transit service and stations, was included to determine if the transit that is present can or should be considered for improvement.

- Parallel route: There is a bus line that runs on at least some portion of the segment in question and also stops there. This excludes express buses that do not stop along the segment.
- Stations: Predominant stop/station type. Selected based on the majority stop type for the length of the segment, of the following options:
  - *Sheltered*: A bus shelter that protects riders from the elements. Usually also includes a bench and some schedule information, but not necessarily.
  - *Improved*: A bus stop with a bench.
  - *Sign post*: A bus stop consisting of just a sign post.

Shared Use Paths

- Path name: Generally already designated (i.e. Iron Horse Regional Trail) or described by its location.
- Cross street 1: Name of the cross street at the beginning of the segment.
- Cross street 2: Name of the cross street at the end of the segment.
- Length: The centerline length of the segment.
- Path width: One of the following:
  - *Wide*: Path is at least twelve feet wide.
  - *Standard*: Path is between eight and twelve feet wide.
  - *Narrow*: Path is less than eight feet wide.

Parallel Alternatives

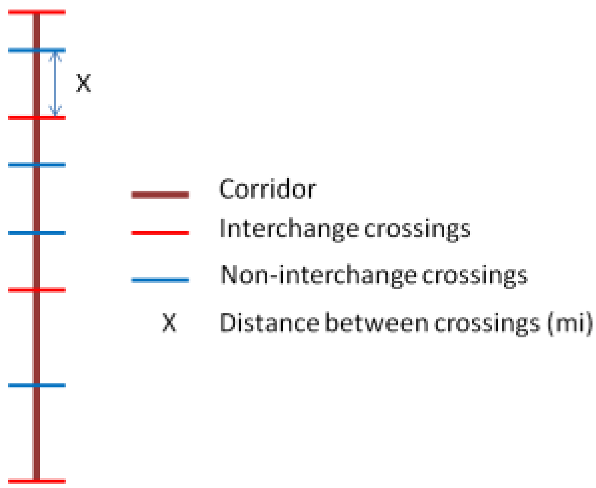
- Side A alternative: Whether there is a surface street that runs parallel to the highway on the west side of the freeway corridor in that segment.
- Side B alternative: Whether there is a surface street that runs parallel to the highway on the east side of the freeway corridor in that segment.
- Path alternative: Whether there is a non-motorized, multiuse path that runs parallel to the freeway corridor within half-mile of the freeway in that segment.
- Presence of park and ride or transit facility: Where there is a park and ride or transit facility within a quarter-mile of freeway access points in that segment.
- Presence of regional transit alternatives: Where there is regional transit service (commuter or other limited-stop service) within a half-mile of freeway access points in that segment.
- Presence of local transit alternatives: Where there is local transit service (frequent stops, all day service) within a quarter-mile of freeway access points in that segment.

Transit Centers

- Name: Name of the transit facility.
- Number of vehicle entrances and exits: A perimeter is drawn around the station area and the number of vehicular crossings is counted.
- Number of vehicle entrances and exits with pedestrian facilities: The number of such entrances and exits that have a sidewalk on at least one side of the roadway.
- Number of vehicle entrances and exits with bicycle facilities: The number of such entrances and exits that include some type of bicycle facility.
- Number of marked crosswalks at selected intersections: Marked crosswalks are generally painted with high-visibility or traditional markings, but can also include paving treatments that stand out from the roadway surface.
- Number of unmarked, permitted crosswalks at selected intersections: The number of permitted crossings that lead to a sidewalk or walkway but have no markings.
- Number of prohibited crossings at selected intersections: Crossings that specifically have a sign that says no pedestrian crossing.
- Number of medians or pedestrian refuges at selected intersections: Medians between travel lanes were counted if they were at least six feet wide. Pedestrian islands created by slip lanes were not included in this count.

SEGMENT PRIORITIZATION METHODOLOGY

In order to focus efforts most effectively, corridor segments should be prioritized to bring those segments that need more attention to the front. The most important element of Complete Streets in a freeway corridor is safe and frequent crossings—segments with distances between two crossings below the median distance between two crossings for all crossings in the corridor. A graphic of this measure is shown below:



It is also critical, although slightly less so, that there are alternative routes on each side of the corridor to reduce the burden of limited crossing opportunities. Based on the needs of bicyclists and pedestrians in a freeway corridor environment, the feature elements gathered during data collection were prioritized based on crossing frequency and presence of parallel alternatives.

As such, prioritization of segments is as follows:

1. Segments with crossing distance/frequency that is longer than the corridor median crossing distance/frequency and has either one or no parallel alternatives.
2. Segments with crossing distance/frequency that is longer than the corridor median crossing distance/frequency and has one parallel alternative on each side of the freeway.
3. Segments with crossing distance/frequency that is shorter than the corridor median crossing distance/frequency and has less than one parallel alternative route on each side of the freeway.
4. Segments with crossing distance/frequency that is shorter than the corridor median crossing distance/frequency and has one parallel alternative on each side of the freeway.

RECOMMENDED TREATMENT METHODOLOGY

While the four levels of prioritization allow for the identification of more important treatments on the corridor level, this prioritization does not identify specific treatments. The methodology for developing recommendations does not focus on prioritizing treatments but instead ranks the level of treatment needed to achieve minimal elements of a Complete Streets Freeway Corridor.

The basis for this methodology is derived from the criteria established in the *Preliminary Guidance on Incorporation of Complete Streets Issues in Caltrans System Planning Documents* developing recommendations section. According to this document, recommendations can be made in the following three categories:

A. Addresses the needs of bicyclists/pedestrians

B. Recommends restriping/signage

C. Recommends reconstruction

Ramp Intersections

The focus of data collection at the ramp intersections is designed to identify potential weaknesses in the current infrastructure and help identify what level of treatment would be recommended to meet the needs of bicycle, pedestrian and transit users. Based on the categories set forth in the *Preliminary Guidance* document above, the features collected at ramp intersections are differentiated as follows:

A. There is no "A" recommendation because the purpose of the data collection at this level is to identify improvement opportunities.

B. Recommends restriping, signage, signal phasing changes:

    a. Unmarked crosswalks, prohibited crossings, and vehicle conflicts.

C. Recommends reconstruction or infrastructure changes:

    a. Missing pedestrian lighting, signals, and crossing lanes; large or extra-large turn radii; and free flow ramps.

Streets

Street segments are evaluated based on mode, with an eye on ensuring the same three levels of recommendation noted by Caltrans in its preliminary guidance document. Criteria for street segments are as follows.

Pedestrians

A. There is no intervention recommended; the facility meets the needs of pedestrians as defined by this methodology:

    a. Continuous sidewalk on both sides with some form of separation from vehicles (wide sidewalk, buffered sidewalk, sidewalk with a shoulder or parking, or sidewalk with a bike lane, buffered bike lane, or cycle track).

B. Requires striping of shoulder or installation of landscaped buffer:

    a. Continuous narrow curbside sidewalks with no separation from vehicle traffic on both sides.

C. Requires reconstruction or infrastructure changes:

    a. Non-contiguous sidewalks or sidewalk missing from one side.

Bicyclists

A. There is no intervention recommended; the facility meets the needs of bicyclists as defined by this methodology:

    a. Continuous designated bicycle facility on both sides with some form of delineation of space from vehicles (bike lane, buffered bike lane, or cycle track).

B. Recommends striping of bike lane or buffering a bike lane or cycletrack:

    a. Any bicycle facility other than a continuous facility on both sides.

C. Recommends reconstruction or infrastructure changes:
   a. Not a likely recommendation except in the case of a path requiring the addition of pavement.

3 I-680 PILOT EVALUATION

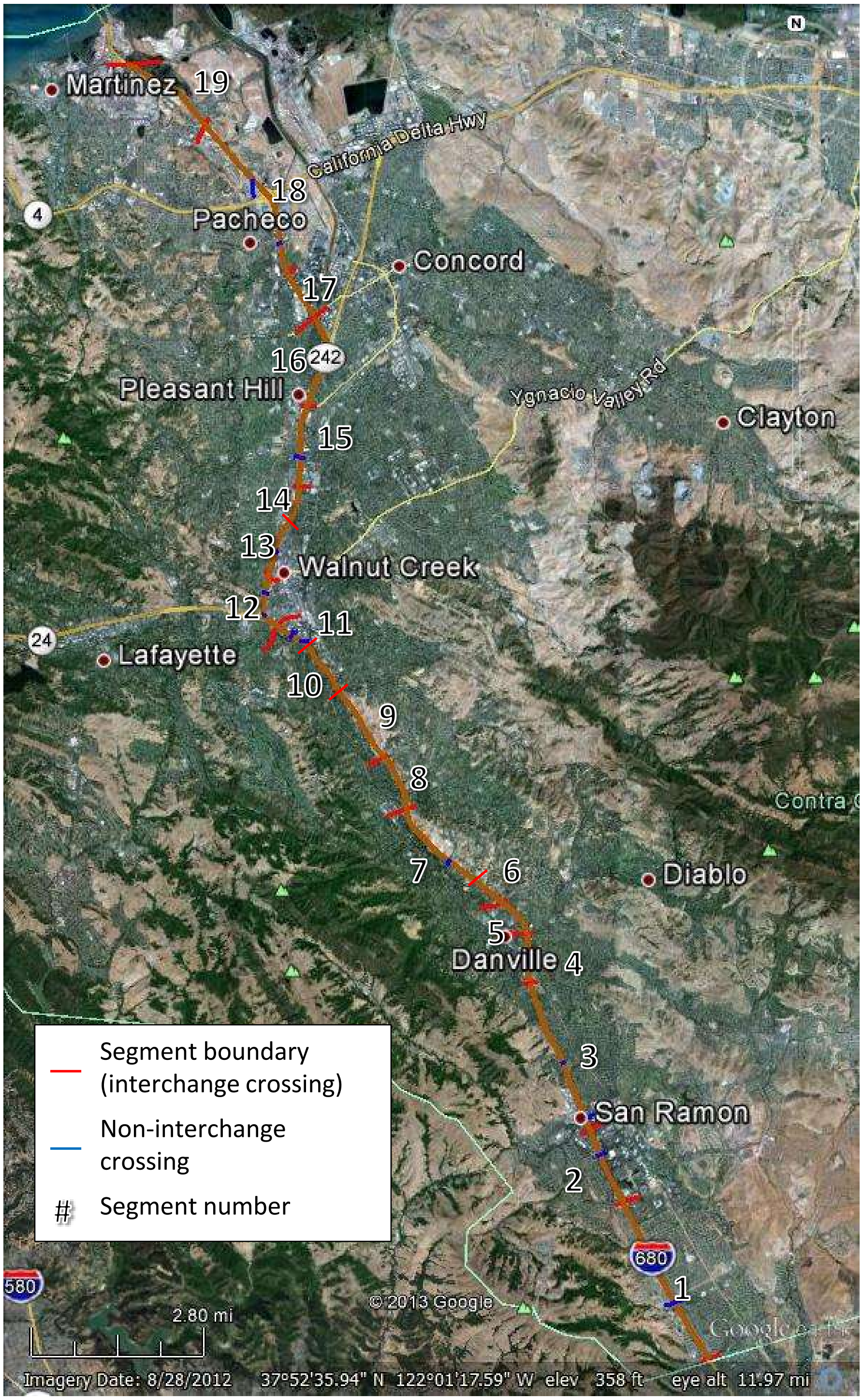
The I-680 highway corridor is 22 miles long and traverses unincorporated land and numerous municipalities, including San Ramon, Danville, Rossmoor, Walnut Creek, Pleasant Hill, Concord, Pacheco, and Martinez. For the purpose of this analysis, the corridor was divided into 19 segments, each bordered by two freeway ramp interchanges. As with all restricted use highways, I-680 presents numerous barriers to the communities it passes through, both across, as there are a limited number of crossings for each city, as well as concurrently, as the highway corridor is the only through-route traversing its exact path. Parallel streets, shared-use paths, and transit services exist for segments of the corridor, but not for the entire length of it.

Currently, no portion of the I-680 freeway corridor through Contra Costa County permits pedestrians, bicycles, or other non-motorized traffic. In lieu of direct access to this corridor, according to the Deputy Directive, Caltrans will facilitate multimodal travel by ensuring connectivity to public transit for bicyclists and pedestrians and by ensuring that the current system operations meet the needs of bicyclists, pedestrians, and transit users. The results of this process, including selecting segments for data collection, prioritization, and ranking of recommended improvements, are discussed in the following section.

DATA COLLECTION

To manage and report the large amount of data collected for this study evaluation, the data collected on each segment has been summarized in a fact sheet format (Appendix A). This method allows for a summary of features and improvement opportunities at the street segment and freeway on-/off-ramp interchange area level. For more detail on the features of each segment, refer to the raw data collection sheets in the accessory excel file contained with this document. The locations of the 19 segments, with interchange and non-interchange crossings, are shown in Figure 1.

Figure 1 I-680 Corridor with Segments and Crossings Identified

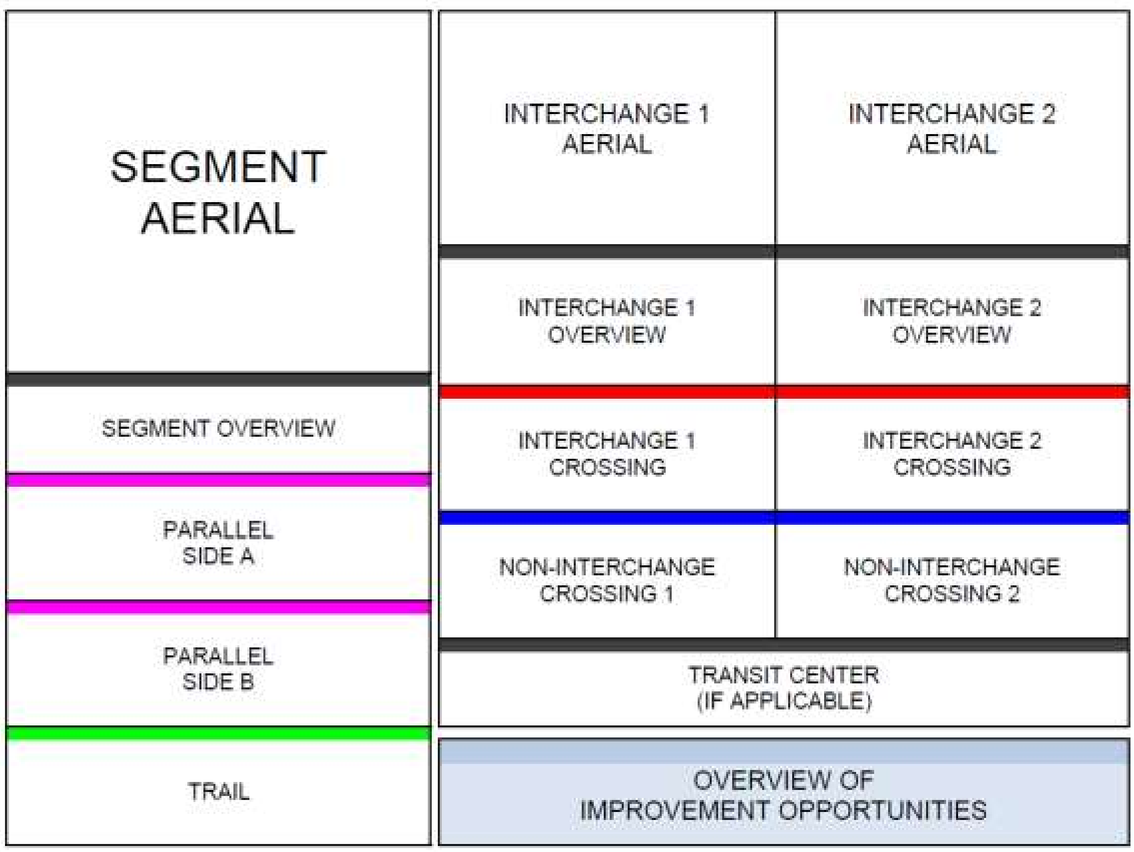


Fact Sheets

The fact sheet is divided into several sections, as shown in Figure 2. Along the left column is an aerial view of the segment, segment overview, and information about each parallel alternative (the number of which varies by segment). The two right columns on the sheet are headed by an aerial of each ramp interchange area, one at each end of the segment. Each ramp intersection has a summary statistic section describing the crosswalks impacted by the ramp interchange, as discussed in the feature selection section. Below the ramp interchange summaries, there are perpendicular street segment summaries describing the street segments with interchanges and crossings without interchanges, if applicable.

The fact sheets for each segment are included in Appendix A of this report. Each segment fact sheet also includes the prioritization rank for treatment at the segment, street, and ramp interchange area levels. The recommendations and prioritization ranks are discussed in the next section.

Figure 2 Segment Fact Sheet Interpretation Key



DEVELOPING RECOMMENDATIONS

Based on the needs of bicyclists and pedestrians in a freeway corridor environment, the feature elements gathered during data collection were prioritized based on **crossing frequency** and **presence of parallel alternatives**. These two factors represent the first level of prioritization for the corridor. The most important element of complete streets in a freeway corridor is safe and frequent crossings. It is also critical, although slightly less so, that there are alternative routes on each side of the corridor to reduce the burden of limited crossing opportunities.

Crossing frequency is the distance (miles) between freeway crossings; most segments have over- or under-pass crossings in addition to the crossings at ramps. Segments were ranked based on the distances between crossings as either above or below the median crossing distance for all crossings in the corridor. The median distance between crossings for the I-680 corridor in Contra Costa County is 0.57 miles.

Segments were then ranked by the presence or absence of alternative parallels on one or both sides. The results of this prioritization can be seen in Figure 3 below.

All but two segments have at least one issue in the prioritization measures. The highest priority segments are numbers 7, 8, 9, 18, and 19. Recommendations for potential treatment are detailed in the sections that follow.

Figure 3 Segment Prioritization Ranking for the I-680 Corridor

Segment	From Exit		To Exit		Distance	Distance	Distance	Side A	Side B	Rank
	#	Name	#	Name	A*	B*	C*	Parallel	Parallel	
1	31	Alcosta Blvd	34	Bollinger Canyon Road	1.09	0.79	0.99	Yes	Yes	2
2	34	Bollinger Canyon Road	36	Crow Canyon Road	0.87	0.41		Yes	Yes	2
3	36	Crow Canyon Road	38	Sycamore Valley Rd	0.21	0.94	1.41	Yes	Yes	2
4	38	Sycamore Valley Rd	39	Diablo Road	0.29	0.5		Yes	No	3
5	39	Diablo Road	40	El Cerro Blvd	0.62			Yes	Yes	2
6	40	El Cerro Blvd	41	El Pintado Rd	0.57			Yes	Yes	4
7	41	El Pintado Rd	42	Stone Valley Rd	0.5	1.11		Yes	No	1
8	42	Stone Valley Rd	43	Livorna Rd	0.91			Yes	No	1
9	43	Livorna Rd	44	Rudgear Rd	1.33			Yes	No	1
10	44	Rudgear Rd	45A	S Main St	0.57			No	Yes	3
11	45A	S Main St	45B	Olympic Blvd	0.38	0.21	0.27	No	Yes	3
12	45B	Olympic Blvd	46B	Ygnacio Valley Rd/Hillside Ave	0.29	0.35	0.28	No	Yes	3
13	46B	Ygnacio Valley Rd/Hillside Ave	47	N Main St	0.38	0.34		No	Yes	3
14	47	N Main St	48	Treat Blvd/Geary Rd/Oak Rd/N Main St	0.5	0.31		Yes	Yes	4
15	48	Treat Blvd/Geary Rd/Oak Rd/N Main St	49A&B	Buskirk Ave/Monument Blvd/Contra Costa Blvd	0.47	0.85		Yes	Yes	2
16	49A&B	Buskirk Ave/Monument Blvd/Contra Costa Blvd	51	Sunvalley Blvd/Willow Pass Rd	1.53			Yes	Yes	2
17	51	Sunvalley Blvd/Willow Pass Rd	52	Concord Ave/Burnett Ave/Contra Costa Blvd	0.82			Yes	Yes	2
18	52	Concord Ave/Burnett Ave/Contra Costa Blvd	54	Pacheco Blvd/Arthur Rd	0.52	1.16	1.17	Yes	No	1
19	54	Pacheco Blvd/Arthur Rd	56	Marina Vista Rd/Waterfront Rd	1.66			Yes	No	1

*Distances are measured between crossings along the segment, listed in miles. Median crossing distance is 0.57 miles

RECOMMENDED TREATMENTS

Ramp Interchange Areas

The next step after segment prioritization was an evaluation of each interchange area based on the criteria described above. Using the fact sheets for each segment, the number of elements that recommend restriping/signage or reconstruction for each segment area are summarized in the table below, Figure 4, and shown in order of their priority rank. There is a wide range of reconstruction needs at the interchange areas, from 0 to 36 elements, depending on the interchange. Based on the rankings, the top segments (7, 8, 9, 18, and 19) should have restriping/adjustment and reconstruction as a higher priority.

Figure 4 Recommended Treatments by Ramp Interchange Area for the I-680 Corridor

Segments	Exit #	Street Name	# of elements recommending restriping, signal timing adjustment- B	# of elements recommending reconstruction- C	Rank
6,7	41	El Pintado Rd	8	2	1
7,8	42	Stone Valley Rd	2	12	1
8,9	43	Livorna Rd	8	9	1
9,10	44	Rudgear Rd	10	6	1
17,18	52	Concord Ave/Burnett Ave/Contra Costa Blvd	7	20	1
18,19	54	Pacheco Blvd/Arthur Rd	9	13	1
19	56	Marina Vista Rd/Waterfront Rd	0	0	1
1	31	Alcosta Blvd	9	7	2
1,2	34	Bollinger Canyon Road	3	7	2
2	36	San Ramon Transit Center	5	6	2
2,3	36	Crow Canyon Road	3	9	2
3,4	38	Sycamore Valley Rd	1	6	2
4,5	39	Diablo Road	6	19	2
5,6	40	El Cerro Blvd	9	14	2
14,15	48	Treat Blvd/Geary Rd/Oak Rd/N Main St	11	23	2
15	48	Pleasant Hill BART Station	10	28	2
15,16	49A&B	Buskirk Ave/Monument Blvd/Contra Costa Blvd	9	36	2
16,17	51	Sunvalley Blvd/Willow Pass Rd	8	18	2
4	38	Danville Park and Ride	2	3	3
10,11	45A	S Main St	5	3	3
11,12	45B	Olympic Blvd	10	17	3
12,13	46B	Ygnacio Valley Rd/Hillside Ave	11	18	3
13	46B	Walnut Creek BART Station	11	34	3
13,14	47	N Main St	5	16	3

Street Segment Evaluation

Street segment evaluation by mode for the corridor followed the criteria shown in Figure 5 (and explained in the methodology section above). Based on these criteria, recommended treatments for each street segment in the corridor is shown in Figure 6. These segments are shown in order of their **segment-level prioritization ranking (Figure 3)**. As with the intersection recommendations, prioritization for improvements along these street segments should follow the ranking detailed above (Figure 3). This is to ensure that the first treatments in the corridor are to the streets and intersections with the greatest number of improvement opportunities.

Figure 5 Street Segment Evaluation Criteria

Bicycle Facilities and Trails	
A	Continuous bicycle lane on both sides
B	Not a continuous lane on both sides
C	Missing shared use path
Pedestrian Facilities	
A	Separated or wide, or narrow with buffer,* continuous, both sides
B	Narrow without continuous buffer, both sides
C	One or both sides missing

*Note: A bike lane can count as a buffer for a sidewalk

Transit Service and Centers

This report does not make recommendations related to transit service, as these should be done in consultation with the transit agencies and relevant jurisdictions. Transit service optimization is a key feature of complete streets, and information about the presence of transit is included in the fact sheets and data collection sheets for each street feature in the corridor.

