State Route 4

Corridor System Management Plan

October 2010

CALTRANS DISTRICT 4

corridor system management plans

Caltrans


4
Richmond
Martinez
Oakland
Concord
242
EXIT
1/2 MILE
Port Chicago
Highway
1/4 MILE

state route 4
corridor system management plan

APPROVED BY:

10-25-10

BIJAN SARTIPI, Date
District 4 Director
California Department of Transportation

I accept this Corridor System Management Plan for the State Route 4 Corridor as a document informing the regional transportation planning process.

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stakeholder acknowledgment

District 4 wishes to acknowledge the time and contributions of stakeholder groups and partner agencies. Current and continuing Corridor System Management Plan (CSMP) development is dependent upon the close participation and co-operation of all major stakeholders. This CSMP represents a cooperative commitment to develop a corridor management vision for the SR-4 Corridor. The strategies evaluated have the potential to impact the local arterial system and the regional and local planning agencies that have the corridor within their jurisdiction. These representatives participated in the Technical Advisory Committee (TAC) and provided essential information, advice and feedback for the preparation of this CSMP. The stakeholders/partners include:

- Metropolitan Transportation Commission
- Contra Costa Transportation Authority
- City of Hercules
- City of Martinez
- City of Concord
- City of Pittsburg
- City of Antioch
- Contra Costa County
- West Contra Costa Transportation Advisory Committee (WCCTAC)
- Transportation Partnership and Cooperation Committee (TRANSPAC)
- East Contra Costa County Transportation Planning Committee (TRANSPLAN)
- Association of Bay Area Governments (ABAG)
- Bay Area Air Quality Management District (BAAQMD)
- Transit Agencies (Bay Area Rapid Transit District, WestCAT, Central Contra Costa Transit Authority, Tri Delta Transit)

A website, **www.corridormobility.org** has been created to support the development of the CSMPs and to provide stakeholders and the public with more information and an opportunity to provide input and review documents.

Disclaimer: The information, opinions, commitments, policies and strategies detailed in this document are those of Caltrans District 4 and do not necessarily represent the information, opinions, commitments, policies and strategies of partner agencies or other organizations identified in this document.

dedication

To Patricia "Pat" Weston (1951-2009)

Caltrans District 4 Planners dedicate this Corridor System Management Plan (CSMP) to the memory of Pat Weston, Chief, Caltrans Office of Advance System Planning, whose seemingly limitless energy and passion for transportation system planning in California has been an inspiration to countless transportation planners and engineers within Caltrans and its partner agencies. Pat's efforts elevated the importance of corridor-based system planning, performance measurement for system monitoring, and the blending of long-range planning with near-term operational strategies. This has resulted in stronger planning partnerships with Traffic Operations in Caltrans and led directly to the requirement to conduct comprehensive corridor planning through CSMP documents. This is but one of a long list of major achievements in Pat's lengthy Caltrans career. She generously shared her knowledge, wisdom and guidance with us over the years. She will be sorely missed as a planner, mentor and friend.

table of contents

APPENDIX (Supporting Documents) **Page**

LIST OF TABLES

LIST OF FIGURES

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introduction

This Corridor System Management Plan (CSMP) represents a cooperative commitment to develop a corridor management vision for the SR-4 Corridor. The CSMP development process was a joint effort of the Department of Transportation (Caltrans), the Metropolitan Transportation Commission (MTC) and the Contra Costa Transportation Authority (CCTA). This Core Stakeholder Group worked with local planning agencies through a Technical Advisory Committee (TAC) to develop this plan. The goal is to propose strategies to achieve the highest mobility benefits to travelers across all jurisdictions and modes along the SR-4 CSMP Corridor.

PLANNING AND POLICY FRAMEWORK

Since passage of the Highway Safety, Traffic Reduction, Air Quality and Port Security Bond Act, known as Proposition 1B, in November 2006, Caltrans has implemented the CSMP process statewide for all corridors with projects funded by the Corridor Mobility Improvement Act (CMIA) Program. The California Transportation Commission (CTC) requires that all corridors with a CMIA-funded project have a CSMP that is developed with regional and local partners. The CSMP recommends how the congestion-reduction gains from the CMIA projects will be maintained with supporting system management strategies. The CTC has also provided guidance in the 2008 Regional Transportation Plan (RTP) Guidelines that the CSMPs are an important input to the development of the RTP.