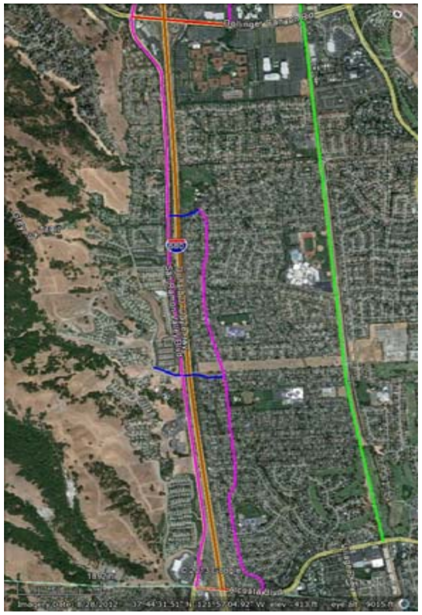
Information about bicycle and pedestrian facilities at transit centers along the corridor is also included in the appendix sheets. These facilities represent critical access points for multimodal travel integration and should be reviewed with transit agencies and relevant jurisdictions.

Figure 6 Street Segment Recommendation Summary for the I-680 Corridor

Segment	Tier 1 Rank	Interchange 1 Crossing- Bikes	Interchange 1 Crossing- Peds	Interchange 2 Crossing- Bikes	Interchange 2 Crossing- Peds	Non-interchange Crossing 1- Bikes	Non-interchange Crossing 1- Peds	Non-interchange Crossing 2- Bikes	Non-interchange Crossing 2- Peds	Side A Parallel- Bikes	Side A Parallel- Peds	Side B Parallel- Bikes	Side B Parallel- Peds	Trail
7	1	B	C	A	A	B	C			A	C			A
8	1	A	A	B	C					A	C			A
9	1	B	C	B	C					A	C			A
18	1	B	C	B	C	B	B	B	B	B	C			C
19	1	B	C	B	C					B	C			C
1	2	B	B	B	C	B	A	A	B	A	C	A	A	A
2	2	B	C	B	C	A	C			A	C	A	C	A
3	2	B	C	A	C	A	C	B	C	A	C	B	C	A
5	2	B	B	B	B					B	C	B	C	A
15	2	B	C	B	B	B	C			B	C	B	C	A
16	2	B	B	B	C					B	C			A
17	2	B	C	B	C					B	B	B	B	A
4	3	A	C	B	B	B	C			B	B			A
10	3	B	C	B	C	A	A			B	C			A
11	3	B	C	B	C	B	A	B	B			B	B	A
12	3	B	C	B	C	B	B	B	C			B	A	A
13	3	B	C	B	C	B	A					B	C	A
6	4	B	B	B	C					B	C	B	C	A
14	4	B	C	B	C	A	A			B	A			A

4 APPENDIX A

Segment 1: Exit 31- Alcosta Boulevard to Exit 34- Bollinger Canyon Road



I-680 Freeway	
Length (miles)	2.88
Bicycles allowed on freeway	No
Alternative parallel roads	Side A: Continuous, Side B: Partial
Alternative parallel trail	Present
Perpendicular crossings	4
Interchange crossings	2
Non-Interchange crossings	2

Side A: San Ramon Valley Blvd.	
Length (mi)	2.9
Shoulders	None
Parking	None
Sides of street with complete sidewalks	One
Predominant walkway type	Narrow Curbside
Predominant bicycle facility	Lane
Continuity of bike facility	Both
Transit service	Yes
Predominant station type	Sign Post

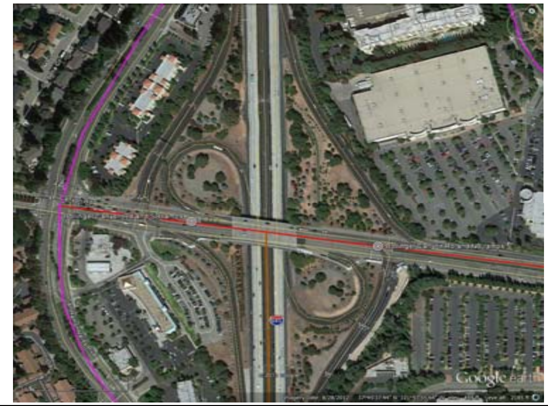
Side B: Davona Drive	
Length (mi)	2
Shoulders	None
Parking	Partial
Sides of street with complete sidewalks	Both
Predominant walkway type	Narrow Curbside
Predominant bicycle facility	Lane
Continuity of bike facility	Both
Transit service	No
Predominant station type	NA

Iron Horse Regional Trail Path	
Length (mi)	2.65
Predominant path width	Wide
Arterial intersections along segment	4

Exit 31 Alcosta Blvd Ramp Interchange	
Ramps	5
Permitted and marked crosswalks	4
Free-flow ramps	1
Unmarked crosswalks	0
Prohibited crossings	5
Crosswalks with or possibly with conflicts	4
Crosswalks without pedestrian lighting	0
Crosswalks missing pedestrian signals	0
Crosswalks longer than two travel lanes	2
Large/extra-large effective turn radii	4

Alcosta Blvd Overpass	
Length (mi)	0.3
Shoulders	None
Parking	None
Sides of street with complete sidewalks	Both
Predominant walkway type	Narrow Curbside
Predominant bicycle facility	Lane
Continuity of bike facility	No
Transit service	Yes
Predominant station type	Sheltered

Pine Valley Road Underpass	
Length (mi)	0.19
Shoulders	None
Parking	Both
Sides of street with complete sidewalks	Both
Predominant walkway type	Narrow Curbside
Predominant bicycle facility	None
Continuity of bike facility	NA
Transit service	Yes
Predominant station type	Sign Post



Exit 34 Bollinger Canyon Rd Ramp Interchange	
Ramps	6
Permitted and marked crosswalks	3
Free-flow ramps	4
Unmarked crosswalks	0
Prohibited crossings	0
Crosswalks with or possibly with conflicts	3
Crosswalks without pedestrian lighting	0
Crosswalks missing pedestrian signals	0
Crosswalks longer than two travel lanes	1
Large/extra-large effective turn radii	2

Bollinger Canyon Rd Overpass	
Length (mi)	0.45
Shoulders	None
Parking	None
Sides of street with complete sidewalks	One
Predominant walkway type	Narrow Curbside
Predominant bicycle facility	None
Continuity of bike facility	NA
Transit service	Yes
Predominant station type	Sign Post

Montevideo Drive Underpass	
Length (mi)	0.15
Shoulders	None
Parking	Partial
Sides of street with complete sidewalks	Both
Predominant walkway type	Narrow Curbside
Predominant bicycle facility	Lane
Continuity of bike facility	Both
Transit service	Yes
Predominant station type	Improved

OVERVIEW OF IMPROVEMENT OPPORTUNITIES

This segment features long distances between crossings that are greater than the median length for the corridor. Approximately half of the bicycle and pedestrian facilities are categorized at B-level or worse. At the Alcosta Blvd ramp interchange, restriping and/or signal adjustment should be considered.

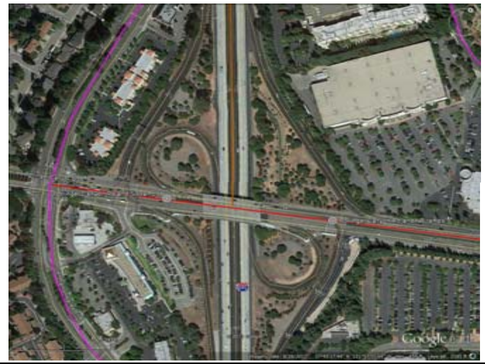
Segment 2: Exit 34- Bollinger Canyon Road to Exit 36- Crow Canyon Road

I-680 Freeway	
Length (miles)	1.29
Bicycles allowed on freeway	No
Alternative parallel roads	Side A: Continuous, Side: B Partial
Alternative parallel trail	Present
Perpendicular crossings	3
Interchange crossings	2
Non-Interchange crossings	1

Side A: San Ramon Valley Blvd	
Length (mi)	1.32
Shoulders	None
Parking	None
Sides of street with complete sidewalks	One
Predominant walkway type	Narrow Curbside
Predominant bicycle facility	Lane
Continuity of bike facility	Both
Transit service	No
Predominant station type	NA

Side B: Sunset Dr/Bishop Dr	
Length (mi)	1.17
Shoulders	None
Parking	None
Sides of street with complete sidewalks	One
Predominant walkway type	Narrow Curbside
Predominant bicycle facility	Lane
Continuity of bike facility	Both
Transit service	Yes
Predominant station type	Sign Post

Iron Horse Regional Trail Path	
Length (mi)	1.33
Predominant path width	Wide
Arterial intersections along segment	1



Exit 34 Bollinger Canyon Rd Ramp Interchange		Exit 36 Crow Canyon Rd Ramp Interchange	
Ramps	6	Ramps	6
Permitted and marked crosswalks	3	Permitted and marked crosswalks	3
Free-flow ramps	4	Free-flow ramps	4
Unmarked crosswalks	0	Unmarked crosswalks	0
Prohibited crossings	0	Prohibited crossings	0
Crosswalks with or possibly with conflicts	3	Crosswalks with or possibly with conflicts	3
Crosswalks without pedestrian lighting	0	Crosswalks without pedestrian lighting	2
Crosswalks missing pedestrian signals	0	Crosswalks missing pedestrian signals	0
Crosswalks longer than two travel lanes	1	Crosswalks longer than two travel lanes	1
Large/extra-large effective turn radii	2	Large/extra-large effective turn radii	2

Bollinger Canyon Rd Overpass		Crow Canyon Rd Overpass	
Length (mi)	0.45	Length (mi)	0.4
Shoulders	None	Shoulders	None
Parking	None	Parking	None
Sides of street with complete sidewalks	One	Sides of street with complete sidewalks	One
Predominant walkway type	Narrow Curbside	Predominant walkway type	Narrow Curbside
Predominant bicycle facility	None	Predominant bicycle facility	None
Continuity of bike facility	NA	Continuity of bike facility	NA
Transit service	Yes	Transit service	Yes
Predominant station type	Sign Post	Predominant station type	Improved

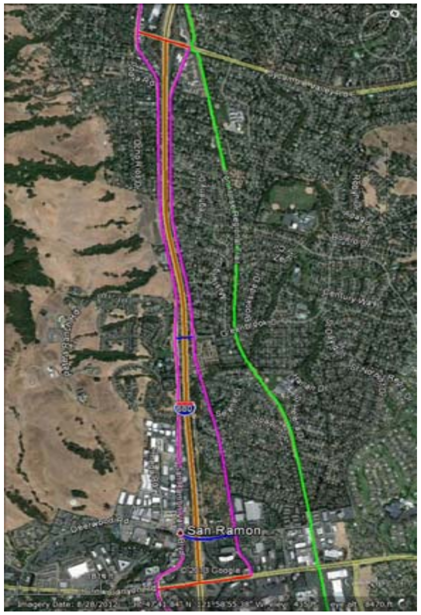
Norris Canyon Rd Overpass	
Length (mi)	0.17
Shoulders	None
Parking	None
Sides of street with complete sidewalks	One
Predominant walkway type	Narrow Curbside
Predominant bicycle facility	Lane
Continuity of bike facility	Both
Transit service	No
Predominant station type	NA

San Ramon Transit Center			
Vehicle access points	3	Crosswalks with median or refuge islands	3
Pedestrian access points	2	Crosswalks with or possibly with conflicts	3
Bicycle access points	2	Crosswalks without pedestrian lighting	4
Marked crosswalks	2	Crosswalks missing pedestrian signals	0
Unmarked crosswalks	2	Crosswalks longer than two travel lanes	2
Prohibited crossings	0	Large/extra-large effective turn radii	0

OVERVIEW OF IMPROVEMENT OPPORTUNITIES

This segment features moderate distances between crossings, compared to the median length in the corridor. Approximately half of all bicycle facilities are categorized at B-level or below, and all pedestrian facilities are categorized at C-level. At the San Ramon Transit Center, restriping and/or signal adjustment should be considered.

Segment 3: Exit 36- Crow Canyon Road to Exit 38- Sycamore Valley Road



I 680 Freeway	
Length (miles)	2.56
Bicycles allowed on freeway	No
Alternative parallel roads	Side A & B: Continuous
Alternative parallel trail	Present
Perpendicular crossings	4
Interchange crossings	2
Non-Interchange crossings	2

Side A: San Ramon Valley Blvd	
Length (mi)	2.7
Shoulders	None
Parking	Partial
Sides of street with complete sidewalks	One
Predominant walkway type	Narrow Curbside
Predominant bicycle facility	Lane
Continuity of bike facility	Both
Transit service	Yes
Predominant station type	Sheltered

Side B: Camino Ramon	
Length (mi)	2.34
Shoulders	None
Parking	Partial
Sides of street with complete sidewalks	One
Predominant walkway type	Narrow Curbside
Predominant bicycle facility	Route
Continuity of bike facility	Both
Transit service	Yes
Predominant station type	Improved

Iron Horse Regional Trail Path	
Length (mi)	2.56
Predominant path width	Wide
Arterial intersections along segment	4

Exit 36 Crow Canyon Rd Ramp Interchange	
Ramps	6
Permitted and marked crosswalks	3
Free-flow ramps	4
Unmarked crosswalks	0
Prohibited crossings	0
Crosswalks with or possibly with conflicts	3
Crosswalks without pedestrian lighting	2
Crosswalks missing pedestrian signals	0
Crosswalks longer than two travel lanes	1
Large/extra-large effective turn radii	2

Crow Canyon Rd Overpass	
Length (mi)	0.4
Shoulders	None
Parking	None
Sides of street with complete sidewalks	One
Predominant walkway type	Narrow Curbside
Predominant bicycle facility	None
Continuity of bike facility	NA
Transit service	Yes
Predominant station type	Improved

Fostoria Way Overpass	
Length (mi)	0.23
Shoulders	None
Parking	None
Sides of street with complete sidewalks	One
Predominant walkway type	Narrow Curbside
Predominant bicycle facility	Lane
Continuity of bike facility	Both
Transit service	No
Predominant station type	NA

Exit 38 Sycamore Valley Rd Ramp Interchange	
Ramps	5
Permitted and marked crosswalks	2
Free-flow ramps	2
Unmarked crosswalks	0
Prohibited crossings	0
Crosswalks with or possibly with conflicts	1
Crosswalks without pedestrian lighting	1
Crosswalks missing pedestrian signals	1
Crosswalks longer than two travel lanes	0
Large/extra-large effective turn radii	2

Sycamore Valley Rd Overpass	
Length (mi)	0.24
Shoulders	None
Parking	None
Sides of street with complete sidewalks	One
Predominant walkway type	Narrow Curbside
Predominant bicycle facility	Lane
Continuity of bike facility	Both
Transit service	Yes
Predominant station type	Sheltered

Greenbrook Drive Overpass	
Length (mi)	0.1
Shoulders	None
Parking	None
Sides of street with complete sidewalks	One
Predominant walkway type	Narrow Curbside
Predominant bicycle facility	None
Continuity of bike facility	NA
Transit service	Yes
Predominant station type	Improved

OVERVIEW OF IMPROVEMENT OPPORTUNITIES

This segment features long distances between crossings that are greater than the median length in the corridor. Approximately half of all bicycle facilities are categorized at B-level or below, and all pedestrian facilities are categorized at C-level.

Segment 4: Exit 38- Sycamore Valley Road to Exit 39- Diablo Road

I-680 Freeway	
Length (miles)	0.8
Bicycles allowed on freeway	No
Alternative parallel roads	Side A Continuous, Side B Partial
Alternative parallel trail	Present
Perpendicular crossings	3
Interchange crossings	2
Non-Interchange crossings	1

Side A: San Ramon Valley Blvd/Hartz Ave	
Length (mi)	0.9
Shoulders	None
Parking	Partial
Sides of street with complete sidewalks	Both
Predominant walkway type	Narrow Curbside
Predominant bicycle facility	Lane
Continuity of bike facility	None
Transit service	Yes
Predominant station type	Improved

Iron Horse Regional Trail Path	
Length (mi)	0.9
Predominant path width	Wide
Arterial intersections along segment	1

Exit 38 Sycamore Valley Rd Ramp Interchange	
Ramps	5
Permitted and marked crosswalks	2
Free-flow ramps	2
Unmarked crosswalks	0
Prohibited crossings	0
Crosswalks with or possibly with conflicts	0
Crosswalks without pedestrian lighting	1
Crosswalks missing pedestrian signals	1
Crosswalks longer than two travel lanes	0
Large/extra-large effective turn radii	2

Sycamore Valley Rd Overpass	
Length (mi)	0.24
Shoulders	None
Parking	None
Sides of street with complete sidewalks	One
Predominant walkway type	Narrow Curbside
Predominant bicycle facility	Lane
Continuity of bike facility	Both
Transit service	Yes
Predominant station type	Sheltered

Laurel Drive Underpass	
Length (mi)	0.26
Shoulders	None
Parking	Both
Sides of street with complete sidewalks	None
Predominant walkway type	Narrow Curbside
Predominant bicycle facility	None
Continuity of bike facility	NA
Transit service	No
Predominant station type	NA

Exit 39 Diablo Rd Ramp Interchange	
Ramps	5
Permitted and marked crosswalks	8
Free-flow ramps	2
Unmarked crosswalks	0
Prohibited crossings	0
Crosswalks with or possibly with conflicts	6
Crosswalks without pedestrian lighting	8
Crosswalks missing pedestrian signals	0
Crosswalks longer than two travel lanes	3
Large/extra-large effective turn radii	6

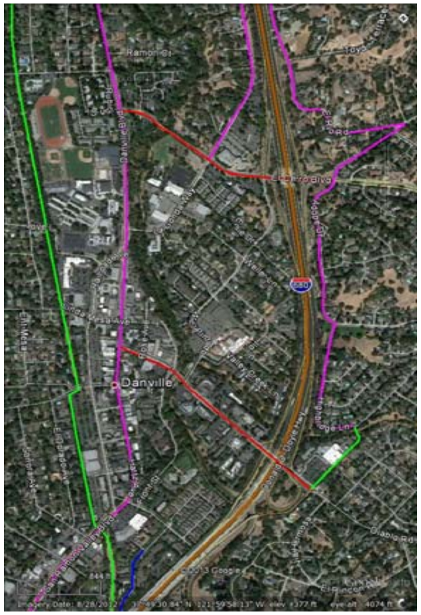
Diablo Road Underpass	
Length (mi)	0.5
Shoulders	None
Parking	Partial
Sides of street with complete sidewalks	Both
Predominant walkway type	Narrow Curbside
Predominant bicycle facility	Lane
Continuity of bike facility	None
Transit service	No
Predominant station type	NA

Danville Park and Ride			
Vehicle access points	1	Crosswalks with median or refuge islands	2
Pedestrian access points	1	Crosswalks with or possibly with conflicts	0
Bicycle access points	1	Crosswalks without pedestrian lighting	0
Marked crosswalks	2	Crosswalks missing pedestrian signals	0
Unmarked crosswalks	0	Crosswalks longer than two travel lanes	2
Prohibited crossings	2	Large/extra-large effective turn radii	1

OVERVIEW OF IMPROVEMENT OPPORTUNITIES

This segment lacks a parallel alternative road on Side B. More than half of all bicycle facilities are categorized at B-level or below, and all pedestrian facilities are categorized at B-level or below. At the Diablo Rd ramp interchange, restriping, signal adjustment, and/or reconstruction should be considered.

Segment 5: Exit 39- Diablo Road to Exit 40- El Cerro Boulevard



I 680 Freeway	
Length (miles)	0.62
Bicycles allowed on freeway	No
Alternative parallel roads	Side A Continuous, Side B Partial
Alternative parallel trail	Present
Perpendicular crossings	2
Interchange crossings	2
Non-Interchange crossings	0

Side A: Hartz Ave/Danville Blvd	
Length (mi)	0.52
Shoulders	None
Parking	Both
Sides of street with complete sidewalks	One
Predominant walkway type	Narrow Curbside
Predominant bicycle facility	Lane
Continuity of bike facility	None
Transit service	Yes
Predominant station type	Sign Post

Side B: Highbridge Lane/Adobe Drive	
Length (mi)	0.65
Shoulders	None
Parking	Both
Sides of street with complete sidewalks	0
Predominant walkway type	None
Predominant bicycle facility	None
Continuity of bike facility	NA
Transit service	No
Predominant station type	NA

Iron Horse Regional Trail Path	
Length (mi)	0.7
Predominant path width	Wide
Arterial intersections along segment	2

Exit 39 Diablo Rd Ramp Interchange	
Ramps	5
Permitted and marked crosswalks	8
Free-flow ramps	2
Unmarked crosswalks	0
Prohibited crossings	0
Crosswalks with or possibly with conflicts	6
Crosswalks without pedestrian lighting	8
Crosswalks missing pedestrian signals	0
Crosswalks longer than two travel lanes	3
Large/extra-large effective turn radii	6

Diablo Road Underpass	
Length (mi)	0.5
Shoulders	None
Parking	Partial
Sides of street with complete sidewalks	Both
Predominant walkway type	Narrow Curbside
Predominant bicycle facility	Lane
Continuity of bike facility	None
Transit service	No
Predominant station type	NA

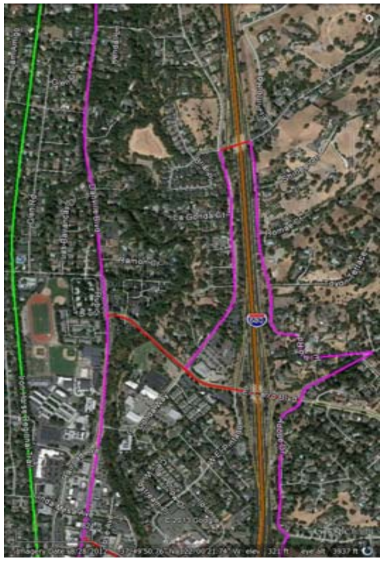
Exit 40 El Cerro Blvd Ramp Interchange	
Ramps	4
Permitted and marked crosswalks	7
Free-flow ramps	0
Unmarked crosswalks	0
Prohibited crossings	2
Crosswalks with or possibly with conflicts	7
Crosswalks without pedestrian lighting	7
Crosswalks missing pedestrian signals	0
Crosswalks longer than two travel lanes	1
Large/extra-large effective turn radii	6

El Cerro Blvd Underpass	
Length (mi)	0.47
Shoulders	None
Parking	Partial
Sides of street with complete sidewalks	Both
Predominant walkway type	Narrow Curbside
Predominant bicycle facility	Lane
Continuity of bike facility	One
Transit service	No
Predominant station type	NA

OVERVIEW OF IMPROVEMENT OPPORTUNITIES

All bicycle and pedestrian facilities are categorized at B-level or below. At the Diablo Rd ramp interchange, restriping, signal adjustment, and/or reconstruction should be considered. At the El Cerro Blvd ramp interchange, restriping and/or signal adjustment should be considered, with reconstruction a lesser need.

Segment 6: Exit 40- El Cerro Boulevard to Exit 41- El Pintado Road

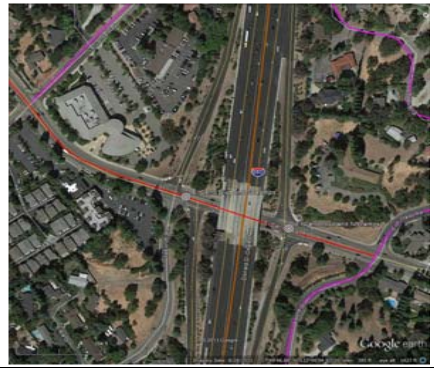


I-680 Freeway	
Length (miles)	0.57
Bicycles allowed on freeway	No
Alternative parallel roads	Side A: 1, Side B: 2
Alternative parallel trail	Present
Perpendicular crossings	2
Interchange crossings	2
Non-Interchange crossings	0

Side A: Danville Blvd	
Length (mi)	0.42
Shoulders	None
Parking	Partial
Sides of street with complete sidewalks	None
Predominant walkway type	Narrow Curbside
Predominant bicycle facility	Lane
Continuity of bike facility	One
Transit service	Yes
Predominant station type	Improved

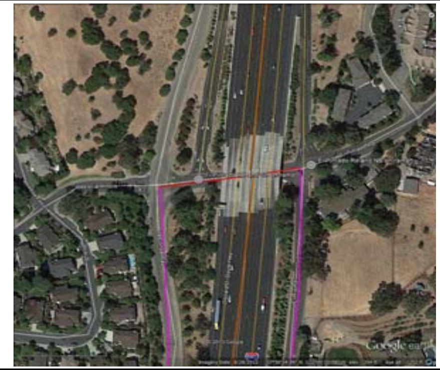
Side A: La Gonda Way	
Length (mi)	0.53
Shoulders	None
Parking	Partial
Sides of street with complete sidewalks	None
Predominant walkway type	Narrow Curbside
Predominant bicycle facility	None
Continuity of bike facility	NA
Transit service	No
Predominant station type	NA

Iron Horse Regional Trail Path	
Length (mi)	0.39
Predominant path width	Wide
Arterial intersections along segment	0



Exit 40 El Cerro Blvd Ramp Interchange	
Ramps	4
Permitted and marked crosswalks	7
Free-flow ramps	0
Unmarked crosswalks	0
Prohibited crossings	2
Crosswalks with or possibly with conflicts	7
Crosswalks without pedestrian lighting	7
Crosswalks missing pedestrian signals	0
Crosswalks longer than two travel lanes	1
Large/extra-large effective turn radii	6

El Cerro Blvd Underpass	
Length (mi)	0.47
Shoulders	None
Parking	Partial
Sides of street with complete sidewalks	Both
Predominant walkway type	Narrow Curbside
Predominant bicycle facility	Lane
Continuity of bike facility	One
Transit service	No
Predominant station type	NA



Exit 41 El Pintado Rd Ramp Interchange	
Ramps	2
Permitted and marked crosswalks	0
Free-flow ramps	1
Unmarked crosswalks	1
Prohibited crossings	6
Crosswalks with or possibly with conflicts	1
Crosswalks without pedestrian lighting	1
Crosswalks missing pedestrian signals	0
Crosswalks longer than two travel lanes	0
Large/extra-large effective turn radii	0

El Cerro Blvd Underpass	
Length (mi)	0.1
Shoulders	None
Parking	Both
Sides of street with complete sidewalks	One
Predominant walkway type	Narrow Curbside
Predominant bicycle facility	None
Continuity of bike facility	NA
Transit service	No
Predominant station type	NA

Side B: El Pintado Rd/El Rio Road	
Length (mi)	0.68
Shoulders	None
Parking	Partial
Sides of street with complete sidewalks	0
Predominant walkway type	None
Predominant bicycle facility	None
Continuity of bike facility	NA
Transit service	No
Predominant station type	NA

OVERVIEW OF IMPROVEMENT OPPORTUNITIES

All bicycle facilities are categorized at B-level, and most pedestrian facilities are categorized at C-level. At the El Cerro Blvd ramp interchange, restriping, and/or signal adjustment should be considered, with reconstruction a lesser need. At the El Pintado Rd ramp interchange, restriping and/or signal adjustment should be considered.

Segment 7: Exit 41- El Pintado Road to Exit 42- Stone Valley Road

I-680 Freeway	
Length (miles)	1.62
Bicycles allowed on freeway	No
Alternative parallel roads	Side A: Continuous, Side B: None
Alternative parallel trail	Present
Perpendicular crossings	3
Interchange crossings	2
Non-Interchange crossings	1

Side A: Danville Blvd	
Length (mi)	1.67
Shoulders	None
Parking	Partial
Sides of street with complete sidewalks	None
Predominant walkway type	Narrow Curbside
Predominant bicycle facility	Lane
Continuity of bike facility	Both
Transit service	Yes
Predominant station type	Improved

Iron Horse Regional Trail Path	
Length (mi)	1.64
Predominant path width	Wide
Arterial intersections along segment	6

Exit 41 El Pintado Rd	
Ramps	2
Permitted and marked crosswalks	0
Free-flow ramps	1
Unmarked crosswalks	1
Prohibited crossings	6
Crosswalks with or possibly with conflicts	1
Crosswalks without pedestrian lighting	1
Crosswalks missing pedestrian signals	0
Crosswalks longer than two travel lanes	0
Large/extra-large effective turn radii	0

El Pintado Rd Underpass	
Length (mi)	0.1
Shoulders	None
Parking	Both
Sides of street with complete sidewalks	One
Predominant walkway type	Narrow Curbside
Predominant bicycle facility	None
Continuity of bike facility	NA
Transit service	No
Predominant station type	NA

Pine Valley Road Underpass	
Length (mi)	0.12
Shoulders	None
Parking	Partial
Sides of street with complete sidewalks	None
Predominant walkway type	Narrow Curbside
Predominant bicycle facility	None
Continuity of bike facility	NA
Transit service	No
Predominant station type	NA

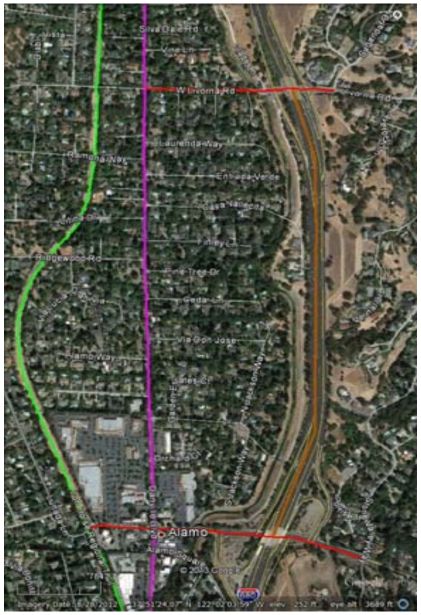
Exit 42 Stone Valley Rd	
Ramps	6
Permitted and marked crosswalks	4
Free-flow ramps	2
Unmarked crosswalks	0
Prohibited crossings	0
Crosswalks with or possibly with conflicts	2
Crosswalks without pedestrian lighting	4
Crosswalks missing pedestrian signals	0
Crosswalks longer than two travel lanes	2
Large/extra-large effective turn radii	4

Stone Valley Rd Underpass	
Length (mi)	0.51
Shoulders	None
Parking	None
Sides of street with complete sidewalks	Both
Predominant walkway type	Narrow Curbside
Predominant bicycle facility	Lane
Continuity of bike facility	Both
Transit service	No
Predominant station type	NA

OVERVIEW OF IMPROVEMENT OPPORTUNITIES

This segment features long distances between crossings that are greater than the median length for the corridor. Approximately half of all bicycle facilities are categorized at B-level or below, and most pedestrian facilities are categorized at C-level. At the El Pintado Rd ramp interchange, restriping and/or signal adjustment should be considered. At the Stone Valley Rd ramp interchange, reconstruction should be considered.

Segment 8: Exit 42- Stone Valley Road to Exit 43- Livorna Road



I-680 Freeway

Length (miles)	0.91
Bicycles allowed on freeway	No
Alternative parallel roads	Side A: Continuous, Side B: None
Alternative parallel trail	Present
Perpendicular crossings	2
Interchange crossings	2
Non-Interchange crossings	0

Side A: Danville Blvd

Length (mi)	0.88
Shoulders	None
Parking	None
Sides of street with complete sidewalks	None
Predominant walkway type	Narrow Curbside
Predominant bicycle facility	Lane
Continuity of bike facility	Both
Transit service	Yes
Predominant station type	Improved

Iron Horse Regional Trail Path

Length (mi)	0.95
Predominant path width	Wide
Arterial intersections along segment	3

Exit 42 Stone Valley Rd Ramp Interchange

Ramps	6
Permitted and marked crosswalks	4
Free-flow ramps	2
Unmarked crosswalks	0
Prohibited crossings	0
Crosswalks with or possibly with conflicts	2
Crosswalks without pedestrian lighting	4
Crosswalks missing pedestrian signals	0
Crosswalks longer than two travel lanes	2
Large/extra-large effective turn radii	4

Stone Valley Rd Underpass

Length (mi)	0.51
Shoulders	None
Parking	None
Sides of street with complete sidewalks	Both
Predominant walkway type	Narrow Curbside
Predominant bicycle facility	Lane
Continuity of bike facility	Both
Transit service	No
Predominant station type	NA

Exit 43 Livorna Rd Ramp Interchange

Ramps	4
Permitted and marked crosswalks	2
Free-flow ramps	2
Unmarked crosswalks	1
Prohibited crossings	5
Crosswalks with or possibly with conflicts	2
Crosswalks without pedestrian lighting	3
Crosswalks missing pedestrian signals	0
Crosswalks longer than two travel lanes	1
Large/extra-large effective turn radii	3

Livorna Rd Underpass

Length (mi)	0.34
Shoulders	None
Parking	Both
Sides of street with complete sidewalks	0
Predominant walkway type	None
Predominant bicycle facility	None
Continuity of bike facility	NA
Transit service	No
Predominant station type	NA

OVERVIEW OF IMPROVEMENT OPPORTUNITIES

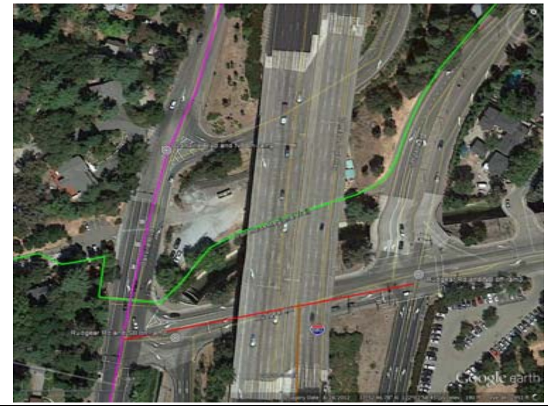
This segment features long distances between crossings that are greater than the median length for the corridor. There is no alternative parallel road on Side B. Most bicycle facilities are categorized at A-level, and most pedestrian facilities are categorized at C-level. At the Stone Valley Rd ramp interchange, reconstruction should be considered. At the Livorna Rd ramp interchange, restriping and/or signal adjustment should be considered.

Segment 9: Exit 43- Livorna Road to Exit 44- Rudgear Road

I-680 Freeway	
Length (miles)	1.34
Bicycles allowed on freeway	No
Alternative parallel roads	Side A: Continuous, Side B: None
Alternative parallel trail	Present
Perpendicular crossings	2
Interchange crossings	2
Non-Interchange crossings	0

Side A: Danville Blvd	
Length (mi)	1.3
Shoulders	None
Parking	None
Sides of street with complete sidewalks	0
Predominant walkway type	None
Predominant bicycle facility	Lane
Continuity of bike facility	Both
Transit service	Yes
Predominant station type	Improved

Iron Horse Regional Trail Path	
Length (mi)	1.41
Predominant path width	Wide
Arterial intersections along segment	2



	Exit 43 Livorna Rd Ramp Interchange	Exit 44 Rudgear Rd Ramp Interchange
Ramps	4	3
Permitted and marked crosswalks	2	2
Free-flow ramps	2	1
Unmarked crosswalks	1	0
Prohibited crossings	5	8
Crosswalks with or possibly with conflicts	2	2
Crosswalks without pedestrian lighting	3	2
Crosswalks missing pedestrian signals	0	0
Crosswalks longer than two travel lanes	1	2
Large/extra-large effective turn radii	3	1

	Livorna Rd Underpass	Rudgear Rd Underpass
Length (mi)	0.34	0.1
Shoulders	None	None
Parking	Both	None
Sides of street with complete sidewalks	0	One
Predominant walkway type	None	Narrow Curbside
Predominant bicycle facility	None	None
Continuity of bike facility	NA	NA
Transit service	No	No
Predominant station type	NA	NA

OVERVIEW OF IMPROVEMENT OPPORTUNITIES

This segment features long distances between crossings that are greater than the median length for the corridor. There is no alternative parallel road on Side B. Most bicycle facilities are categorized at B-level, and all pedestrian facilities are categorized at C-level. At the Livorna Rd and Rudgear Rd ramp interchanges, there is a strong need for restriping and/or signal adjustment, and a low need for reconstruction.

Segment 10: Exit 44- Rudgear Road to Exit 45A- South Main Street

I-680 Freeway

Length (miles)	0.57
Bicycles allowed on freeway	No
Alternative parallel roads	Side A: Continuous, Side B: None
Alternative parallel trail	Present
Perpendicular crossings	3
Interchange crossings	2
Non-Interchange crossings	1

Side A: Danville Blvd

Length (mi)	0.66
Shoulders	None
Parking	None
Sides of street with complete sidewalks	None
Predominant walkway type	Narrow Curbside
Predominant bicycle facility	None
Continuity of bike facility	NA
Transit service	Yes
Predominant station type	Sign Post

Iron Horse Regional Trail Path

Length (mi)	0.79
Predominant path width	Wide
Arterial intersections along segment	0

Exit 44 Rudgear Rd Ramp Interchange

Ramps	3
Permitted and marked crosswalks	2
Free-flow ramps	1
Unmarked crosswalks	0
Prohibited crossings	8
Crosswalks with or possibly with conflicts	2
Crosswalks without pedestrian lighting	2
Crosswalks missing pedestrian signals	0
Crosswalks longer than two travel lanes	2
Large/extra-large effective turn radii	1

Rudgear Rd Underpass

Length (mi)	0.1
Shoulders	None
Parking	None
Sides of street with complete sidewalks	One
Predominant walkway type	Narrow Curbside
Predominant bicycle facility	None
Continuity of bike facility	NA
Transit service	No
Predominant station type	NA

Iron Horse Trail Underpass

Length (mi)	0.11
Shoulders	None
Parking	None
Sides of street with complete sidewalks	Both
Predominant walkway type	Buffered
Predominant bicycle facility	Lane
Continuity of bike facility	Both
Transit service	No
Predominant station type	NA

Exit 45A S Main St Ramp Interchange

Ramps	3
Permitted and marked crosswalks	1
Free-flow ramps	2
Unmarked crosswalks	1
Prohibited crossings	2
Crosswalks with or possibly with conflicts	2
Crosswalks without pedestrian lighting	1
Crosswalks missing pedestrian signals	0
Crosswalks longer than two travel lanes	0
Large/extra-large effective turn radii	0

S Main Street Underpass

Length (mi)	0.12
Shoulders	None
Parking	None
Sides of street with complete sidewalks	One
Predominant walkway type	Narrow Curbside
Predominant bicycle facility	None
Continuity of bike facility	NA
Transit service	Yes
Predominant station type	Improved

OVERVIEW OF IMPROVEMENT OPPORTUNITIES

There is no alternative parallel road on Side A. Most bicycle facilities are categorized at B-level, and most pedestrian facilities are categorized at C-level. At the Rudgear Rd ramp interchange, restriping and/or signal adjustment should be considered.

Segment 11: Exit 45A- South Main Street to Exit 45B- Olympic Boulevard

I-680 Freeway

Length (miles)	0.86
Bicycles allowed on freeway	No
Alternative parallel roads	Side A: None, Side B: Complete
Alternative parallel trail	1 Complete, 1 Partial
Perpendicular crossings	4
Interchange crossings	2
Non-Interchange crossings	2

Side B: S Main Street

Length (mi)	0.72
Shoulders	None
Parking	Partial
Sides of street with complete sidewalks	Both
Predominant walkway type	Narrow Curbside
Predominant bicycle facility	None
Continuity of bike facility	NA
Transit service	Yes
Predominant station type	Sheltered

Iron Horse Regional Trail Path

Length (mi)	0.81
Predominant path width	Wide
Arterial intersections along segment	1

Lancaster Road Extension Path

Length (mi)	0.17
Predominant path width	Standard
Arterial intersections along segment	0

Exit 45A S Main St Ramp Interchange

Ramps	3
Permitted and marked crosswalks	1
Free-flow ramps	2
Unmarked crosswalks	1
Prohibited crossings	2
Crosswalks with or possibly with conflicts	2
Crosswalks without pedestrian lighting	1
Crosswalks missing pedestrian signals	0
Crosswalks longer than two travel lanes	0
Large/extra-large effective turn radii	0

S Main St Underpass

Length (mi)	0.12
Shoulders	None
Parking	None
Sides of street with complete sidewalks	One
Predominant walkway type	Narrow Curbside
Predominant bicycle facility	None
Continuity of bike facility	NA
Transit service	Yes
Predominant station type	Improved

Lilac Dr Underpass

Length (mi)	0.15
Shoulders	None
Parking	One
Sides of street with complete sidewalks	Both
Predominant walkway type	Narrow Curbside
Predominant bicycle facility	None
Continuity of bike facility	NA
Transit service	No
Predominant station type	NA

Exit 45B Olympic Blvd Ramp Interchange

Ramps	5
Permitted and marked crosswalks	8
Free-flow ramps	2
Unmarked crosswalks	0
Prohibited crossings	2
Crosswalks with or possibly with conflicts	8
Crosswalks without pedestrian lighting	6
Crosswalks missing pedestrian signals	0
Crosswalks longer than two travel lanes	3
Large/extra-large effective turn radii	6

Olympic Blvd Underpass

Length (mi)	0.9
Shoulders	None
Parking	Partial
Sides of street with complete sidewalks	One
Predominant walkway type	Narrow Curbside
Predominant bicycle facility	Lane
Continuity of bike facility	None
Transit service	No
Predominant station type	NA

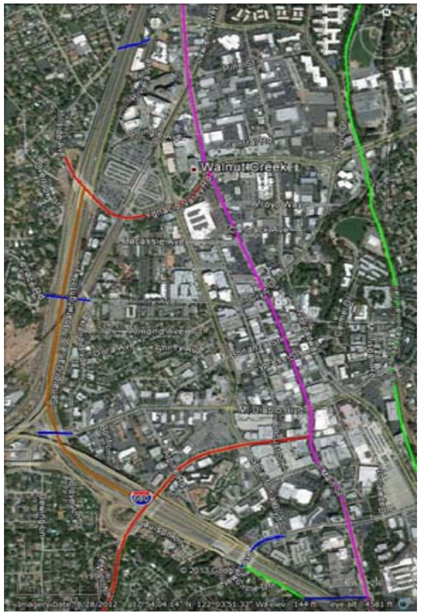
Newell Ave Underpass

Length (mi)	0.16
Shoulders	None
Parking	Partial
Sides of street with complete sidewalks	Both
Predominant walkway type	Narrow Curbside
Predominant bicycle facility	Lane
Continuity of bike facility	None
Transit service	No
Predominant station type	NA

OVERVIEW OF IMPROVEMENT OPPORTUNITIES

There is no alternative parallel road on Side A. Most bicycle facilities are categorized at B-level, and most pedestrian facilities are categorized at C-level. At the Olympic Blvd ramp interchange, restriping, and/or signal adjustment should be considered, with reconstruction a lesser need.

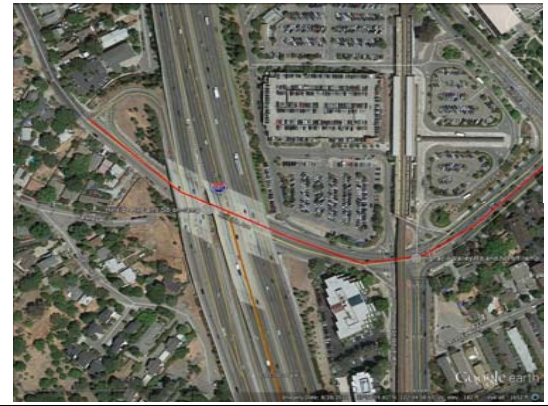
Segment 12: Exit 45B- Olympic Boulevard to Exit 46B- Ygnacio Valley Road/Hillside Avenue



I-680 Freeway	
Length (miles)	0.93
Bicycles allowed on freeway	No
Alternative parallel roads	Side A: None, Side B: Complete
Alternative parallel trail	Present
Perpendicular crossings	4
Interchange crossings	2
Non-Interchange crossings	2

Side B: N Main Street	
Length (mi)	0.73
Shoulders	None
Parking	Partial
Sides of street with complete sidewalks	Both
Predominant walkway type	Wide Curbside
Predominant bicycle facility	None
Continuity of bike facility	NA
Transit service	Yes
Predominant station type	Sign Post

Iron Horse Regional Trail Path	
Length (mi)	0.59
Predominant path width	Wide
Arterial intersections along segment	0



Exit 45B Olympic Blvd Ramp Interchange		Exit 46B Ygnacio Valley Rd/Hillside Ave Ramp Interchange	
Ramps	5	Ramps	3
Permitted and marked crosswalks	8	Permitted and marked crosswalks	11
Free-flow ramps	2	Free-flow ramps	1
Unmarked crosswalks	0	Unmarked crosswalks	0
Prohibited crossings	2	Prohibited crossings	2
Crosswalks with or possibly with conflicts	8	Crosswalks with or possibly with conflicts	9
Crosswalks without pedestrian lighting	6	Crosswalks without pedestrian lighting	9
Crosswalks missing pedestrian signals	0	Crosswalks missing pedestrian signals	1
Crosswalks longer than two travel lanes	3	Crosswalks longer than two travel lanes	2
Large/extra-large effective turn radii	6	Large/extra-large effective turn radii	5
Olympic Blvd Underpass		**Hillside Ave Underpass**	
Length (mi)	0.9	Length (mi)	0.47
Shoulders	None	Shoulders	None
Parking	Partial	Parking	Partial
Sides of street with complete sidewalks	One	Sides of street with complete sidewalks	One
Predominant walkway type	Narrow Curbside	Predominant walkway type	Wide Curbside
Predominant bicycle facility	Lane	Predominant bicycle facility	None
Continuity of bike facility	None	Continuity of bike facility	NA
Transit service	No	Transit service	Yes
Predominant station type	NA	Predominant station type	Sheltered
Mt Diablo Blvd Underpass		**Trinity Ave Overpass**	
Length (mi)	0.1	Length (mi)	0.11
Shoulders	None	Shoulders	One
Parking	None	Parking	None
Sides of street with complete sidewalks	Both	Sides of street with complete sidewalks	One
Predominant walkway type	Narrow Curbside	Predominant walkway type	Narrow Curbside
Predominant bicycle facility	None	Predominant bicycle facility	None
Continuity of bike facility	NA	Continuity of bike facility	NA
Transit service	Yes	Transit service	No
Predominant station type	NA	Predominant station type	NA

OVERVIEW OF IMPROVEMENT OPPORTUNITIES

There is no alternative parallel road on Side A. All bicycle facilities are categorized at B-level, and most pedestrian facilities are categorized at C-level. At the Olympic Blvd and Hillside Ave ramp interchanges, restriping and/or signal adjustment should be considered, with reconstruction a lesser need.