In the San Francisco Bay Area, Caltrans is completing nine CSMPs. This SR-4 CSMP reflects data and projects from MTC's current RTP, *Change in Motion, Transportation 2035 Plan*, adopted April 2009. The CSMP recommends strategies that could potentially become projects through the regional transportation project development and prioritization process. In the San Francisco Bay Area, the CSMP process has taken place in coordination with the MTC's Freeway Performance Initiative (FPI), which provided the performance assessments and technical analysis for the CSMPs.

This CSMP focuses on highway mobility within the context of the State's most congested urban corridors. While the CSMP describes the arterials and other modes in the corridor, the focus of the recommended strategies is on maximizing the existing infrastructure through coordinated application of system management technologies such as ramp metering, coordinated traffic signals, changeable message signs for traveler information and incident management. It describes the current land use, transit, bicycle/pedestrian facilities, and the Focusing Our Vision (FOCUS) regional blueprint Priority Development and Conservation Areas. These are provided as a backdrop for understanding how the highway corridor works.

THE SR-4 CSMP

The objectives of the SR-4 CSMP are to reduce delay within the corridor (mobility), reduce variation of travel time (reliability), reduce accident and injury rates (safety), restore lost lane miles (productivity), and reduce distressed lane miles (system preservation). The limits of the SR-4 CSMP were determined, in collaboration with MTC, by identifying the key travel corridor in which CMIA-funded projects are located. The CMIA-funded project is:

- SR-4 Widening Somersville Road to SR-160

The SR-4 CSMP addresses State Highways, local parallel roadways, the bicycle and pedestrian network, and regional transit services pertinent to corridor mobility. The CSMP also identifies gaps in the bicycle and pedestrian network and regional transit services and discusses opportunities for the future.

The CSMP makes some recommendations for increasing other modal services that can make the highway operate more efficiently, but the main thrust of the strategies is to enable better system management of the highway. By focusing on more efficient operation of the highway network, the CSMP moves toward optimizing current infrastructure, improving our ability to analyze and identify what leads to congestion in a corridor, and strengthening interagency partnerships to ensure that all parts of the transportation system work together well.

METHODOLOGY

A corridor performance assessment and technical analysis of the SR-4 CSMP Corridor was conducted through the FPI, a partnership between MTC and Caltrans. The performance assessment evaluated the current highway performance along the corridor and determined causes of performance problems.

Simulation modeling was used to forecast future travel conditions along the corridor. Traffic analysis methods were used to identify bottlenecks and to predict the impacts of a variety of operational strategies and investment scenarios. The simulation model was limited to the intersections at each freeway interchange and could not feasibly model the diversion effects outside of their impacts on the surface streets in the immediate vicinity of each interchange.

The comprehensive corridor analysis results consisting of existing and future traffic conditions were first discussed at the SR-4 CSMP TAC meeting in March 2009. The TAC met at regular intervals to provide further input on conclusions and recommendations for short and long-term corridor management improvement strategies.

The proposed short-term and long-term improvement strategies include:

By 2015 (short term) – *in addition to programmed improvements*

- Complete and activate the ITS network.
- Implementing transportation management & capacity enhancement strategies
- Improve BART access, parking and operations.

By 2030 (long term)

- Implementing transportation management & capacity enhancement strategies
- Improve BART access, parking and operations.

FIRST GENERATION CSMP

This CSMP represents the *"first generation"* of corridor system management plans informing the transportation planning process. This CSMP identifies corridor management strategies applied on a network wide basis. The selected strategies address existing and forecasted mobility, lost productivity, bottlenecks, and reliability problems. The CSMP recognizes that transit services and goods movement are also adversely affected by the same problems. To implement some of these strategies, key capital projects are also identified. This list is not meant to be inclusive of all potential projects in the corridor. The CSMP builds upon the capital project recommendations of the SR-4 Corridor Study, the 2009 Contra Costa Transportation Authority Countywide Transportation Plan and the 2009 MTC RTP (*T2035).* These recommendations add system management and other strategies to provide additional benefit and efficiencies.