Segment 13: Exit 46B- Ygnacio Valley Road/Hillside Avenue to Exit 47- North Main Street

I-680 Freeway	
Length (miles)	0.72
Bicycles allowed on freeway	No
Alternative parallel roads	Side A: None, Side B: Complete
Alternative parallel trail	Present
Perpendicular crossings	3
Interchange crossings	2
Non-Interchange crossings	1

Side B: N Main St	
Length (mi)	0.78
Shoulders	None
Parking	Partial
Sides of street with complete sidewalks	One
Predominant walkway type	Narrow Curbside
Predominant bicycle facility	None
Continuity of bike facility	0
Transit service	Yes
Predominant station type	Sign Post

Iron Horse Regional Trail Path	
Length (mi)	0.72
Predominant path width	Wide
Arterial intersections along segment	1

Exit 46B Ygnacio Valley Rd/Hillside Ave Ramp Interchange	
Ramps	3
Permitted and marked crosswalks	11
Free-flow ramps	1
Unmarked crosswalks	0
Prohibited crossings	2
Crosswalks with or possibly with conflicts	9
Crosswalks without pedestrian lighting	9
Crosswalks missing pedestrian signals	1
Crosswalks longer than two travel lanes	2
Large/extra-large effective turn radii	5

Ygnacio Valley Rd/Hillside Ave Underpass	
Length (mi)	0.47
Shoulders	None
Parking	Partial
Sides of street with complete sidewalks	One
Predominant walkway type	Wide Curbside
Predominant bicycle facility	None
Continuity of bike facility	NA
Transit service	Yes
Predominant station type	Sheltered

Parkside Drive Underpass	
Length (mi)	0.1
Shoulders	None
Parking	Both
Sides of street with complete sidewalks	Both
Predominant walkway type	Narrow Curbside
Predominant bicycle facility	None
Continuity of bike facility	NA
Transit service	Yes
Predominant station type	Sign Post

Exit 47 N Main St Ramp Interchange	
Ramps	5
Permitted and marked crosswalks	4
Free-flow ramps	2
Unmarked crosswalks	1
Prohibited crossings	0
Crosswalks with or possibly with conflicts	4
Crosswalks without pedestrian lighting	5
Crosswalks missing pedestrian signals	0
Crosswalks longer than two travel lanes	4
Large/extra-large effective turn radii	5

N Main Street Overpass	
Length (mi)	0.78
Shoulders	None
Parking	Partial
Sides of street with complete sidewalks	One
Predominant walkway type	Narrow Curbside
Predominant bicycle facility	None
Continuity of bike facility	NA
Transit service	Yes
Predominant station type	Sign Post

Walnut Creek BART Station			
Vehicle access points	5	Crosswalks with median or refuge islands	8
Pedestrian access points	7	Crosswalks with or possibly with conflicts	10
Bicycle access points	0	Crosswalks without pedestrian lighting	14
Marked crosswalks	14	Crosswalks missing pedestrian signals	0
Unmarked crosswalks	1	Crosswalks longer than two travel lanes	10
Prohibited crossings	0	Large/extra-large effective turn radii	10

OVERVIEW OF IMPROVEMENT OPPORTUNITIES

There is no alternative parallel road on Side A. All bicycle facilities are categorized at B-level, and most pedestrian facilities are categorized at C-level. At the Hillside Ave ramp interchange, restriping and/or signal adjustment should be considered, with reconstruction a lesser need. At the Walnut Creek BART Station, restriping and/or signal adjustment should also be considered, with reconstruction a lesser need . At the N Main St ramp interchange, reconstruction should be considered.

Segment 14: Exit 47- North Main Street to Exit 48- Treat Boulevard/Geary Road/Oak Road

I-680 Freeway	
Length (miles)	0.81
Bicycles allowed on freeway	No
Alternative parallel roads	Side A: Continuous, Side B: None
Alternative parallel trail	Present
Perpendicular crossings	3
Interchange crossings	2
Non-Interchange crossings	1

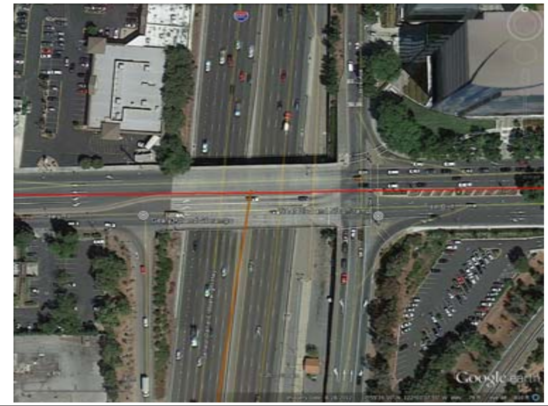
Side A: N Main St	
Length (mi)	0.65
Shoulders	None
Parking	Both
Sides of street with complete sidewalks	Both
Predominant walkway type	Wide Curbside
Predominant bicycle facility	None
Continuity of bike facility	NA
Transit service	Yes
Predominant station type	Sign Post

Iron Horse Regional Trail Path	
Length (mi)	0.66
Predominant path width	Wide
Arterial intersections along segment	0

Exit 47 N Main St Ramp Interchange	
Ramps	5
Permitted and marked crosswalks	4
Free-flow ramps	2
Unmarked crosswalks	1
Prohibited crossings	0
Crosswalks with or possibly with conflicts	4
Crosswalks without pedestrian lighting	5
Crosswalks missing pedestrian signals	0
Crosswalks longer than two travel lanes	4
Large/extra-large effective turn radii	5

N Main St Overpass	
Length (mi)	0.19
Shoulders	None
Parking	None
Sides of street with complete sidewalks	One
Predominant walkway type	Narrow Curbside
Predominant bicycle facility	None
Continuity of bike facility	NA
Transit service	Yes
Predominant station type	Sign Post

Contra Costa Canal Trail	
Length (mi)	0.51
Predominant path width	Wide



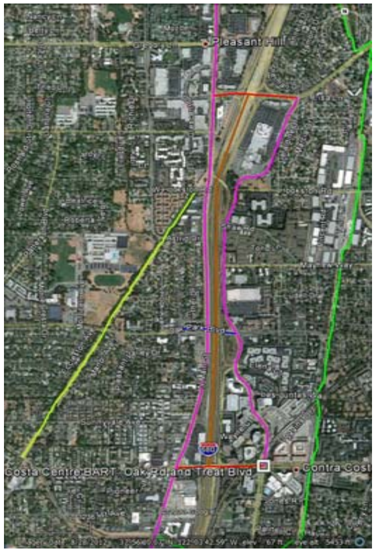
Exit 48 Treat Blvd/Geary Rd/Oak Rd Ramp Interchange	
Ramps	7
Permitted and marked crosswalks	8
Free-flow ramps	5
Unmarked crosswalks	1
Prohibited crossings	3
Crosswalks with or possibly with conflicts	7
Crosswalks without pedestrian lighting	9
Crosswalks missing pedestrian signals	1
Crosswalks longer than two travel lanes	4
Large/extra-large effective turn radii	4

Geary Rd/Treat Blvd Overpass	
Length (mi)	0.21
Shoulders	None
Parking	None
Sides of street with complete sidewalks	One
Predominant walkway type	Narrow Curbside
Predominant bicycle facility	None
Continuity of bike facility	NA
Transit service	Yes
Predominant station type	Sign Post

OVERVIEW OF IMPROVEMENT OPPORTUNITIES

Most bicycle facilities are categorized at B-level, and approximately half of all pedestrian facilities are categorized at C-level. At the N Main St ramp interchange, reconstruction should be considered. At the Treat/Geary/Oak Rd ramp interchange, restriping, signal adjustment, and/or reconstruction should be considered.

Segment 15: Exit 48- Geary Road/Treat Boulevard to Exit 49A- Buskirk Ave/Monument Boulevard



I-680 Freeway

Length (miles)	1.32
Bicycles allowed on freeway	No
Alternative parallel roads	Side A and B: Continuous
Alternative parallel trail	2
Perpendicular crossings	3
Interchange crossings	2
Non-Interchange crossings	1

Side A: N Main St/Contra Costa Blvd

Length (mi)	1.32
Shoulders	None
Parking	Partial
Sides of street with complete sidewalks	One
Predominant walkway type	Narrow Curbside
Predominant bicycle facility	None
Continuity of bike facility	NA
Transit service	No
Predominant station type	NA

Side B: Oak Rd/Buskirk Ave

Length (mi)	1.51
Shoulders	None
Parking	Partial
Sides of street with complete sidewalks	None
Predominant walkway type	Narrow Curbside
Predominant bicycle facility	None
Continuity of bike facility	NA
Transit service	Yes
Predominant station type	Sign Post

Iron Horse Regional Trail Path

Length (mi)	1.33
Predominant path width	Wide
Arterial intersections along segment	3

EBMUD Regional Trail Path

Length (mi)	1.1
Predominant path width	Wide
Arterial intersections along segment	3

Exit 48 Geary Rd/Treat Blvd Ramp Interchange

Ramps	7
Permitted and marked crosswalks	8
Free-flow ramps	5
Unmarked crosswalks	1
Prohibited crossings	3
Crosswalks with or possibly with conflicts	7
Crosswalks without pedestrian lighting	9
Crosswalks missing pedestrian signals	1
Crosswalks longer than two travel lanes	4
Large/extra-large effective turn radii	4

Geary Rd/Treat Blvd Overpass

Length (mi)	0.21
Shoulders	None
Parking	None
Sides of street with complete sidewalks	One
Predominant walkway type	Narrow Curbside
Predominant bicycle facility	None
Continuity of bike facility	NA
Transit service	Yes
Predominant station type	Sign Post

Oak Park Blvd Overpass

Length (mi)	0.18
Shoulders	Both
Parking	None
Sides of street with complete sidewalks	One
Predominant walkway type	Narrow Curbside
Predominant bicycle facility	None
Continuity of bike facility	NA
Transit service	Yes
Predominant station type	Sign Post

Exit 49A&B Buskirk Ave/Monument Blvd Ramp Interchange

Ramps	7
Permitted and marked crosswalks	14
Free-flow ramps	1
Unmarked crosswalks	0
Prohibited crossings	3
Crosswalks with or possibly with conflicts	6
Crosswalks without pedestrian lighting	14
Crosswalks missing pedestrian signals	0
Crosswalks longer than two travel lanes	7
Large/extra-large effective turn radii	14

Monument Blvd Underpass

Length (mi)	0.27
Shoulders	None
Parking	None
Sides of street with complete sidewalks	Both
Predominant walkway type	Narrow Curbside
Predominant bicycle facility	None
Continuity of bike facility	NA
Transit service	Yes
Predominant station type	Sign Post

Pleasant Hill/Contra Costa Centre BART Station

Vehicle access points	6	Crosswalks with median or refuge islands	6
Pedestrian access points	6	Crosswalks with or possibly with conflicts	10
Bicycle access points	2	Crosswalks without pedestrian lighting	14
Marked crosswalks	14	Crosswalks missing pedestrian signals	0
Unmarked crosswalks	0	Crosswalks longer than two travel lanes	10
Prohibited crossings	0	Large/extra-large effective turn radii	4

OVERVIEW OF IMPROVEMENT OPPORTUNITIES

This segment features long distances between crossings that are greater than the median length for the corridor. All bicycle facilities are categorized at B-level, and most pedestrian facilities are categorized at C-level. At the Treat/Geary/Oak Rd ramp interchange, the Pleasant Hill BART Station, and the Buskirk/Monument Blvd ramp interchange, restriping, signal adjustment, and/or reconstruction should be considered.

Segment 16: Exit 49A- Buskirk Avenue/Monument Boulevard to Exit 51- Sunvalley Boulevard/Willow Pass Road

I-680 Freeway	
Length (miles)	1.53
Bicycles allowed on freeway	No
Alternative parallel roads	Side A: Continuous, Side B: None
Alternative parallel trail	Present
Perpendicular crossings	2
Interchange crossings	2
Non-Interchange crossings	0

Side A: Contra Costa Blvd	
Length (mi)	0.94
Shoulders	None
Parking	None
Sides of street with complete sidewalks	Both
Predominant walkway type	Narrow Curbside
Predominant bicycle facility	None
Continuity of bike facility	NA
Transit service	Yes
Predominant station type	Improved

Iron Horse Regional Trail Path	
Length (mi)	1.48
Predominant path width	Wide
Arterial intersections along segment	0

Exit 49A&B Buskirk Ave/Monument Blvd Ramp Interchange	
Ramps	7
Permitted and marked crosswalks	14
Free-flow ramps	1
Unmarked crosswalks	0
Prohibited crossings	3
Crosswalks with or possibly with conflicts	6
Crosswalks without pedestrian lighting	14
Crosswalks missing pedestrian signals	0
Crosswalks longer than two travel lanes	7
Large/extra-large effective turn radii	14

Monument Blvd Underpass	
Length (mi)	0.27
Shoulders	None
Parking	None
Sides of street with complete sidewalks	Both
Predominant walkway type	Narrow Curbside
Predominant bicycle facility	None
Continuity of bike facility	NA
Transit service	Yes
Predominant station type	Sign Post

Exit 51 Sunvalley Blvd/Willow Pass Rd Ramp Interchange	
Ramps	5
Permitted and marked crosswalks	5
Free-flow ramps	3
Unmarked crosswalks	1
Prohibited crossings	3
Crosswalks with or possibly with conflicts	4
Crosswalks without pedestrian lighting	6
Crosswalks missing pedestrian signals	1
Crosswalks longer than two travel lanes	3
Large/extra-large effective turn radii	5

Sunvalley Blvd/Willow Pass Rd Underpass	
Length (mi)	0.65
Shoulders	None
Parking	None
Sides of street with complete sidewalks	One
Predominant walkway type	Narrow Curbside
Predominant bicycle facility	None
Continuity of bike facility	NA
Transit service	Yes
Predominant station type	Sign Post

OVERVIEW OF IMPROVEMENT OPPORTUNITIES

This segment features long distances between crossings that are greater than the median length for the corridor. All bicycle facilities are categorized at B-level, and most pedestrian facilities are categorized at C-level. At the Buskirk/Monument Blvd ramp interchange, restriping, signal adjustment, and/or reconstruction should be considered. At the Sunvalley/Willow Pass Rd ramp interchange, restriping and/or signal adjustment should be considered, with reconstruction a lesser need.

Segment 17: Exit 51- Sunvalley Boulevard/Willow Pass Road to Exit 52- Concord Avenue/Burnett Avenue

I-680 Freeway	
Length (miles)	0
Bicycles allowed on freeway	No
Alternative parallel roads	Side A & B: Continuous
Alternative parallel trail	Present
Perpendicular crossings	2
Interchange crossings	2
Non-Interchange crossings	0
Side A: Contra Costa Blvd	
Length (mi)	0.93
Shoulders	None
Parking	None
Sides of street with complete sidewalks	Both
Predominant walkway type	Narrow Curbside
Predominant bicycle facility	None
Continuity of bike facility	0
Transit service	Yes
Predominant station type	Sign Post
Side B: Diamond Blvd	
Length (mi)	0.82
Shoulders	None
Parking	None
Sides of street with complete sidewalks	Both
Predominant walkway type	Narrow Curbside
Predominant bicycle facility	None
Continuity of bike facility	0
Transit service	Yes
Predominant station type	Sign Post
Iron Horse Regional Trail Path	
Length (mi)	1
Predominant path width	Wide
Arterial intersections along segment	0

Exit 51 Sunvalley Blvd/Willow Pass Rd Ramp Interchange	
Ramps	5
Permitted and marked crosswalks	5
Free-flow ramps	3
Unmarked crosswalks	1
Prohibited crossings	3
Crosswalks with or possibly with conflicts	4
Crosswalks without pedestrian lighting	6
Crosswalks missing pedestrian signals	1
Crosswalks longer than two travel lanes	3
Large/extra-large effective turn radii	5
Sunvalley Blvd/Willow Pass Rd Underpass	
Length (mi)	0.65
Shoulders	None
Parking	None
Sides of street with complete sidewalks	One
Predominant walkway type	Narrow Curbside
Predominant bicycle facility	None
Continuity of bike facility	NA
Transit service	Yes
Predominant station type	Sign Post

Exit 52 Concord Ave/Burnett Ave Ramp Interchange	
Ramps	6
Permitted and marked crosswalks	6
Free-flow ramps	6
Unmarked crosswalks	0
Prohibited crossings	1
Crosswalks with or possibly with conflicts	6
Crosswalks without pedestrian lighting	6
Crosswalks missing pedestrian signals	1
Crosswalks longer than two travel lanes	3
Large/extra-large effective turn radii	4
Concord Ave Underpass	
Length (mi)	0.25
Shoulders	None
Parking	None
Sides of street with complete sidewalks	One
Predominant walkway type	Narrow Curbside
Predominant bicycle facility	None
Continuity of bike facility	NA
Transit service	No
Predominant station type	NA

OVERVIEW OF IMPROVEMENT OPPORTUNITIES

This segment features long distances between crossings that are greater than the median length for the corridor. All bicycle facilities are categorized at B-level, and approximately half of all pedestrian facilities are categorized at C-level. At the Sunvalley/Willow Pass Rd ramp interchange, restriping, signal adjustment, and/or reconstruction should be considered. . At the Concord/Burnett Ave ramp interchange, restriping, signal adjustment, and/or reconstruction should also be considered.

Segment 18: Exit 52- Concord Avenue/Burnett Avenue to Exit 54- Pacheco Boulevard/Arthur Road

I-680 Freeway	
Length (miles)	2.85
Bicycles allowed on freeway	No
Alternative parallel roads	Side A: Continuous, Side B: None
Alternative parallel trail	Partial
Perpendicular crossings	4
Interchange crossings	2
Non-Interchange crossings	2

Side A: Contra Costa Blvd/Pacheco Blvd	
Length (mi)	2.71
Shoulders	Partial
Parking	Partial
Sides of street with complete sidewalks	None
Predominant walkway type	Narrow Curbside
Predominant bicycle facility	Route
Continuity of bike facility	Both
Transit service	Yes
Predominant station type	Sign Post

Iron Horse Regional Trail Path	
Length (mi)	1.53
Predominant path width	Wide
Arterial intersections along segment	0

Exit 52 Concord Ave/Burnett Ave Ramp Interchange	
Ramps	6
Permitted and marked crosswalks	6
Free-flow ramps	6
Unmarked crosswalks	0
Prohibited crossings	1
Crosswalks with or possibly with conflicts	6
Crosswalks without pedestrian lighting	6
Crosswalks missing pedestrian signals	1
Crosswalks longer than two travel lanes	3
Large/extra-large effective turn radii	4

Exit 54 Pacheco Blvd/Arthur Rd Ramp Interchange	
Ramps	4
Permitted and marked crosswalks	3
Free-flow ramps	1
Unmarked crosswalks	3
Prohibited crossings	1
Crosswalks with or possibly with conflicts	5
Crosswalks without pedestrian lighting	6
Crosswalks missing pedestrian signals	0
Crosswalks longer than two travel lanes	3
Large/extra-large effective turn radii	3

Concord Ave/Burnette Ave Underpass	
Length (mi)	0.25
Shoulders	None
Parking	None
Sides of street with complete sidewalks	One
Predominant walkway type	Narrow Curbside
Predominant bicycle facility	None
Continuity of bike facility	NA
Transit service	No
Predominant station type	NA

Arthur Rd Underpass	
Length (mi)	0.45
Shoulders	Partial
Parking	Partial
Sides of street with complete sidewalks	One
Predominant walkway type	Narrow Curbside
Predominant bicycle facility	None
Continuity of bike facility	NA
Transit service	No
Predominant station type	NA

Center Ave Underpass	
Length (mi)	0.1
Shoulders	None
Parking	None
Sides of street with complete sidewalks	Both
Predominant walkway type	Narrow Curbside
Predominant bicycle facility	Route
Continuity of bike facility	Both
Transit service	Yes
Predominant station type	Sign Post

Blum Rd Underpass	
Length (mi)	0.31
Shoulders	Partial
Parking	Partial
Sides of street with complete sidewalks	Both
Predominant walkway type	Narrow Curbside
Predominant bicycle facility	Route
Continuity of bike facility	Both
Transit service	No
Predominant station type	NA

OVERVIEW OF IMPROVEMENT OPPORTUNITIES

This segment features long distances between crossings that are greater than the median length for the corridor. There is no alternative parallel road on Side B. All bicycle facilities are categorized at B-level, most pedestrian facilities are categorized at C-level, and there are portions of missing trail. At the Concord/Burnett Ave ramp interchange, restriping, signal adjustment, and/or reconstruction should be considered. . At the Pacheco/Arthur Rd ramp interchange, restriping and/or signal adjustment should be considered, with reconstruction a lesser need.

Segment 19: Exit 54- Pacheco Boulevard/Arthur Road to Exit 56- Marina Vista Road/Waterfront Road

I-680 Freeway	
Length (miles)	1.66
Bicycles allowed on freeway	No
Alternative parallel roads	Side A: Continuous, Side B: None
Alternative parallel trail	None
Perpendicular crossings	2
Interchange crossings	2
Non-Interchange crossings	0

Side A: Pacheco Blvd/Shell Ave	
Length (mi)	2.44
Shoulders	Both
Parking	None
Sides of street with complete sidewalks	Both
Predominant walkway type	Substandard
Predominant bicycle facility	Route
Continuity of bike facility	None
Transit service	Yes
Predominant station type	Sign Post

Exit 54 Pacheco Blvd/Arthur Rd Ramp Interchange	
Ramps	4
Permitted and marked crosswalks	3
Free-flow ramps	1
Unmarked crosswalks	3
Prohibited crossings	1
Crosswalks with or possibly with conflicts	5
Crosswalks without pedestrian lighting	6
Crosswalks missing pedestrian signals	0
Crosswalks longer than two travel lanes	3
Large/extra-large effective turn radii	3

Arthur Rd Underpass	
Length (mi)	0.45
Shoulders	Partial
Parking	Partial
Sides of street with complete sidewalks	One
Predominant walkway type	Narrow Curbside
Predominant bicycle facility	None
Continuity of bike facility	NA
Transit service	No
Predominant station type	NA

Exit 56 Marina Vista Rd/Waterfront Rd Ramp Interchange	
Ramps	4
Permitted and marked crosswalks	0
Free-flow ramps	0
Unmarked crosswalks	0
Prohibited crossings	0
Crosswalks with or possibly with conflicts	0
Crosswalks without pedestrian lighting	0
Crosswalks missing pedestrian signals	0
Crosswalks longer than two travel lanes	0
Large/extra-large effective turn radii	0

Marina Vista Rd/Waterfront Rd Underpass	
Length (mi)	0.9
Shoulders	Both
Parking	None
Sides of street with complete sidewalks	0
Predominant walkway type	None
Predominant bicycle facility	Lane
Continuity of bike facility	None
Transit service	No
Predominant station type	NA

OVERVIEW OF IMPROVEMENT OPPORTUNITIES

This segment features long distances between crossings that are greater than the median length for the corridor. There is no alternative parallel road on Side B. All bicycle facilities are categorized at B-level, all pedestrian facilities are categorized at C-level, and there are portions of missing trail. At the Pacheco/Arthur Rd ramp interchange, restriping and/or signal adjustment should be considered, with reconstruction a lesser need.

Appendix D: Smart Mobility Framework (SMF) Place Type Analysis Methodology

I-680 Corridor System Management Plan
Smart Mobility Framework (SMF)
Place Type Analysis Methodology

System Metrics Group, Inc.

August 15, 2012

Table of Contents

List of Exhibits

Introduction

System Metrics Group, Inc. (SMG) performed a place type assessment for the Contra Costa I-680 Corridor System Management Plan (CSMP). This analysis was done at the Traffic Analysis Zone (TAZ) level using the Smart Mobility Framework (SMF) Place Types. This document summarizes the findings of this analysis and describes the methodology used to label the place types.

These place type results should be reviewed by members of the I-680 CSMP Staff Working Group and Technical Advisory Committee (TAC) before being finalized. This will ensure that local expertise and knowledge of the communities is applied to the analysis.

Place Type Analysis Results Summary

Figure 1 is a map showing the results of the analysis for the I-680 corridor. Descriptions of the SMF Place Types are summarized in Figure 2. The table in Figure 2 also provides examples of areas related to the I-680 CSMP that were labeled as belonging to each SMF Place Type.

Based on the analysis, most of the I-680 CSMP corridor may be best described as the *Suburban Community* place type. Other predominant types include *Special Use Areas* such as the oil refineries near Martinez and the Concord Naval Weapons Station, and protected open space such as Mount Diablo State Park. *Suburban Centers* can be found in San Ramon in other areas.

Areas near the Walnut Creek and Concord BART rail transit stations were labeled as *Urban Centers* surrounded by a mix of *Suburban Centers* and *Close-In Compact Communities* all lying adjacent to I-680 and SR-242. Though the SMF Place Types have several sub-categories for the *Close-In* label, the SMG analysis did not attempt to distinguish between *Close-In Centers, Close-In Corridors,* or *Close-In Neighborhoods*. These were labeled with the more general *Close-In Compact Communities* designation.

Some *Suburban Community Dedicated Use Areas* along the corridor include Bishop Ranch in San Ramon, the California State University East Bay campus in Concord, and Waterworld Theme Park in Pleasant Hill.

Figure 1: SMF Place Types

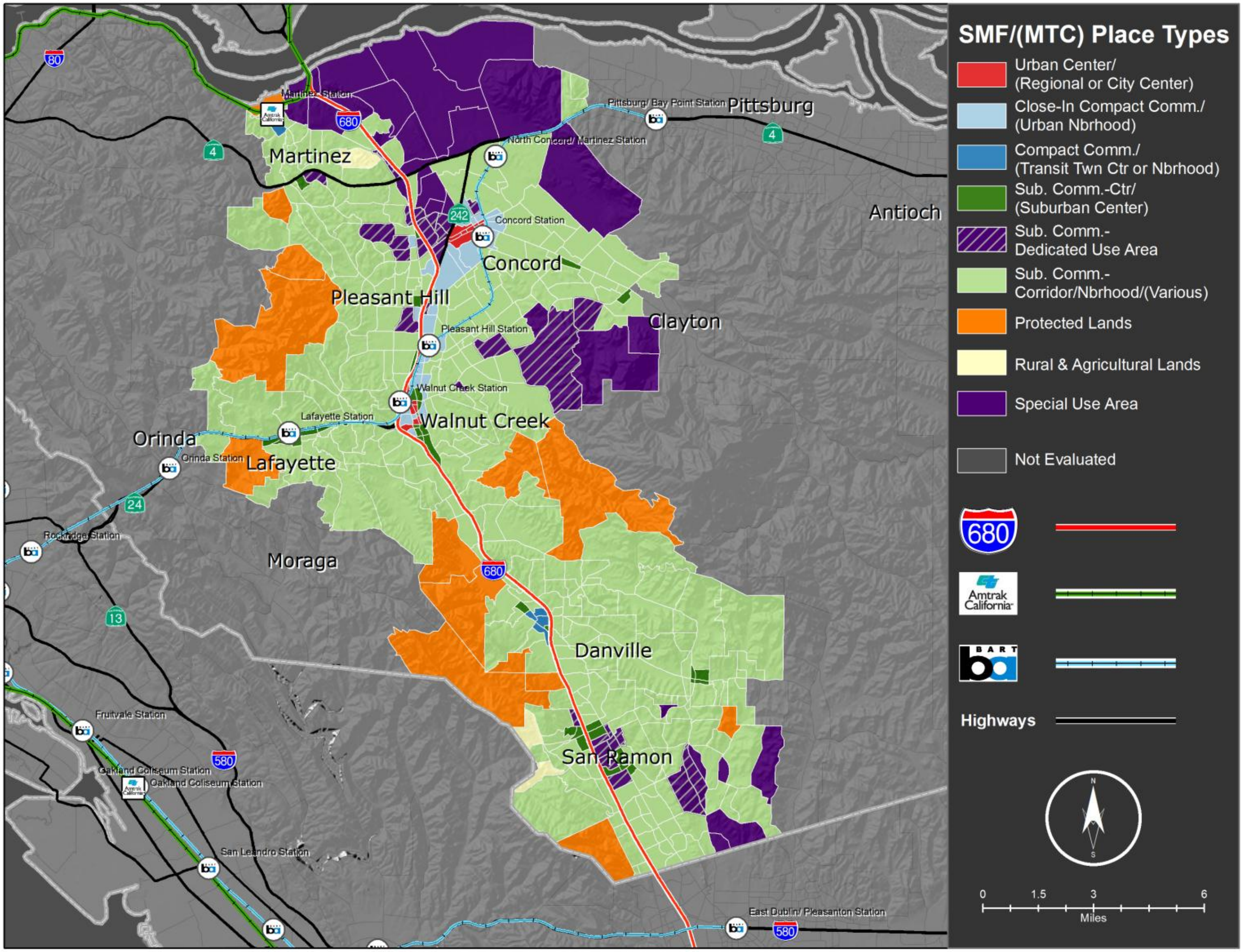


Figure 2: SMF Place Type Descriptions with Examples

Place Type	Definition	I-680 Corridor Examples
Urban Centers	High density, mixed use places with high jobs-housing ratios overall, well-connected street networks, high levels of transit service & pedestrian supportive environments. Transit-oriented development (TOD) fits into all of the urban place types.	
Urban Cores	Central cities & large downtowns with full range of horizontally- & vertically-mixed land uses & with high capacity transit stations/corridors present or planned. Urban cores hubs of transit systems with excellent transit coverage, service levels, & intermodal passenger transfer opportunities including convenient airport access.	None Identified
Urban Centers	Major activity centers with full range of horizontally- & vertically-mixed land uses & with high capacity transit stations/corridors present or planned.	Downtown Concord Downtown Walnut Creek
Close-in Compact Communities	Located near Urban Core or Urban Centers, close-in compact communities comprised primarily of housing but with scattered mixed use centers & arterial corridors forming the skeleton of the transportation system. Housing is varied in density & type. Transit is available to connect neighborhoods to multiple destinations, with an emphasis on serving commute trips. Residents may think of	Concord (near urban centers) Pleasant Hill (near urban centers) Walnut Creek (near urban centers)
Close-in Centers	Small & medium sized downtowns, Transit Oriented Developments, institutions, lifestyle centers, & other centers of activity	
Close-in Corridors	Arterial streets with variety of fronting development types, with frequent transit service & transfer opportunities	
Close-in Neighborhoods	Walkable neighborhoods with housing in close proximity to shops, services, & public facilities, as well as good multi-modal connections to urban centers. Housing density varies from medium to high. Fine-grained circulation network of streets with high comfort for pedestrians & bicyclists	
Compact Communities	Historic cities & towns as well as newer places characterized by strong presence of community design elements. While most compact communities outside of metropolitan regions, some on the periphery of metropolitan regions.	Downtown Danville Downtown Martinez
Suburban Communities	Low integration of housing with jobs, retail, & services, poorly connected street networks, low levels of transit service, large surface parking, & inadequate walkability. Suburban communities defined by weak-to-moderate presence of location efficient community design factors. Vary with respect to regional accessibility; some suburban communities located w/in easy commute distance of urban centers. Places that share characteristics with suburban communities—such as high proportion of detached housing, categorized as being in the suburban community place type only if they match the place type characterization relative to location efficiency factors	| | | | \/
Centers	Mid-size & small downtowns, lifestyle centers, or other activity centers embedded within suburban communities.	Blackhawk-Camino Tassajara Concord Danville Lafayette Pleasant Hill San Ramon Walnut Creek
Corridors	Arterial streets with variety of fronting development types, frequently characterized by inadequate walk & bike environments, low land use efficiency & poor aesthetics.	S. Main St Corridor (Walnut Creek)
Dedicated Use Areas	Large tracts of land used for commercial purposes such as business or industrial park or warehousing, or for recreational purposes such as golf courses.	Bishop Ranch Cal State East Bay Diablo Valley College Golf Courses (various) Pleasant Hill Education Center Sleep Train Pavilion Sun Valley Mall Veteran's Administration/Kaiser Permanente Hospital Waterwold California Willows Shopping Center
Neighborhoods	Residential subdivisions & complexes including housing, public facilities & local-serving commercial uses, typically separated by arterial corridors	Various
Rural and Agricultural Lands	Settlement pattern with widely-spaced towns separated by farms, vineyards, orchard, or grazing lands. The rural & agricultural place type may include tourist & recreation destinations which can significantly affect land uses, character & mobility needs	Viano Vineyards (Martinez)
Rural Towns	Rural towns provide mix of housing, services & public institutions in compact form that serve surrounding rural areas. They vary in size from crossroads with single clusters of commercial uses to towns offering full range of retail & service businesses. Towns may also be the focus of tourist & recreational activity or gateways to recreation areas in protected lands.	None Identified
Rural Settlements and Agricultural Lands	Scattered dwelling units & supporting commercial uses & public facilities, no significant subdivisions & limited non-agricultural industrial or commercial land use, & lands in agricultural or grazing use.	None Identified
Protected Lands	Lands protected from development by virtue of ownership, long-term regulation, or resource constraints	Briones Regional Park Carquinez Strait Regional Shoreline Lafayette Reservoir Recreation Area Las Trampas Regional Wilderness Lime Ridge Little Hills Ranch Regional Recreational Area Mt. Diablo State Park
Special Use Areas	Large tracts of single use lands that outside of, or poorly integrated with, their surroundings	Buchanan Field Airport CEMEX Clayton Aggregates Concord Disposal Services Concord Naval Weapons Station Keller Canyon Landfill Miscellaneous Industrial/Oil Refineries Sewage/Water Treatment Plants U.S. Army Reserve Parks Reserve Forces Training Area

Analysis Methodology Overview

This section describes the methodology used by SMG to label the TAZes by SMF Place Type. Most of the SMF Place Types describe areas at jurisdictional levels below the city or town level. Three of the 18 place types (Suburban Communities, Compact Communities and Rural and Agricultural Lands) can be applicable to a town or city level, but the remaining (e.g., "corridor-level") require a greater level of detail. This required the study team to perform an analysis smaller than the city or town level in order to capture the differentiation among the communities along the I-680 corridor. The study team attempted to label TAZes as given place types based on general criteria from the Smart Mobility Framework that include:

- Completeness in relation to land use and activities
- Connectivity of Transportation Networks
- Accessibility to a range of destinations throughout the area
- Local transit service
- Safe and convenient bicycling and walking.[1]

The process for developing the place types was iterative as illustrated in Figure 3. The process began by using 2010 land use and socio-economic data at the TAZ level.[2]

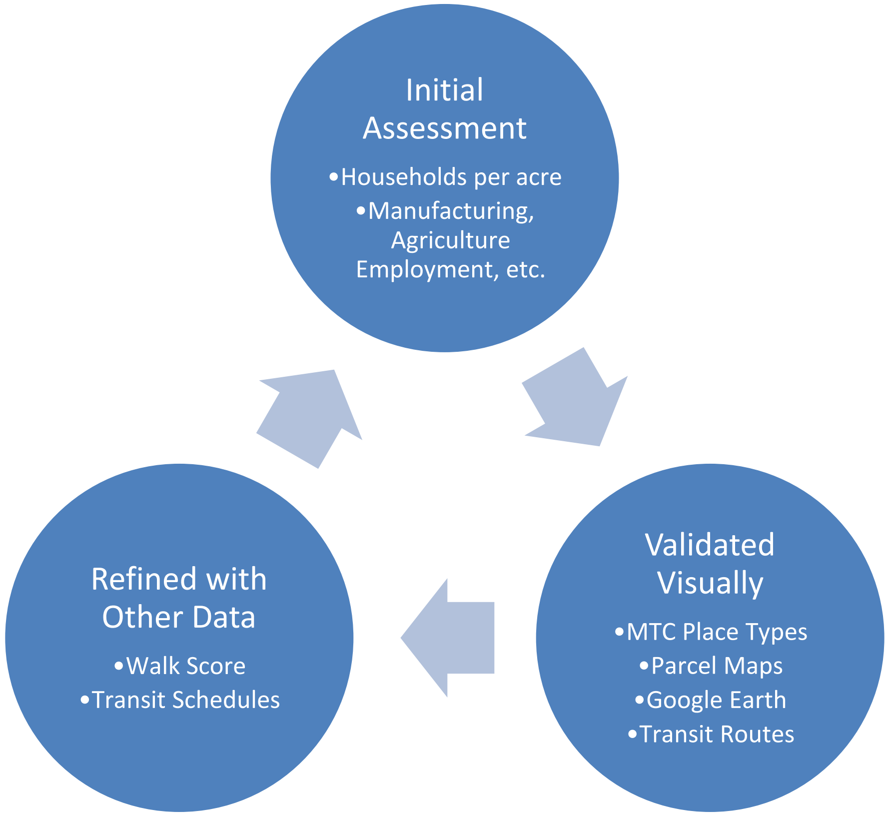
The TAZ-level data is used to develop the CCTA countywide travel demand model and is linked to Geographic Information System (GIS) spatial coverages for visualization. Key data from this dataset included households and employment data including manufacturing and agricultural employment.

This data was supplemented by other data from Walk Score®, an internet-based site that rates street addresses based on the walkability to nearby utilitarian amenities (e.g., grocery, restaurants, entertainment)[3]. Transit schedules were also used to attempt to label place types.

Finally, TAZes were labeled based on a visual inspection of land use parcel and transit station and route GIS coverages provided by CCTA as well at maps showing Metropolitan Transportation Commission (MTC) Place Types. One of the most important tools used by the study team was Google Earth®, a geo-spatial satellite imagery viewing software that also has a "Street View" feature that allows one to view images at street level.

[1] California Department of Transportation. *(2010). Smart Mobility 2010: A Call to Action for the New Decade*. http://www.dot.ca.gov/hq/tpp/offices/ocp/documents/smf_files/SMF_handbook_062210.pdf
[2] Contra Costa Transportation Authority (2010). CCTA Countywide Model Master Land Use Data.
[3] www.walkscore.com

Figure 3: General Place Type Evaluation Methodology



Labeling TAZes with SMF Place types was an iterative process using all of the data sources and tools described above. There were also challenges in that there are no firm guidelines to apply quantitative measures to place types. For example, one of the key features of a highly compact place is residential density, but there are no thresholds to use for what constitutes a *Close-In Compact Neighborhood* versus a *Suburban Neighborhood*. The same holds true for other quantitative measures.

However, in combination with a visual validation, it may be possible to develop a "first cut" at identifying place types pending a thorough review by community representatives with extensive local experience and knowledge.

The following sections discuss in more detail each of the data sources and tools used for this analysis, including:

- CCTA Traffic Analysis Zone (TAZ) Data
- MTC Place Types
- CCTA Parcel Maps
- Google Earth®
- Walk Score®
- Transit Schedules.

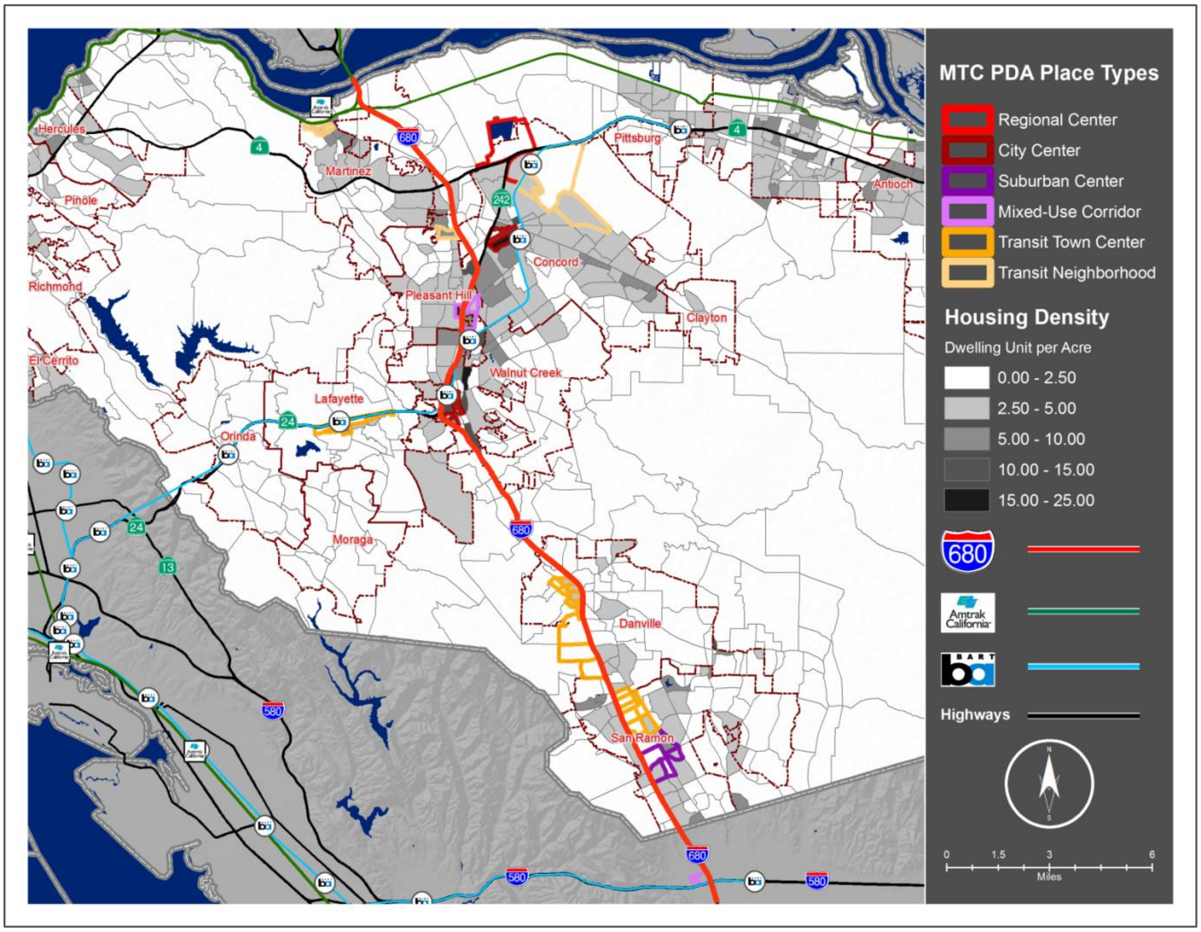
CCTA Traffic Analysis Zone (TAZ) Data

The first step in the place type analysis was to obtain 2010 Land Use data by TAZ from the CCTA travel demand model. This extensive data includes several key variables that were used at least for the initial screening of TAZes including:

- Acres
- Households
- Total Employment
- Retail Employment
- Service Employment
- Other Employment
- Agricultural Employment
- Manufacturing Employment
- Wholesale Employment.

The TAZ household and acreage data were used to develop the Households per Acre statistic used to gauge residential housing density. Though it is preferable to use housing units per acre instead of households per acre as a measure of density, this data was not readily available for the analysis. The reason that housing units is a better measure is that it accounts for empty units that may be available. Because the foreclosure crisis hit some areas of Contra Costa County particularly hard, using households may not represent the true residential density of a particular TAZ. Figure 4 illustrates how household density data was used as part of the evaluation and combined visually with MTC Place Types (discussed below).

Figure 4: Household Density and MTC Place Types



The CCTA data also has several employment statistics that were used to identify the mix of employment in a TAZ. For this analysis SMG grouped retail and service employment into a category called "Local Serving" commercial employment, which may be an indicator of commercial retail businesses that residents may be able to readily access. For example, a TAZ with high number of retail stores and services and high residential densities may be a TAZ that is a compact community if verified by visual inspection.

Manufacturing and Wholesale employment were added together into a single category because this type of employment may be indicative of a special use area. A TAZ with high total manufacturing and wholesale employment, high relative employment as a percentage of other types of employment, and with low residential densities is likely a TAZ that is a *Special Use Area* place type.

Agricultural employment was used to identify "Rural and Agricultural Lands" place types. If a TAZ has high total agricultural employment and as a percentage of other employment types in conjunction with residential densities, then that place type was flagged as rural and agricultural pending a visual inspection.

The CCTA data was sorted first by the Manufacturing+Wholesale employment category. TAZes with high absolute and relative levels of employment were reviewed in Google Earth®. If the analyst concluded that they appeared to be a *Special Use Area* they were labeled accordingly. Once the analyst was unable to determine the place type visually, this analysis was stopped and other methods were used to evaluate the TAZes. The same approach was used for Agricultural land uses.

Initially, the household density metric was analyzed in a similar manner to the employment data. Once sorted, the analyst would flag the highest density TAZes and flag them as being *Close-In*. This *Close-In* classification was further scrutinized by using the Walk Score®, "Local Serving" employment, and visually to qualitatively label the TAZ was *Close-In* or a "Center" (e.g., Urban or Suburban) or one of the *Suburban Community* classifications.

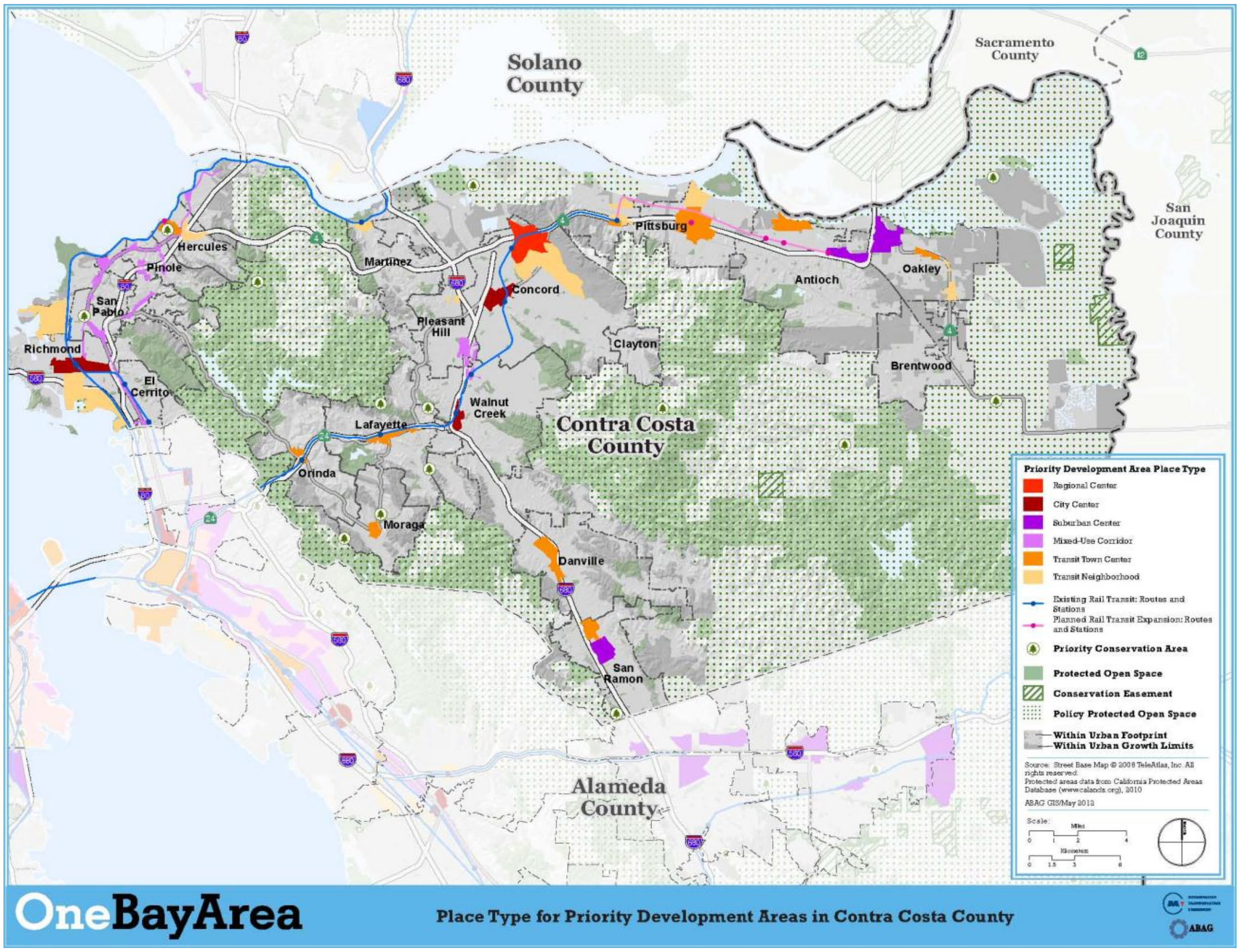
As one of the final review steps in the analysis, these socio-economic data items were used to identify TAZes that may have a place type label applied incorrectly during the process. The data were re-sorted by assigned place type and a review of the extreme values was performed. For example, if a TAZ was labeled as a *Close-In* place type, yet had a very low household density, that TAZ was reviewed visually a final time for classification.