Since Caltrans and the regions launched this first cycle of corridor system management planning in 2007 (called *first generation CSMPs*), the statewide planning policy context has evolved significantly. Assembly Bill (AB) AB 32 policy on reducing greenhouse gas emissions has moved into implementation with passage of Senate Bill (SB) SB 375, landmark legislation requiring the regions to meet state-designated greenhouse gas emissions reduction targets. The CTC has developed guidance on how the regions will develop a Sustainable Community Strategy (SCS) in their next RTP cycle; MTC's next RTP is slated for completion in 2013. The SCS will promote strategies to reduce green house gas emissions through more efficient land use patterns, reduce vehicle travel, support transit, bicycle and pedestrian mode choices, and improve supply and affordability of housing within the Bay Area to reduce commuting into the region.

The *second generation CSMPs* will reflect the SCS and the 2013 RTP, and will grapple with the issue of providing mobility and reducing highway congestion within the context of a new regional planning framework. The *second generation CSMP* scope will expand to include integrated land-use and transportation (in the context of SCS required by SB 375) and a more comprehensive look at transit and non-motorized travel strategies and options.

STAKEHOLDER ISSUES AND CONCERNS

Stakeholder concerns following the CSMP development process focused on SB 375 requirements, CSMP analysis scope, and potential impacts to the local arterial network. Stakeholders had concerns that recommended improvements in the CSMP do not emerge from a multI-modal and integrated transportation land use planning effort, such as integrating transit, bicycle and pedestrian networks, and demand management. Local jurisdictions are also concerned about the impacts ramp metering could have on local on-ramps and arterials, as well as concern that the operations analysis performed accounted for mainline delay, but not ramp delay. Concern was also expressed that travel forecasts in this corridor analysis did not account for a proposed Concord Naval Weapons Station redevelopment that has yet to be approved or initiated. This represents a summary of the issues and concerns shared by stakeholders during the CSMP development process; a more detailed listing of stakeholder issues and concerns are located in Section 1.7 of the CSMP Overview.

CSMP DOCUMENT

The SR-4 CSMP document is organized into three key volumes. The CSMP Summary serves as a stand-alone document and provides corridor facts and description summaries, key findings and recommended improvements from the technical analysis. The main CSMP document provides the CSMP Overview, Corridor Description, technical analysis memorandum and recommendations. The Appendix contains information about corridor segments, freeway agreements, CMIA projects, maintenance plans, and corridor concept. Within the main CSMP document, the CSMP Overview describes the CSMP purpose and need, consistency and relationship to other plans, the CSMP stakeholder engagement process and the CSMP performance measures and objectives. The CSMP Corridor Description contains a more detailed description of the corridor and its significance within the highway system and other modal systems. The CSMP technical analysis reports present existing and future conditions and trends, corridor management issues and strategies, and a prioritized list of short and long-term recommendations based on these analysis.

The SR-4 Corridor system will be regularly monitored using identified performance measures and Traffic Operations Systems (TOS) data, and will be reported in subsequent CSMP updates. This information will be used to continually improve system performance.

Contra Loma IC looking East

State Route 4

CSMP summary

1. SR-4 CSMP Corridor Facts/Segment Data Summary
2. CSMP Overview
3. Corridor Description
4. Comprehensive Corridor Performance Assessment
5. Recommended Corridor Management Improvement Strategies

1. SR-4 CSMP CORRIDOR FACTS

Corridor Limits: *I-80 interchange in Hercules to SR-4/ SR-160 interchange in Antioch*

Corridor Description

The SR-4 CSMP limits are 31.13 miles long beginning in the city of Hercules at I-80 traversing unincorporated Contra Costa County, and the cities of Martinez, Concord, Pittsburg and Antioch before ending at the SR-4/160 interchange. The segments between I-80 and I-680 are functionally classified as Expressway while the remaining segments are functionally classified as Freeway.