MTC Place Types

SMG mapped the MTC Place Types to the CCTA TAZ coverage (Shown in Figure 4 above). The MTC Place Types were developed in coordination with local jurisdictions to help communities to identify Priority Development Areas (PDAs) where there exist opportunities for future infill development as shown in Figure 5.

The MTC Place Type classifications may be more prescriptive of what can be done to benefit a community rather than descriptive of an existing condition where the SMF Place Types are more descriptive in labeling of existing land uses within an area that may be candidates for transition to another place type.

Figure 5: MTC Contra Costa County Place Types



Source: Association of Bay Area Governments (ABAG) Jobs-Housing Connection Strategy. May 2012.

The MTC Place Types were used in this analysis to validate the SMF Place Type labeling. For example, downtown Danville is a *Transit Town Center* PDA with local commitment to increase housing and amenities in a pedestrian-friendly environment served by transit.[1]

Since downtown Danville currently has housing densities, relatively high Walk Scores® to existing amenities, and relatively accessible transit services it was labeled by the study team as a "Compact Community" SMF Place Type to be consistent with the community defined *Transit Town Center* Place Type.

SMG attempted to label TAZes with an MTC/SMF correspondence. However, the existing condition of the location did not correspond to the future-looking MTC Place Type. For example, TAZes adjacent to the North Concord/Martinez BART Station are designated as a *Regional Center* MTC Place Type. But when these were reviewed by the study team, these locations were deemed to be closer to the

[1] Eligibility to be classified as a PDA, a community has to be near existing or planned fixed transit or served by comparable bus service, and planned for more housing according to MTC guidelines.

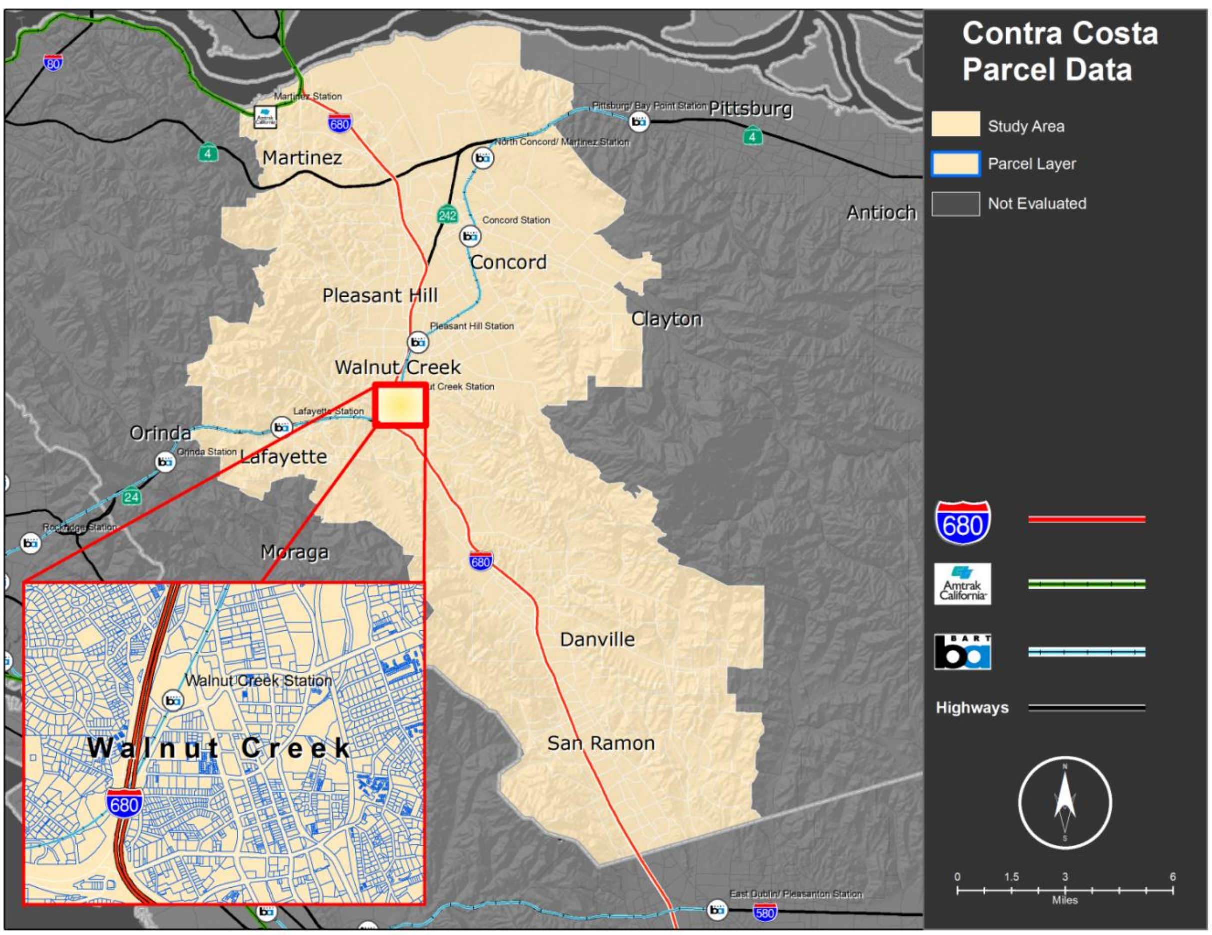
Suburban Community or *Special Use Area* SMF Place Type even though much of that area has been designated by the community to transition to a *Regional Center* PDA. The SMG analysis indicated relatively low existing residential densities as well as few people-oriented land uses and amenities near the BART Station.

CCTA Parcel Maps

The parcel maps by CCTA proved extremely useful to identify *Suburban Community* Place Types. The parcel maps show each parcel of land along with street layouts for Contra Costa County as illustrated in Figure 6. Since much of the I-680 study corridor may be considered suburban residential in nature, the majority of TAZes were labeled *Suburban Community* by overlaying the TAZ GIS coverage on top of the parcel maps and manually selecting TAZes that "looked" suburban due to the street layout (e.g., having cul-de-sacs).

Follow-up analyses using other metrics were used to ultimately label TAZes, but this tool allowed the study team to quickly identify the majority of place types.

Figure 6: Contra Costa County Parcel Data

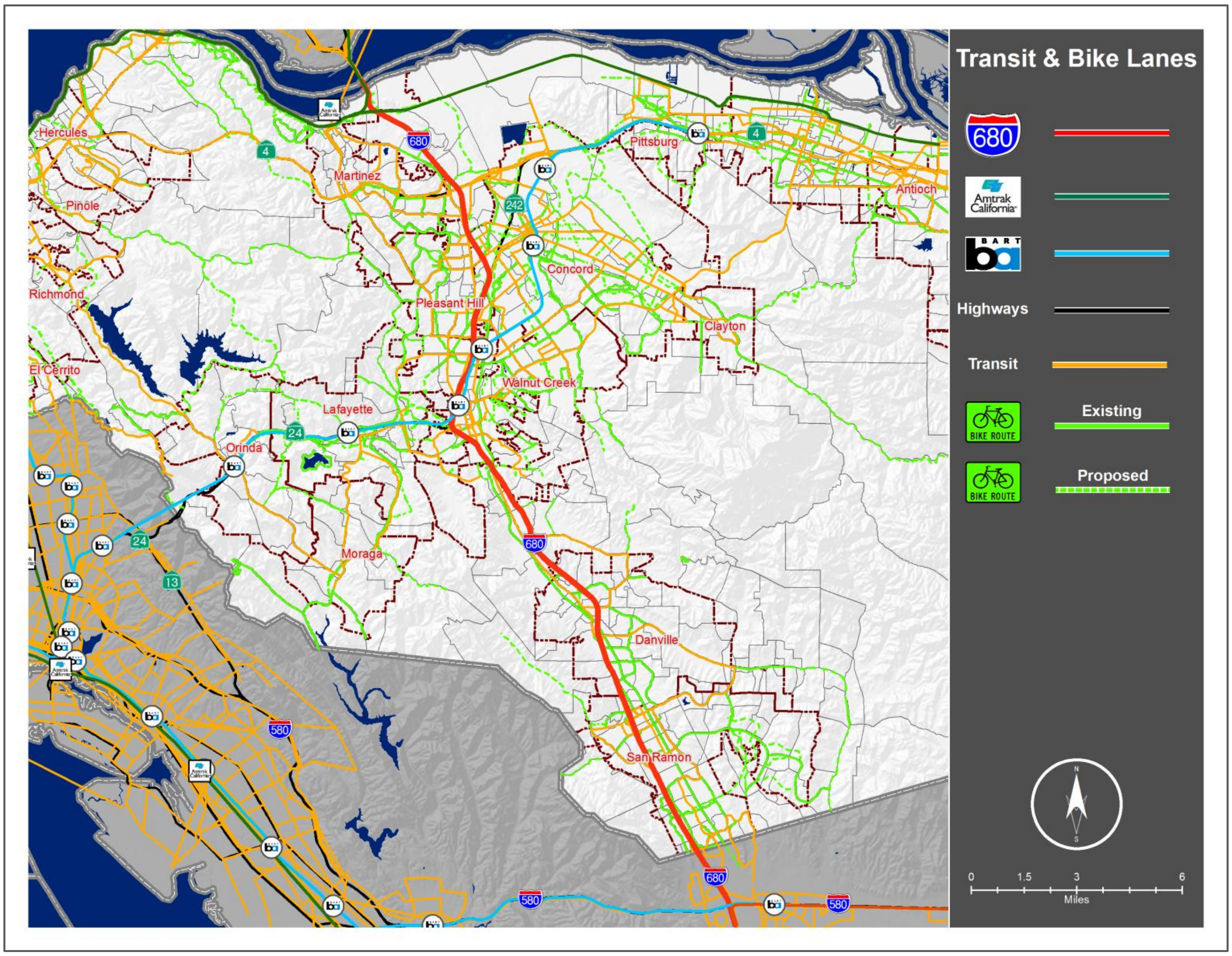


Source: CCTA Parcel GIS Coverages 2012.

CCTA Transit, Bicycle and Pedestrian GIS Coverages

These GIS coverages illustrated in Figure 7 were useful to visually identify TAZes with high concentrations of transit and non-motorized access. These coverages were used primarily to qualitatively review TAZes. For example, TAZes within a quarter mile of BART stations were flagged for identification as an Urban or Suburban Center, or *Close-In* place types unless other criteria suggested that another place type classification was more important.

Figure 7: Contra Costa County Transit and Bike Lanes



Source: CCTA Transit and Bicycle GIS Coverages 2012.

Google Earth®

Google Earth is a well-known virtual globe mapping software package used by Caltrans and other regional agencies for planning purposes.

Google Earth was the primary tool used to visually validate SMF Place Types in conjunction with CCTA Parcel Maps. All TAZes labeled *Special Use Area* were validated using Google Earth, and it was instrumental in reviewing all TAZes where questions existed about the Place Type label.

Uses of Google Earth include cases where a TAZ was labeled as *Close-In*, but had a low Walk Score® or was labeled as a *Suburban Community*, but had a high Walk Score. As mentioned earlier, TAZes with high manufacturing or agricultural employment were verified using Google Earth before labeling them as *Special Use Area*.

Walk Score®

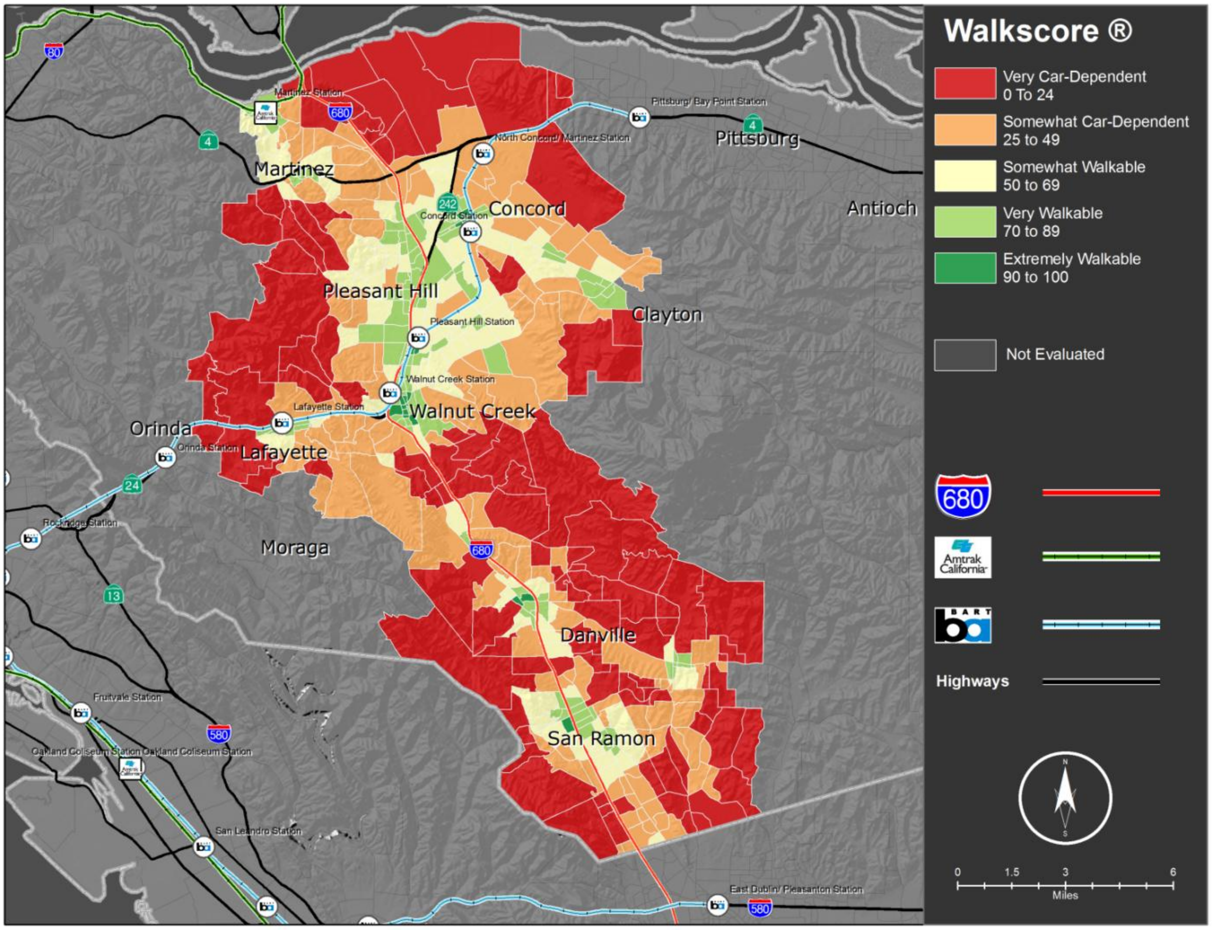
Walk Score®[1] is a system to rate, from a score of 0 to 100, the walkability of a location based on an algorithm that evaluates the distance to utilitarian amenities in various categories. (Walk Score, 2011) The patent pending methodology calculates the most likely route and distance to one of nine amenity categories and penalizes locations that have long blocks or low intersection density. In addition it weights the categories according to their importance. The nine categories and the respective weightings are shown below:

- Grocery
- Coffee
- Banks
- Books
- Entertainment
- Parks
- Schools
- Restaurants
- Shopping.

SMG recognizes that Walk Score® may not be fully tested as a metric for pedestrian-oriented neighborhoods as it is not currently used by Caltrans, CCTA, or other regional entities for planning. Moreover, there may be very walkable neighborhoods that are not quantified as such by Walk Score. The study team, therefore, used it as one metric among many in evaluating place types.

[1] http://www.walkscore.com/

Figure 8: I-680 Corridor Walk Scores



Source: SMG analysis of Walk Score. 2012

To analyze the TAZes, SMG took the centroid of each TAZ near the corridor or belonging to a city or town that touches the corridor and used the Walk Score® website to produce the associated score for the TAZ. The results of this analysis are shown in Exhibit x below. For very large TAZes, this may not accurately capture the walkability of that TAZ if, say, the TAZ is largely vacant, but with a walkable neighborhood on edge of the TAZ. The team used the Walk Score® recommended ranges for walkability as follows:

- 0-24 Very Car Dependent
- 25-49 Somewhat Car Dependent
- 50-69 Somewhat Walkable
- 70-89 Very Walkable
- 90-100 Extremely Walkable.

If a TAZ was near an *Urban Center* Place Type such as in Walnut Creek, had relatively high household densities, and a high Walk Score, it would be labeled as an *In-Close Compact* TAZ. If the same TAZ was instead not adjacent to an Urban Center, it would be labeled as a *Suburban Center*.

One result of using the Walk Score® methodology, was that the team labeled some TAZes in the Blackhawk-Camino Tassajara community as a *Suburban Center* based on the Walk Score® in addition to the residential densities and the access transit in that area. One of the objectives of the SMF is to be able to identify areas with potentially high "latent" location efficiency where land use, urban design patterns, and demographic characteristics could improve Smart Mobility outcomes if a fuller range of transportation facilities and services were present. (California Department of Transportation, 2010)

It is also important to note that Walk Score® was correlated with TAZ size. This is to be expected since TAZes are sized based on the demographics in an area. Cities or towns with higher population or employment densities have smaller TAZes.

Transit Schedules

In some cases, transit schedules were reviewed to assess the frequency of service. This was done if there was a question about whether to label a TAZ as a *Suburban Community* or a Close-In Community. A TAZ with a transit access with a high frequency of peak period service may be designated a Close-In Community if adjacent to other TAZes with a similar label or if it lay near an Urban Center.

Works Cited

California Department of Transportation. (2010). *Smart Mobility 2010: A Call to Action for the New Decade.* Sacramento: California Department of Transportation.

Contra Costa Transportation Authority. (2012). 2010 CCTA Countywide Model Master Land Use Data. Pleasant Hill, California, USA.

Walk Score. (2011). *Walk Score Methodology.* Seattle.

Walk Score. (2012). *Walk Score*. Retrieved June 2012, from Walk Score: www.walkscore.com

Appendix E: Bottleneck Identification

There were several data sources used to identify corridor bottlenecks. In addition to a review of previous studies and on-going Caltrans monitoring efforts, PeMS data and tachometer vehicle runs using GPS technology were the major sources used to identify these choke points. Field visits and videotaping were used to validate the locations prior to an extensive review by Caltrans, MTC, and CCTA staff.

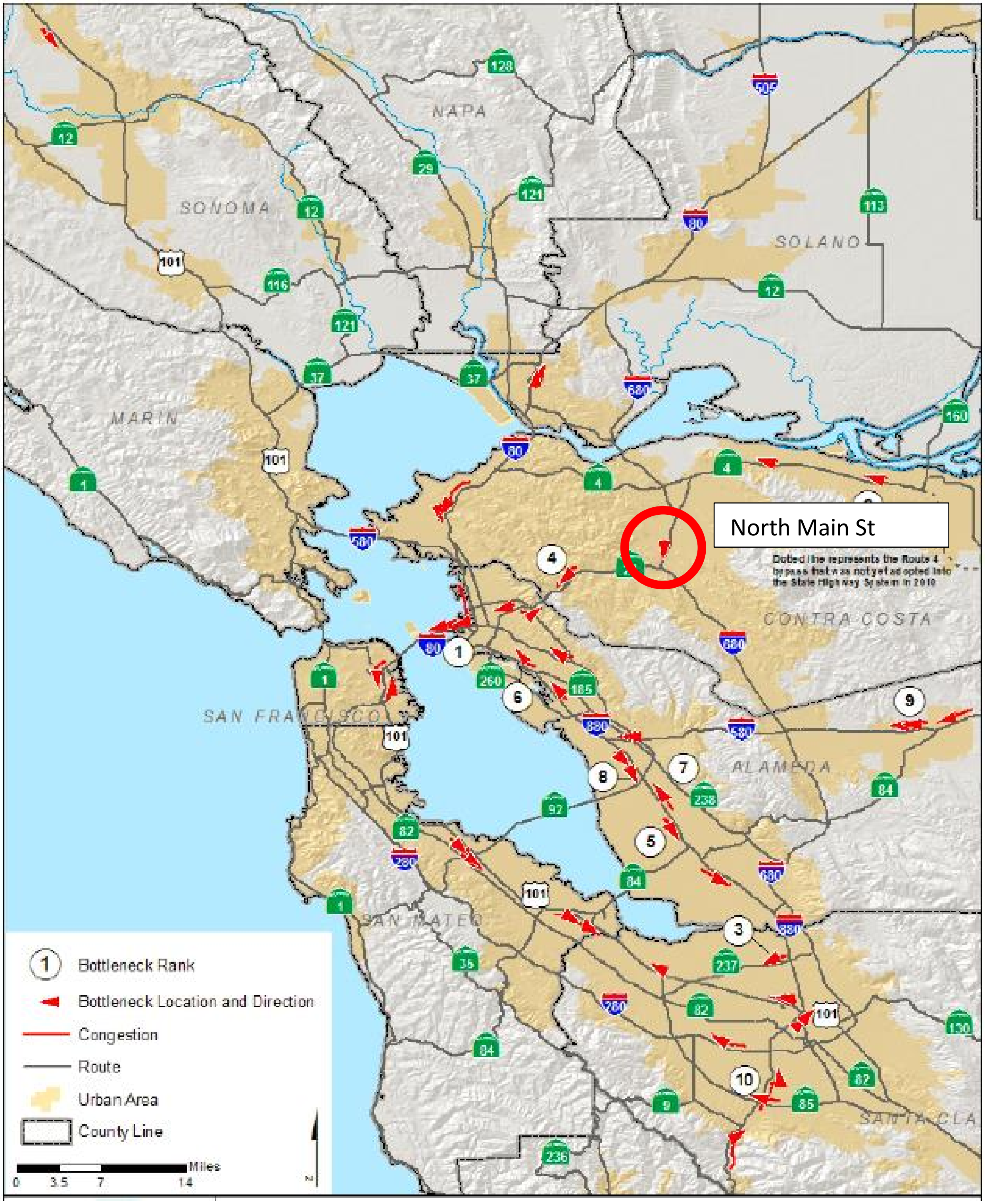
Caltrans Mobility Performance Report (MPR)

The MPR is the Caltrans report to actively monitor State Highway System (SHS) performance at the county, Caltrans district, and statewide level. The most recent MPR, year 2010, reports freeway annual vehicle hours of delay (AVHD) and lost productivity. Furthermore, it identifies major bottleneck locations, specifically on the Contra Costa County I-680 CSMP corridor. The report lists Contra Costa I-680 as the eighth most congested freeway in the district. Exhibit E-1 shows the District 4, AM peak period, bottleneck locations, while Exhibit E-2 illustrates the PM peak period. The Contra Costa County I-680 CSMP corridor bottlenecks are circled in red.

The exhibits support four of the bottlenecks presented above. In the AM peak period, Exhibit E-1 shows a bottleneck in the southbound direction, just north of the SR-24 interchange in Walnut Creek. This location is consistent with the southbound bottleneck, identified at the lane drop, just south of the southbound off-ramp to North Main Street in Walnut Creek.

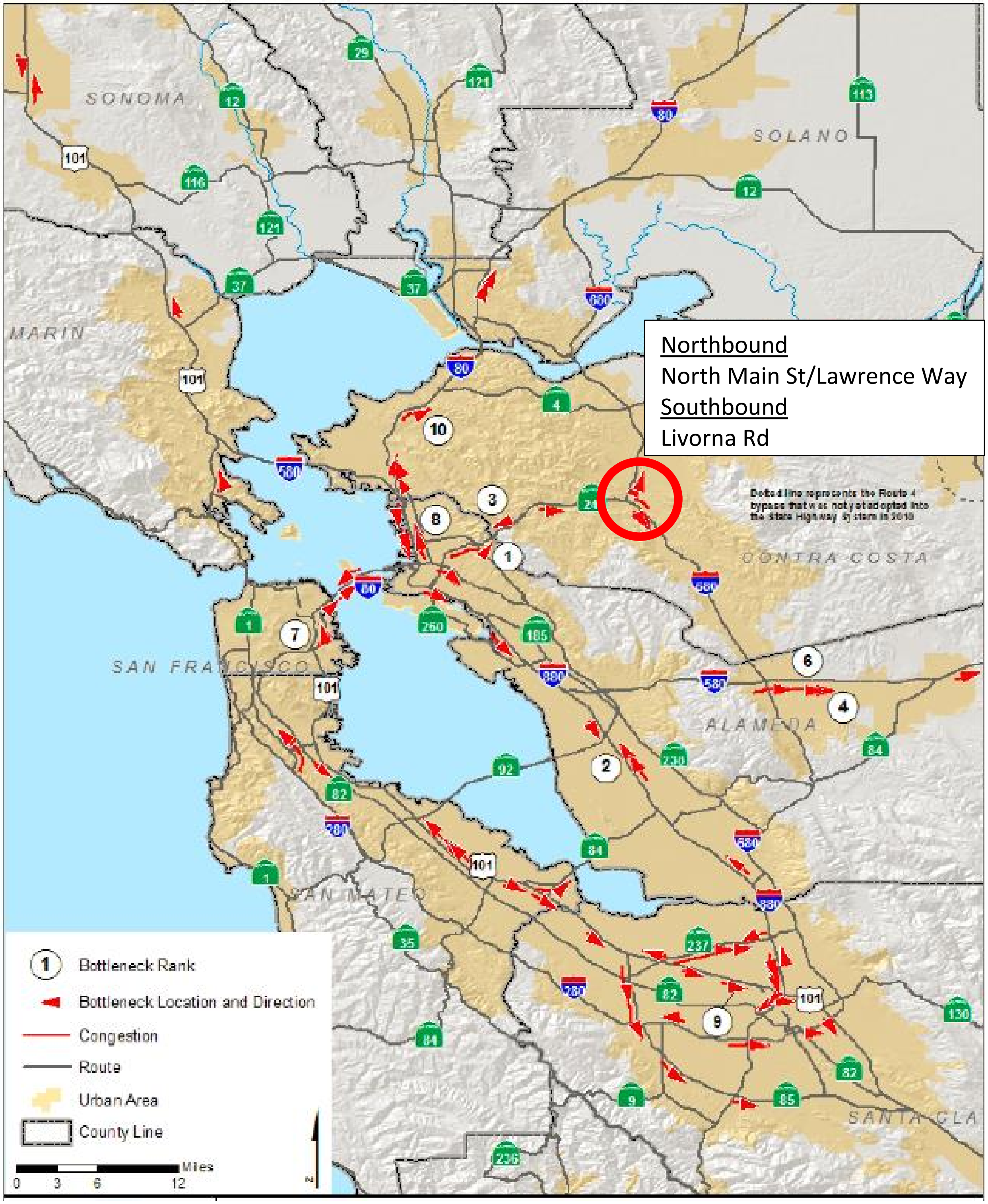
Exhibit E-2 shows the PM peak period bottlenecks, with two Contra Costa County I-680 CSMP corridor bottlenecks highlighted. The northernmost location is consistent with the bottlenecks at the North Main Street off-ramp in Walnut Creek. Immediately downstream from that location is another bottleneck at the on-ramp from Lawrence Way (and North Main St) and the off-ramp to Treat Boulevard. The fourth consistent bottleneck is the PM peak period bottleneck identified in the MPR at the approximate location of the Livorna southbound off-ramp bottleneck.

Exhibit E-1: Caltrans MPR AM Peak Period Bottlenecks



Source: Caltrans 2010 Mobility Performance Report.

Exhibit E-2: Caltrans MPR PM Peak Period Bottlenecks



Source: Caltrans 2010 Mobility Performance Report.

Other Studies

Other efforts have also identified bottlenecks on the corridor. In August 2013, the Draft Final Traffic Operations Report: MTC Phase I Express Lane Project – I-680 Corridor identified bottlenecks on the corridor based on tachometer runs conducted on April 17, 18, and 19, 2012, which are summarized below in Exhibit E-3. Each of these bottlenecks was also verified as bottleneck locations for the Contra Costa County I-680 CSMP.

Exhibit E-3: MTC Phase I Express Lane Project Bottlenecks

Direction	Bottleneck Location Between…	From…		To…		Active During		I-680 CSMP Bottleneck Location
		AbsPM	CaPM	AbsPM	CaPM	AM	PM	
Northbound	Crow Canyon WB on-ramp and Sycamore off-ramp	35.85	R4.436	37.9	R6.508		✓	Yes
	El Cerro on-ramp and El Pintado on-ramp	39.71	R8.319	40.24	R8.844		✓	Yes, combined with downstream El Pintado On Ramp
	El Pintado on-ramp and Stone Valley off-ramp	40.24	R8.844	41.8	R10.403	✓	✓	Yes, combined with upstream El Cerro On Ramp
	Livorna on-ramp and Rudgear Road off-ramp	42.79	R11.398	43.85	R12.456		✓	Yes
	Olympic/SR 24 off-ramp to Olympic on-ramp	45.38	13.875	45.59	14.09		✓	Yes
	North Main on-ramp and Treat off-ramp	47.24	15.734	47.67	16.171		✓	Yes, but also identified lane drop at NB Off to N. Main St. as a bottleneck location
Southbound	Stone Valley on-ramp and El Pintado off-ramp	41.6	R10.208	40.273	R8.881	✓		Yes
	Livorna on-ramp and Stone Valley off-ramp	42.526	R11.134	41.958	R10.566	✓		Yes
	South of the lane drop North Main off-ramp and North Main on-ramp	47.384	15.883	47.002	15.501	✓		Yes

Source: Metropolitan Transportation Commission. Draft Final Traffic Operations Report: MTC Phase I Express Lane Project – I-680 Corridor

PeMS Data

A detailed analysis of PeMS data was performed to supplement this effort. Speed contour plots show speeds for every detector location at five-minute intervals period throughout the day. The resultant plot shows the location, extent, and duration of congestion. Multiple days of plots were examined to assess bottlenecks. The PeMS review was used to identify potential bottleneck areas that would be examined with further field reviews conducted in March 2012, November 2012, and March 2013.

Exhibit E-4 shows a series of daily contour plots for the northbound direction. Exhibit E-5 shows the southbound direction plots.

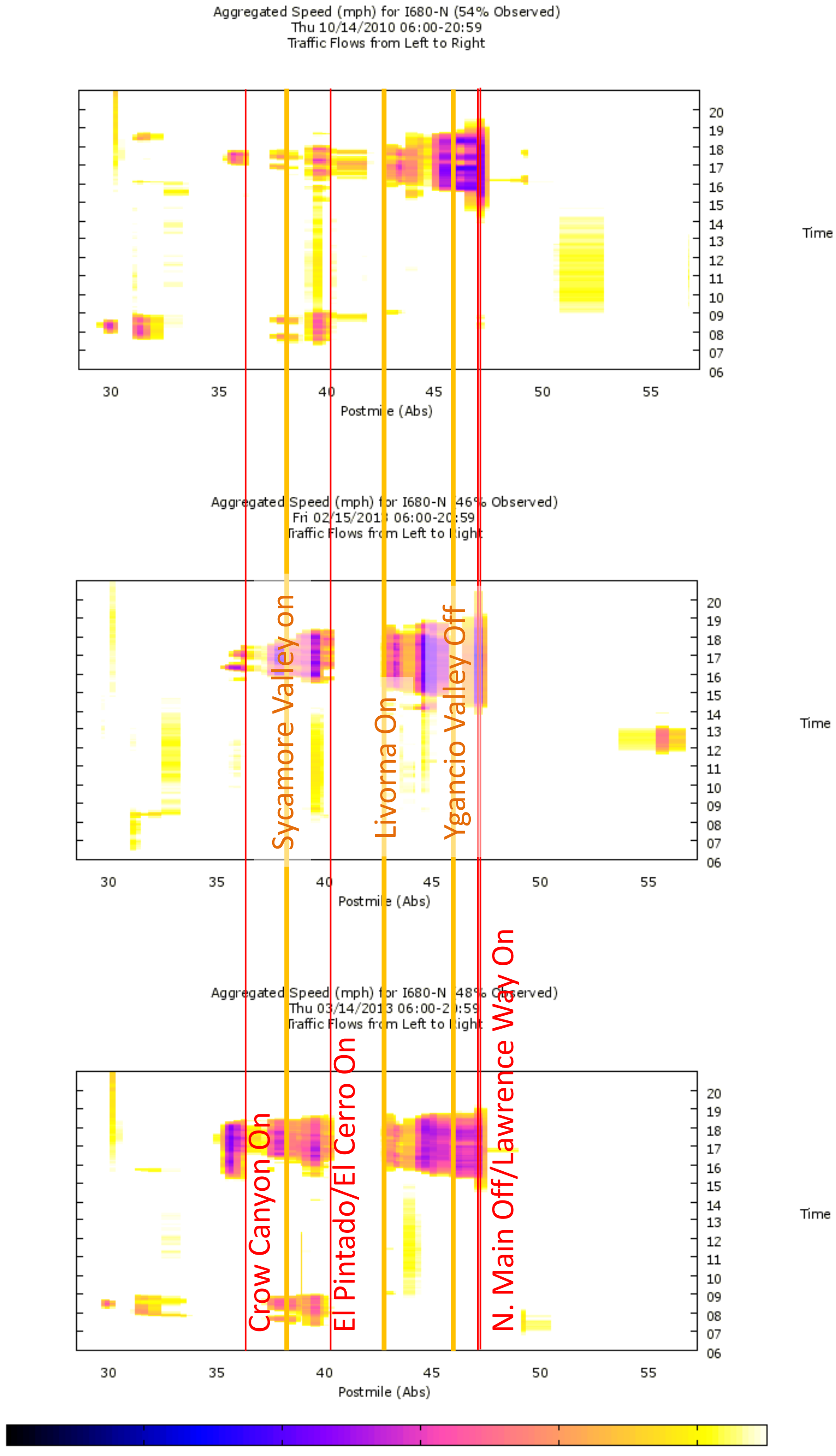
The plots show three days of data: October 14, 2010, February 15, 2013, and March 14, 2013. The x-axis is the PeMS absolute postmile (AbsPM). The absolute postmiling system starts at the southern end of I-680, at postmile "0.00" in Santa Clara County, and ascends to the northern end of the freeway at I-80 in Solano County. The limits of the Contra Costa County I-680 CSMP corridor, for the TOPL simulation effort, are from Stoneridge Drive in the City of Pleasanton in Alameda County (AbsPM 28.7) to the Solano County Line (AbsPM 57.16). Travel down the corridor is from left to right along the x-axis.

The y-axis is the hour of the day. Starting at the bottom is the midnight hour, "0", extending to 11:59 PM (i.e., 23:59) at the top. The color coded areas show the reported speeds. Areas with no color reported average speeds greater than 55mph. The colors get progressively darker as the speeds slow. Areas coded in yellow are not severely congested, but do show some slowing in the 45-55mph range. The darkest areas are those experiencing the most congestion.

In the northbound direction, several potential bottlenecks were identified as shown in Exhibit E-4. These locations are marked by red and purple lines. The red lines represent the major or controlling bottlenecks, identified in Exhibit 5-2, and the purple lines represent other bottleneck locations (hidden or minor). There are several locations that show yellow shading. These areas report some slowing, but not consistently, and were not confirmed during field visits. All the major bottlenecks identified by this current study appear in the plots as being severely congested.

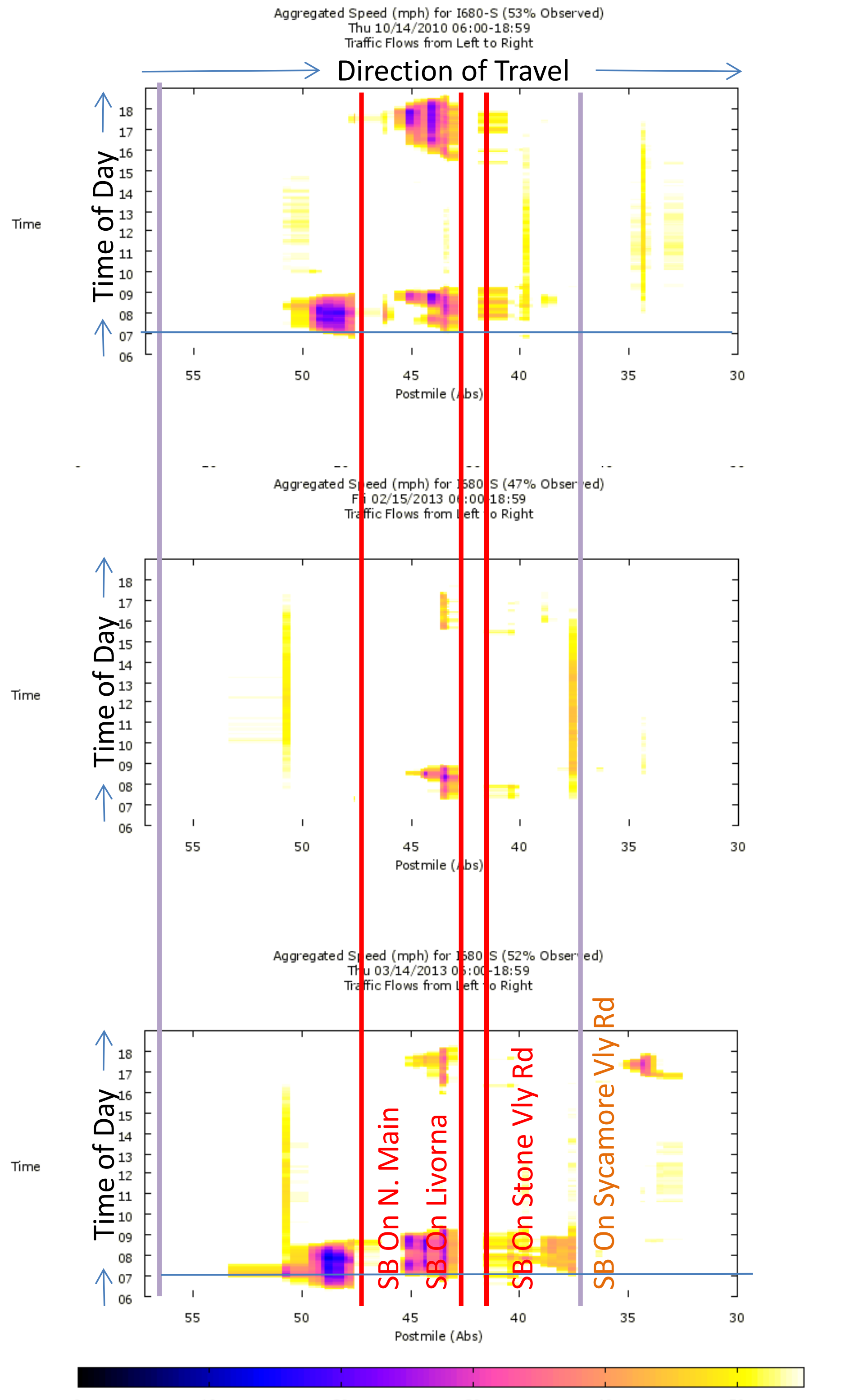
Exhibit E-5 displays similar charts for the southbound direction. All the major bottlenecks, identified by and shown in Exhibit 5-2, also appear in these plots, except for the Stone Valley Road bottleneck location. This location was identified by other studies (see above), and by tachometer runs conducted on March 21, 2013.

Exhibit E-4: Northbound I-680 Speed Contour Plots



Source: SMG Analysis of Caltrans Performance Measurement System (PeMS) data

Exhibit E-5: Southbound I-680 Speed Contour Plots



Source: SMG Analysis of Caltrans Performance Measurement System (PeMS) data

Field Observations

An important aspect of this effort was to perform field visits to validate bottlenecks. A field analysis was conducted in March 2012, November 2012, and March 2013. During these visits, bottleneck locations were video-taped where possible.

A tachometer, or probe run, is a way to measure speeds and is very useful for precisely locating bottleneck locations. Exhibits E-6 and E-7 are northbound plots showing the bottlenecks from Livorna Road north to Treat Boulevard. Exhibit E-6 was collected on March 21, 2012 and Exhibit E-7 was collected one year later on March 27, 2013.

In the exhibits, the x-axis is the postmile and the y-axis is the recorded speed. Each line on the plot represents the journey of a GPS-equipped vehicle driving down the roadway. The direction of travel is from left to right on the x-axis. A bottleneck is shown where a vehicle accelerates out of a congested condition.

Both exhibits show the following northbound bottlenecks:

- Lawrence Way On/Treat Off
- North Main Off
- Olympic On/Ygnacio Valley Road Off
- Livorna On.

Exhibit E-8 is a southbound tachometer plot (with the direction of travel from right to left along the x-axis) that shows the Stone Valley Road and the Livorna Road on-ramps, as well as the North Main St off-ramp bottleneck.

Exhibit E-6: Northbound I-680 Tachometer Plot March 21, 2012

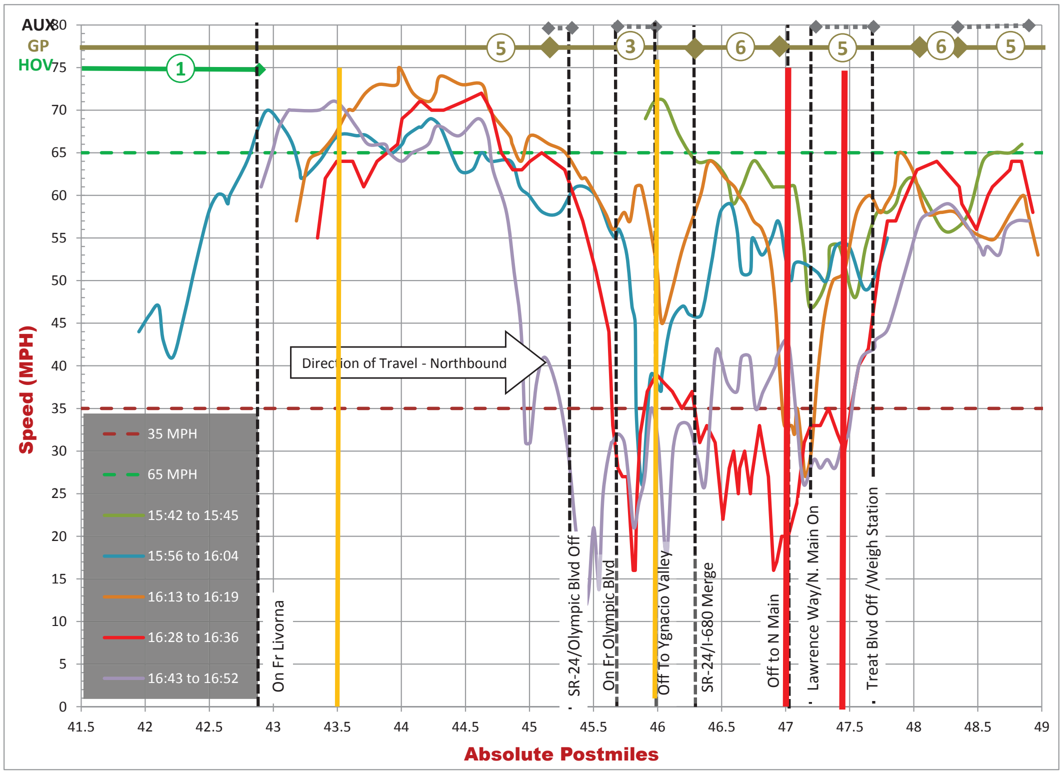


Exhibit E-7: Northbound I-680 Tachometer Plot March 27, 2013

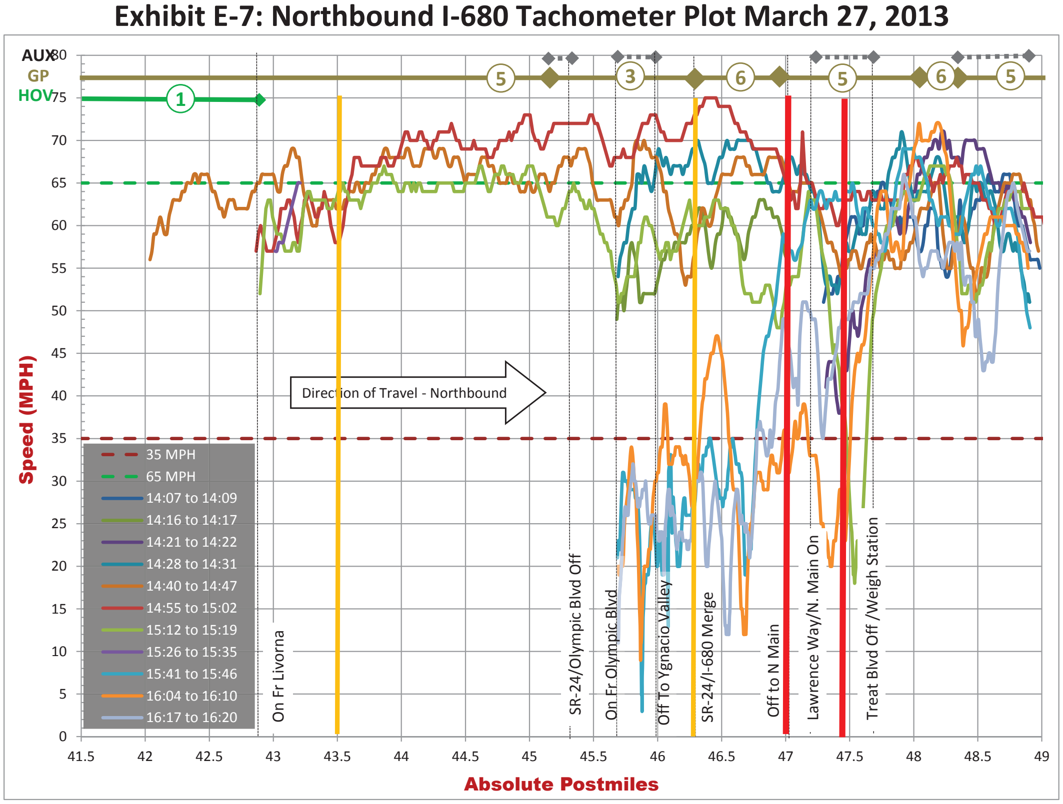
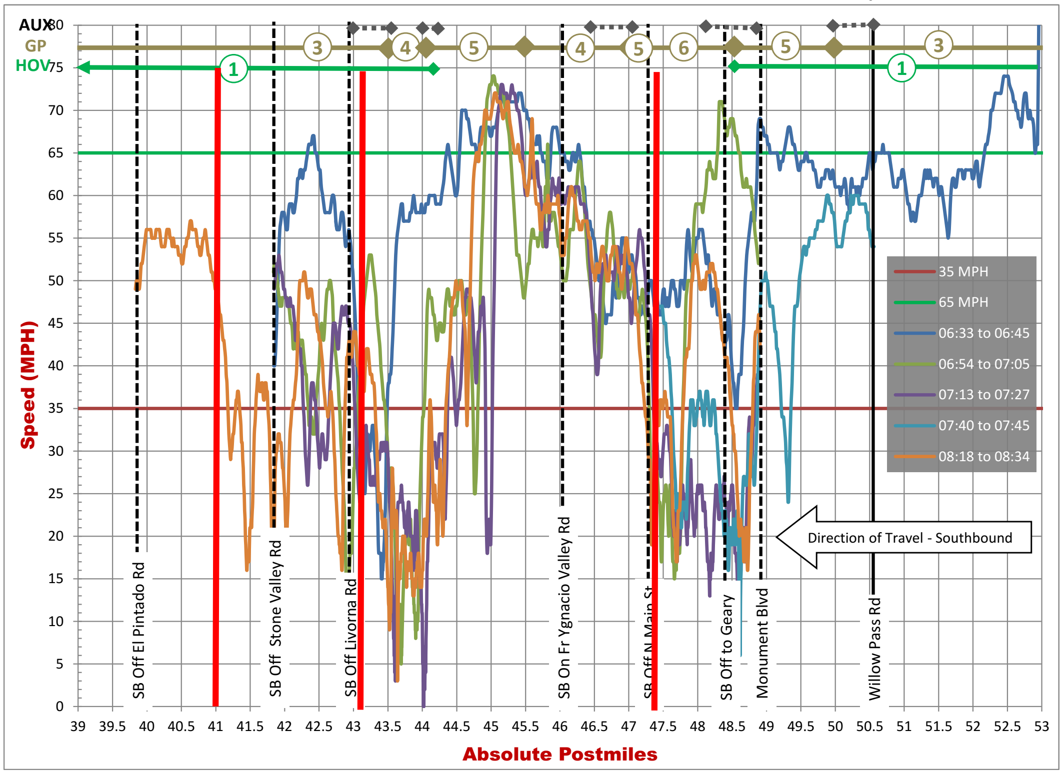