Corridor Concept 2035:

4E-10F(2H) *F=Freeway H=HOV or HOT Lane*

Route Designation and Regional Setting

Functional Classification	Urban Principal Arterial - Freeway
Designations	STAA Route: Yes Terminal Access Route: Yes SHELL Route: No
IRRS	Yes – Basic
Lifeline	No
MPO	MTC
Air Quality District	BAAQMD
Average Mode Split	SOV: 69.46% HOV: 16.5% Public: 7.42%, Walk: 1.54%, Other: 1.64%, Tele: 4.3%

MultI-Modal Service

Primary providers of bus and rail: BART, Central Contra Costa Connection Transit Authority and Tri Delta Transit.

Interregional Significance

SR-4 is an east-west route providing interregional travel between the Central Valley and Bay Area for commute, recreational and commercial traffic.

Corridor Specific Issues

- Connects to interstate system via I-80 and I-680.
- Major commuter link between SF/East Bay. employment centers and Contra Costa County housing.
- High volumes of commuter, recreational and major regional and interregional freight traffic.

Corridor Objectives

- Reduce reoccurring delay within the corridor.
- Reduce variation of travel time.
- Improve connectivity between modes.
- Reduce distressed lane miles
- Reduce accident and injury rate

Performance Measure	***Desired Outcome***
Mobility	Reduce Delay in Corridor
Reliability	Reduce Travel Time Variation
Safety	Reduce Number of Accidents

Current Performance

Top 3 Congested Locations:

Location	***VHD***
CC4 Somersville Rd. to Loveridge Rd. (WB) AM	2,470
CC4 Loveridge Rd. to Somersville Rd. (EB) PM	2,054
CC4 Willow Pass Rd. to Port Chicago Hwy (WB) AM	1,566

Key Bottlenecks

Location / Direction	**AM/PM**
CC4 Willow Pass Rd. to Port Chicago Hwy	*AM-WB*
CC4 Somersville Rd. to Loveridge Rd.	*AM-WB*
CC4 Loveridge Rd. to Somersville Ave.	*PM-EB*
CC4 SR-242 to Port Chicago Hwy.	*PM-EB*
CC4 I-680 to Solano Way	*PM-EB*

Recommended Corridor Management Strategies

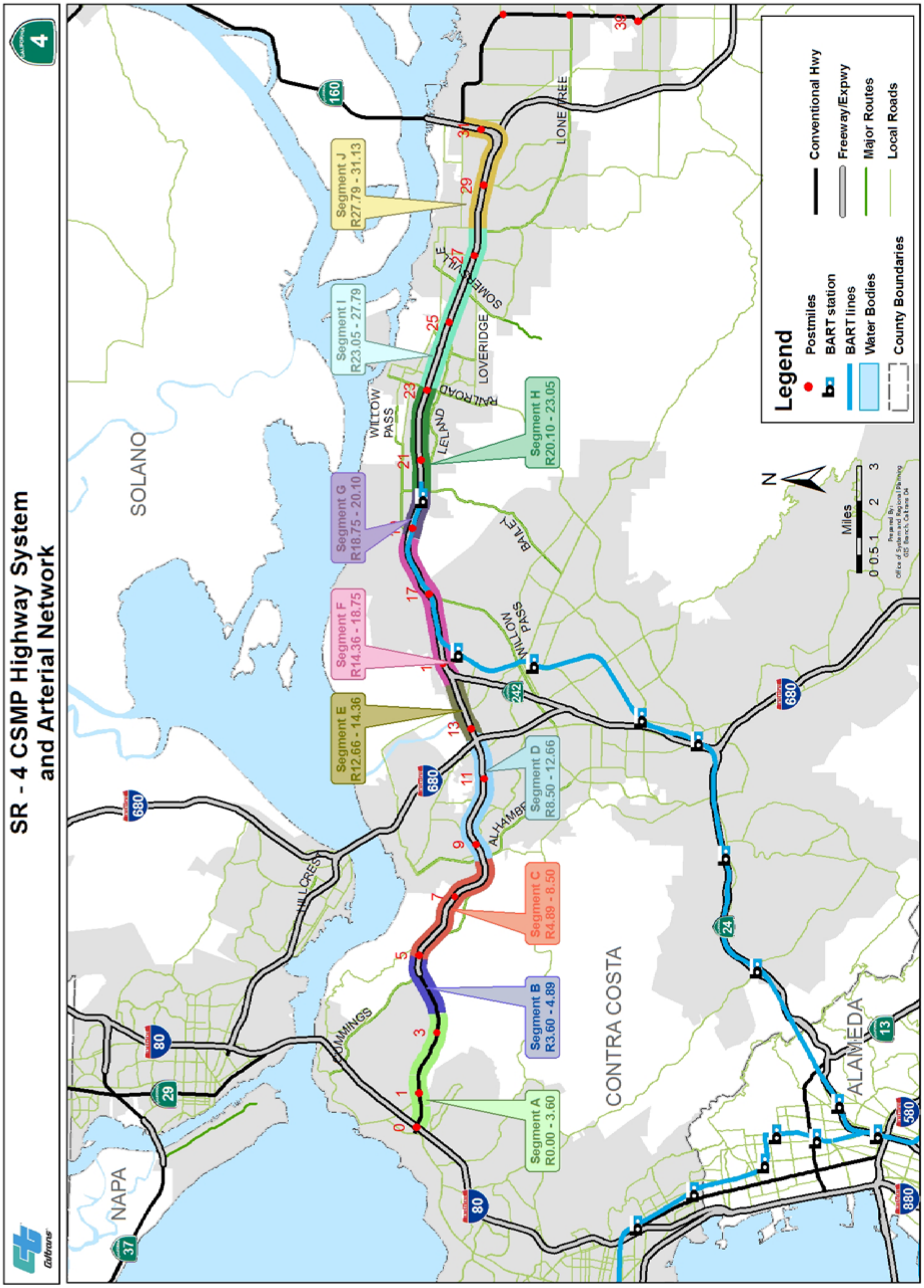
Near-Term (2015)

- Deploy ITS technologies on SR-4 throughout Contra Costa County.
- Address existing and projected bottlenecks by implementing transportation management & capacity enhancement strategies WB between I-680 and Hillcrest Ave.
- Address existing and projected bottlenecks by implementing transportation management & capacity enhancement strategies EB between Pacheco Blvd. and Port Chicago Hwy.
- Implement transit strategies in the SR-4 Corridor (BART parking capacity, bus feeder service and expanded Park & Ride at Pacheco Rd.)

Long-Term (2030)

- Further address existing and projected bottlenecks by implementing transportation management & capacity enhancement strategies WB between I-680 and Hillcrest Ave
- Further address existing and projected bottlenecks by implementing transportation management & capacity enhancement strategies EB between I-80 and SR-160.
- Implement transit strategies in the SR-4 Corridor (BART parking capacity, bus feeder service and an expanded Park & Ride network).

SR-4 CSMP HIGHWAY SYSTEM AND ARTERIAL NETWORK



CORRIDOR SYSTEM MANAGEMENT PLAN STATE ROUTE 4

Segment Data Summary

CSMP Segment	CO/RTE/PM	Vehicle Hours of Delay (VHD) (AM/PM)		EB PM Peak-Volumes		WB AM Peak Volumes		AADT (2007)	2008 Truck %	Accident Rate (Actual/ Statewide Average)		HOV	Aux	Bottleneck Location (AM/PM)	
		AM	PM	2007	2030	2007	2030			Actual	Avg			EB	WB
A	CC-4 0.00 -3.60			2,128	3,402	1,574	2,253	38,000	6.23	0.26	0.46				
B	CC-4 3.60-4.89			2,128	3,402	1,574	2,253	44,000	6.23	0.19	0.22				
C	CC-4-4.89-8.50			2,309	3,071	1,761	2,364	49,000	6.23	0.17	0.19				
D	CC-4-8.50-12.66			3,797	5,049	3,547	5,935	65,000	5.09	0.28	0.25		X		
E	CC-4-12.66-14.36			4,110	5,495	4,877	8,410	86,000	6.76	0.30	0.28	X	X		
F	CC-4-14.36-18.75	1,566 (WB)	318 (EB)	7,828	9,475	8,327	11,359	90,000	5.17	0.25	0.29	X		PM	AM
G	CC-4-18.75-20.10			6,424	8,253	6,637	9,750	142,000	5.52	0.25	0.31	X	X		
H	CC-4-20.10-23.05			5,474	7,471	5,578	9,201	131,000	4.60	0.34	0.37	X	X		
I	CC-4-23.05-27.79	2,470 (WB)	2,064 (EB)	4,311	7,674	4,976	8,946	114,000	4.60	0.46	0.46			PM	AM
J	CC-4-27.79-31.13			4,208	7,674	2,715	5,652	82,000	5.37	0.29	0.29				