Exhibit E-8: Southbound I-680 Tachometer Plot March 21, 2013



Appendix F: Evaluation Scenarios and Associated Projects

Scenario	Project Type	Project Name	Project Description	RTP Project No.	Project Source Document
1	Arterial-Widening	Buskirk Avenue Widening (phase 2)	Widen and improve Buskirk Ave between Monument Blvd and Hookston Rd to provide 2 through lanes in each direction (includes Rd realignment, new traffic signals and bicycle/pedestrian streetscape improvements)	230239	2009 County Transportation Plan (CTP) Table B.4-Page 170;MTC RTP/SCS App C: Page C-12, Row#09 (http://onebayarea.org/pdf/Draft_EIR_Chapters/Appendix_C_Transportation_Projects_in_Each_EIR_Alternative.pdf)
	Arterial-Widening	Widen Contra Costa Blvd at Gregory Gardens	Widen Rdway to provide a third SB lane	230240	2009 County Transportation Plan (CTP) Table B.4-Page 168
	Freeway-Auxiliary Lanes	I-680 Auxiliary Lanes: Sycamore Valley Rd to Crow Canyon Rd (Segment 2)	Construct auxiliary lane on I-680 in both directions between Sycamore Valley Rd in Danville to Crow Canyon Rd in San Ramon	22602	2009 County Transportation Plan (CTP) Table B.7-Page 229 CCTA Website-Measure C projects page Fact Sheet 2011 District 4 TSDP. Page 16-7;MTC RTP/SCS App C: Page C-10, Row#19 (http://onebayarea.org/pdf/Draft_EIR_Chapters/Appendix_C_Transportation_Projects_in_Each_EIR_Alternative.pdf)
	Freeway-Express Lanes	Express Lanes – Extend north to Livorna Rd	Convert existing SB HOV to Express from Rudgear Rd to Alcosta Blvd and in NB from Alcosta Blvd to Livorna Rd. No widening or additional lanes. Includes striping and sign gantries, signage, FasTrak® toll tag readers, and CCTV. BAIFA to install equipment and observation areas for CHP enforcement	????	http://www.baifaexpresslanes.org/projects/express_lanes/pdfs/I680_contra_costa_south_factsheet.pdf
2b	Freeway-Express Lanes	NB HOT Lane from Main Street to SR-242	Construct an HOV lane on I-680 nortbound between North Main Street and Route 242 (See Bay Area Region/Multi-County Project #240587)	22351	2009 County Transportation Plan (CTP) Table B.4-Page 182 2011 Caltrans D4 TSDP (Page 16-7) CCTA Website-Measure J projects page Fact Sheet. Central, East, Southwest Arterial and Freeway Ramp Metering Study. DKS Associates/CH2M HILL. 2003;MTC RTP/SCS App C: Page C-10, Row#10 (http://onebayarea.org/pdf/Draft_EIR_Chapters/Appendix_C_Transportation_Projects_in_Each_EIR_Alternative.pdf)
	Freeway-Express Lanes	SB HOT Lane from Marina Vista to Livorna (includes SB HOV Gap Closure)	Widen I-680 SB for express lanes from Marina Vista Ave to Livorna Rd	240588	MTC RTP/SCS App C: Page C-04, Row#18 (http://onebayarea.org/pdf/Draft_EIR_Chapters/Appendix_C_Transportation_Projects_in_Each_EIR_Alternative.pdf)
	Freeway-HOV	Direct Access Connector Ramps (DAR)	Includes reconstruction of overcrossing, widening of median, construction of new HOV-only on- and off-ramps in both NB and SB directions, and modifications to local street network. ramps would be HOV only for same hours of operation as HOV lanes.	22352	2009 County Transportation Plan (CTP) Table B.7-Page 228 CCTA Website-Measure J projects page Fact Sheet 2011 District 4 TSDP. Page 16-8;MTC RTP/SCS App C: Page C-10, Row#11 (http://onebayarea.org/pdf/Draft_EIR_Chapters/Appendix_C_Transportation_Projects_in_Each_EIR_Alternative.pdf)
	Freeway-Interchange	I-680/SR-4 Interchange Improvements (Phases 1-3 of 5)	Construct improvements at I-680/SR-4. Improvements will be constructed in phases & will include: Phase 1 - NB I-680 to WB SR 4 connector. Phase 2 - EB SR 4 to SB I-680 connector & improvements to SR 4 IC at Pacheco Blvd. Phase 3 - SR 4 widening between Morello Ave in Martinez & SR 242 in Concord.	21205	CCTA Website-Measures C/J projects page Fact Sheet 2009 County Transportation Plan (CTP);MTC RTP/SCS App C: Page C-10, Row#02 (http://onebayarea.org/pdf/Draft_EIR_Chapters/Appendix_C_Transportation_Projects_in_Each_EIR_Alternative.pdf)
3	Arterial-Ferry	Contra Costa Blvd. Improvement Project	Construct additional right and left turn lanes on Contra Costa Blvd between 2nd Ave and Monument Blvd at various intersections, modify intersection lane alignments, add new class II bike lane, improve traffic operations throughout corridor	230240	2009 County Transportation Plan (CTP) Table B.4-Page 170
	Arterial-Widening	Pacheco Boulevard, Widen from Blum to Martinez City Limit	Widen Pacheco Blvd from 2-4 lanes b/n Blum Rd to Arthur Rd	98133	2009 County Transportation Plan (CTP) Table B.4-Page 167 CCTA Website-Measure C projects page Fact Sheet;MTC RTP/SCS App C: Page C-11, Row#10 (http://onebayarea.org/pdf/Draft_EIR_Chapters/Appendix_C_Transportation_Projects_in_Each_EIR_Alternative.pdf)
	Arterial-Widening	Widen and extend major streets, and improve interchanges in central Contra Costa County	Widen and extend major streets, and improve interchanges in central Contra Costa County	22609	MTC RTP/SCS App C: Page C-10, Row#22 (http://onebayarea.org/pdf/Draft_EIR_Chapters/Appendix_C_Transportation_Projects_in_Each_EIR_Alternative.pdf)
	Freeway-Interchanges	Improve Interchanges and parallel arterials to I-680	Improve interchanges and arterials parallel to I-680 and SR-24	98126	2011 District 4 TSDP;MTC RTP/SCS App C: Page C-11, Row#09 (http://onebayarea.org/pdf/Draft_EIR_Chapters/Appendix_C_Transportation_Projects_in_Each_EIR_Alternative.pdf)
	Freeway-Interchanges	I-680/SR-4 Interchange Improvements (Phases 4-5 of 5)	Improve I-680/SR-4 interchange Phases 4 and 5 (includes connecting soutbound I-680 to EB SR- 4, connecting WB SR- 4 to NB I-680, and constructing HOV flyover ramps from WB SR-4 to I-680 SB from I-680 NB to EB SR- 4)	22350	MTC RTP/SCS App C: Page C-10, Row#09 (http://onebayarea.org/pdf/Draft_EIR_Chapters/Appendix_C_Transportation_Projects_in_Each_EIR_Alternative.pdf)
4	Freeway-Auxiliary Lanes	Miscellaneous Auxiliary Lanes	Alcosta Rd to Bollinger Canyon Rd El Cerro to El Pintado El Pintado Rd to Stone Valley Rd Stone Valley Rd to Livorna Rd Livorna On to Rudgear Off		
5	Active Transportation	Improve Bicycle and Pedestrian lanes	Improve bicycle and pedestrian trails		

Appendix G: Climate and Energy Conservation – VMT by Speed Bin

Facility Type	Speed Bin	2010 Base Year			2030 Constrained/Revised					
		Base Case	Scenario 1	Scenario 2	Base Case	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
Arterials/ Ramps	<=5 mph	4,113	4,114	3,056	6,979	6,657	6,157	5,092	5,095	9,439
	10	4,970	4,243	4,392	29,388	24,505	19,750	21,488	22,023	16,850
	15	20,773	19,132	21,349	76,681	74,841	65,465	70,003	65,528	59,384
	20	56,643	57,707	51,543	94,708	85,902	86,105	76,667	77,019	73,186
	25	190,379	183,439	178,459	266,302	263,129	238,559	250,534	239,300	233,154
	30	1,208,253	1,211,965	1,190,360	1,439,606	1,429,879	1,420,871	1,414,665	1,405,745	1,403,130
	35	803,740	779,974	769,473	969,142	953,065	946,617	940,491	927,342	929,233
	>40 mph	498,873	499,816	498,469	677,975	682,341	670,212	669,180	679,935	679,668
I-680 General Purpose	10		1,115		25,762	50,195		2,239	2,241	
	15		23,612		73,321	33,185	35,588	33,146	42,271	43,965
	20	57,012	27,937	3,598	215,124	111,409	115,561	110,735	96,332	116,000
	25	62,485	53,260	12,862	204,943	220,805	164,105	182,911	35,441	22,203
	30	143,665	60,227	70,337	260,974	174,729	184,398	171,382	164,244	152,684
	35	333,671	232,447	203,218	563,222	515,007	503,812	529,781	426,980	468,665
	40	352,673	351,521	264,657	695,962	616,829	529,892	512,710	505,374	461,773
	45	526,258	420,645	458,980	982,436	918,711	1,033,149	976,661	1,095,187	1,046,623
	50	820,476	779,899	680,564	1,187,138	1,368,526	1,047,082	1,123,134	1,178,823	1,156,004
	55	1,192,114	1,325,093	1,405,598	745,598	789,863	1,155,848	1,152,500	1,235,126	1,314,774
	60	1,263,078	1,284,016	1,388,086	569,200	764,389	697,478	675,228	849,926	839,903
	>=65 mph	413,781	577,299	550,008	326,013	298,863	303,919	311,705	307,073	316,650
I-680 HOV/ Express	15				2,047	2,087				
	20				558	559	32,497	32,450	1,961	11,573
	25					44,371	48,201	33,955	14,478	33,521
	30	1,904	1,909	1,894	2,747	42,812	45,114	35,708	52,395	76,949
	35	13,318	54,982	84,755	28,002	57,432	110,955	134,629	119,258	51,007
	40		35,353	57,542	24,952	78,964	65,203	121,437	114,040	90,470
	45		41,054	74,628	80,389	160,305	198,404	129,269	181,835	231,111
	50	19,548	49,572	86,479	93,321	128,851	138,405	190,791	146,528	96,088
	55	79,144	134,722	190,942	277,784	206,674	264,737	259,926	208,147	235,219
	60	239,654	214,034	271,101	228,123	163,760	239,421	207,268	252,915	252,401
	>=65 mph	190,331	134,113	121,268	136,793	86,882	76,726	76,966	106,283	112,946
Other Freeway	15				160,149	159,072	159,035	159,088	158,975	158,198
	20			10,799	23,932	23,848	23,239	23,280	23,120	23,015
	25	21,800	21,629	11,193	87,709	87,623	34,289	42,886	23,691	23,608
	30	22,193	22,194	8,200	232,020	211,697	251,646	242,978	261,056	255,085
	35	210,713	210,162	195,358	225,514	244,085	217,606	217,630	218,233	219,865
	40	26,425	26,392	39,115	210,175	209,884	199,237	199,113	432,037	170,598
	45	68,641	68,792	72,839	606,626	596,749	607,619	610,869	375,230	635,343
	50	441,618	426,079	412,810	269,384	266,243	248,345	245,068	273,880	242,250
	55	155,095	167,057	152,684	321,448	353,400	377,457	377,666	352,118	358,085
	60	868,707	871,334	836,851	423,520	404,564	410,025	409,445	410,167	426,750
	>=65 mph	466,602	466,002	561,503	256,488	256,657	321,094	307,440	308,136	310,556

Appendix H: Benefit-Cost Analysis Results

This appendix provides more detailed Benefit-Cost Analysis (BCA) results than found in Section 9 of the Contra Costa County I-680 CSMP Final Report. The BCA results for this CSMP were estimated by using the *California Life-Cycle Benefit/Cost Analysis Model (Cal-B/C) Version 5.0 Corridor*.

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

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

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

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

- **Life-Cycle Costs** - present values of all net project costs, including initial and subsequent costs, in real current dollars.
- **Life-Cycle Benefits** - sum of the present value benefits for the project.
- **Net Present Value** - life-cycle benefits minus the life-cycle costs. The value of benefits exceeds the value of costs for a project with a positive net present value.
- **Benefit/Cost Ratio** - benefits relative to the costs of a project. A project with a benefit-cost ratio greater than one has a positive economic value.
- **Rate of Return on Investment** - discount rate at which benefits and costs are equal. For a project with a rate of return greater than the discount rate, the benefits are greater than costs, and the project has a positive economic value. The user can use rate of return to compare projects with different costs and different benefit flows over different time periods. This is particularly useful for project staging.
- **Payback Period** - number of years it takes for the net benefits (life-cycle benefits minus life-cycle costs) to equal the initial construction costs. For a project with a payback period longer than the life-cycle of the project, initial construction costs are not recovered. The payback period varies inversely with the benefit-cost ratio. A shorter payback period yields a higher benefit-cost ratio.

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

- **Person-Hours of Time Saved** - reduction in person-hours of travel time due to the project. A positive value indicates a net benefit.
- **CO_2 Emissions Saved (tons)** - CO_2 emissions saved because of the project. The emissions are estimated using average speed categories using data from the California Air Resources Board (CARB) EMFAC model. This is a gross calculation because the emissions factors do not take into account changes in speed cycling or driver behavior. A negative value indicates a project benefit. Projects in areas with severe congestion will generally lower CO_2 emissions.
- **CO_2 Emissions Saved (in millions of dollars)** - valued CO_2 emissions using a recent economic valuing methodology.

A copy of Cal-B/C v5.0 Corridor, the User's Guide, and detailed technical documentation can be found at the Caltrans' Division of Transportation Planning, Office of Transportation Economics website at www.dot.ca.gov/hq/tpp/offices/ote/benefit.html.

The exhibits in this appendix are listed as follows:

- Exhibit H-1: BCA Results – S1 – Fully-Funded, Programmed Mobility Related Projects
- Exhibit H-2: BCA Results – S2 – S1 + Express Lanes, Direct Access Ramp, Phase 3 of the I-680/SR-4 Interchange Improvements
- Exhibit H-3: BCA Results – S3 – I-680/SR-4 Interchange Improvements (Phases 1,2,4,5), Arterial Improvements
- Exhibit H-4: BCA Results – S4 – Auxiliary Lanes
- Exhibit H-5: BCA Results – S5 – VMT Reduction Strategy - Bicycle/Pedestrian Improvements
- Exhibit H-6: Cumulative BCA Results

Exhibit H-1: BCA Results – S1 – Fully-Funded, Programmed Mobility Related Projects

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INVESTMENT ANALYSIS

SUMMARY RESULTS

Life-Cycle Costs (mil. $)	$90.4
Life-Cycle Benefits (mil. $)	$778.8
Net Present Value (mil. $)	$688.4
Benefit / Cost Ratio:	8.6
Rate of Return on Investment:	49.0%
Payback Period:	3 years

ITEMIZED BENEFITS (mil. $)	Average Annual	Total Over 20 Years
Travel Time Savings	$35.4	$708.4
Veh. Op. Cost Savings	$3.1	$61.7
Accident Cost Savings	$0.0	$0.0
Emission Cost Savings	$0.4	$8.7
TOTAL BENEFITS	$38.9	$778.8
Person-Hours of Time Saved	4,113,077	82,261,547
CO_2 Emissions Saved (tons)	15,507	310,137
CO_2 Emissions Saved (mil. $)	$0.3	$5.5

Incremental Costs (mil. $)	$90.4
Incremental Benefits (mil. $)	$778.8
Incremental Benefit / Cost Ratio	8.6

Exhibit H-2: BCA Results – S2 – S1 + Express Lanes, Direct Access Ramp, I-680/SR-4 Interchange Improvements (Phase 3)

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INVESTMENT ANALYSIS

SUMMARY RESULTS

Life-Cycle Costs (mil. $)	$518.1
Life-Cycle Benefits (mil. $)	$1,222.5
Net Present Value (mil. $)	$704.4
Benefit / Cost Ratio:	2.4
Rate of Return on Investment:	14.4%
Payback Period:	8 years

ITEMIZED BENEFITS (mil. $)	Average Annual	Total Over 20 Years
Travel Time Savings	$56.7	$1,133.4
Veh. Op. Cost Savings	$3.9	$78.9
Accident Cost Savings	$0.0	$0.0
Emission Cost Savings	$0.5	$10.1
TOTAL BENEFITS	$61.1	$1,222.5
Person-Hours of Time Saved	6,394,054	127,881,078
CO_2 Emissions Saved (tons)	19,013	380,257
CO_2 Emissions Saved (mil. $)	$0.3	$6.6

Incremental Costs (mil. $)	$427.7
Incremental Benefits (mil. $)	$443.6
Incremental Benefit / Cost Ratio	1.0

Exhibit H-3: BCA Results – S3 – I-680/SR-4 Interchange Improvements (Phases 1,2,4,5), Arterial Improvements

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INVESTMENT ANALYSIS

SUMMARY RESULTS

Life-Cycle Costs (mil. $)	$458.7
Life-Cycle Benefits (mil. $)	$952.2
Net Present Value (mil. $)	$493.5
Benefit / Cost Ratio:	2.1
Rate of Return on Investment:	14.2%
Payback Period:	7 years

ITEMIZED BENEFITS (mil. $)	Average Annual	Total Over 20 Years
Travel Time Savings	$48.4	$968.3
Veh. Op. Cost Savings	-$0.7	-$14.1
Accident Cost Savings	$0.0	$0.0
Emission Cost Savings	-$0.1	-$2.0
TOTAL BENEFITS	$47.6	$952.2
Person-Hours of Time Saved	5,702,478	114,049,567
CO_2 Emissions Saved (tons)	-3,280	-65,605
CO_2 Emissions Saved (mil. $)	-$0.1	-$1.2

Exhibit H-4: BCA Results – S4 – Auxiliary Lanes

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INVESTMENT ANALYSIS

SUMMARY RESULTS

Life-Cycle Costs (mil. $)	$95.2
Life-Cycle Benefits (mil. $)	$1,642.1
Net Present Value (mil. $)	$1,546.9
Benefit / Cost Ratio:	17.2
Rate of Return on Investment:	126.9%
Payback Period:	1 year

ITEMIZED BENEFITS (mil. $)	Average Annual	Total Over 20 Years
Travel Time Savings	$77.1	$1,542.7
Veh. Op. Cost Savings	$4.3	$86.5
Accident Cost Savings	$0.0	$0.0
Emission Cost Savings	$0.6	$12.8
TOTAL BENEFITS	$82.1	$1,642.1
Person-Hours of Time Saved	8,944,929	178,898,588
CO_2 Emissions Saved (tons)	20,937	418,750
CO_2 Emissions Saved (mil. $)	$0.4	$7.9

Exhibit H-5: BCA Results – BCA Results – S5 – VMT Reduction Strategy (Bicycle/Pedestrian Improvements)

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INVESTMENT ANALYSIS

SUMMARY RESULTS

Life-Cycle Costs (mil. $)	$87.5
Life-Cycle Benefits (mil. $)	$813.6
Net Present Value (mil. $)	$726.1
Benefit / Cost Ratio:	9.3
Rate of Return on Investment:	26.0%
Payback Period:	2 years

ITEMIZED BENEFITS (mil. $)	Average Annual	Total Over 20 Years
Travel Time Savings	$37.3	$745.5
Veh. Op. Cost Savings	$3.0	$60.6
Accident Cost Savings	$0.0	$0.0
Emission Cost Savings	$0.4	$7.6
TOTAL BENEFITS	$40.7	$813.6
Person-Hours of Time Saved	6,194,957	123,899,141
CO_2 Emissions Saved (tons)	6,740	134,807
CO_2 Emissions Saved (mil. $)	$0.1	$2.1

Exhibit H-6: Cumulative BCA Results

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INVESTMENT ANALYSIS

SUMMARY RESULTS

Life-Cycle Costs (mil. $)	$1,250.0
Life-Cycle Benefits (mil. $)	$5,409.2
Net Present Value (mil. $)	$4,159.2
Benefit / Cost Ratio:	4.3
Rate of Return on Investment:	n/a
Payback Period:	n/a

ITEMIZED BENEFITS (mil. $)	Average Annual	Total Over 20 Years
Travel Time Savings	$254.9	$5,098.3
Veh. Op. Cost Savings	$13.7	$273.7
Accident Cost Savings	$0.0	$0.0
Emission Cost Savings	$1.9	$37.2
TOTAL BENEFITS	$270.5	$5,409.2
Person-Hours of Time Saved	31,349,496	626,989,922
CO_2 Emissions Saved (tons)	58,917	1,178,345
CO_2 Emissions Saved (mil. $)	$ 1.05	$ 20.98