Sources:

CO/RTE/PM: CSMP segmentation modified from 2002 TCCR segments.

VHD: SR-4 Final Existing Conditions Technical Memorandum (ECT). PBS&J Consultants dated February 17, 2009

Volumes: SR-4 Final Future Conditions Technical Memorandum (FCT). PBS&J Consultants dated July 17, 2009

AADT: http://www.dot.ca.gov/hq/traffops/saferesr/trafdata/

Truck %: http://www.dot.ca.gov/hq/traffops/saferesr/trafdata/

Accident Rate: TASAS Table B

2. CSMP OVERVIEW

A CSMP is a transportation planning document that plans for the safe, efficient and effective mobility of people and goods within the most congested transportation corridors. Each CSMP presents an analysis of existing and future traffic conditions and proposes traffic management strategies and capital improvements to maintain and enhance mobility within each corridor. The corridor management planning strategy is based on the integration of system planning and system management. Each CSMP will address State Highways, local parallel roadways, regional transit services, and other regional modes pertinent to corridor mobility.

CSMPs are being developed throughout the State for corridors within which funding is being used from the CMIA and Highway 99 Bond Programs created by the passage of the Highway Safety, Traffic Reduction, Air Quality, and Port Security Bond Act of 2006, approved by the voters as Proposition 1B in November 2006. The intent is to eventually develop CSMPs for all urban freeway corridors.

The CSMP transportation network is defined to include, but is not limited to, State Highways, major arterials, intercity and regional rail service, regional transit services, and regional bicycle facilities.

Purpose and Need Statement

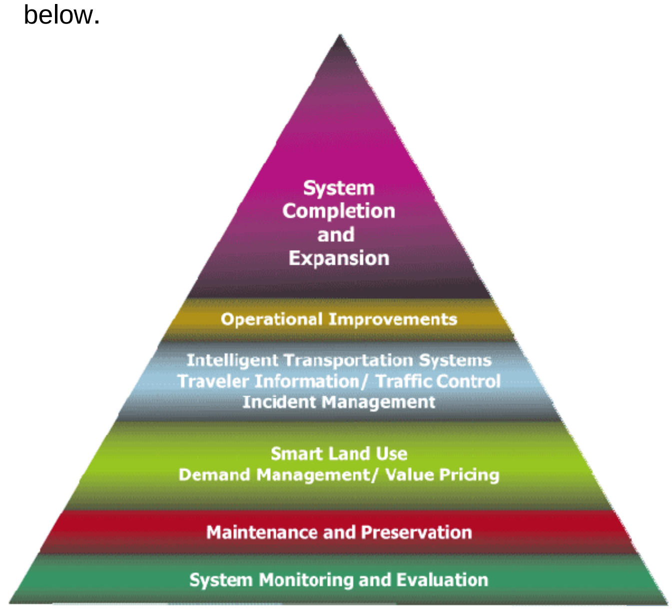
On March 15, 2007, the CTC adopted *Resolution CMIS-P-0607-02.* In Sections 2.12 and 2.13 of this resolution, the CTC resolved that "…the Commission expects Caltrans and regional agencies to preserve the mobility gains of urban corridor capacity improvements over time that will be described in CSMPs, which may include the installations of traffic detection equipment, the use of ramp metering, operational improvements, and other traffic management elements as appropriate…" and "…the nominating agencies including the installation of detection equipment and other supporting elements, to the project delivery council on a semiannual basis…".

The immediate purpose of preparing CSMPs is to satisfy the requirements to qualify for funding highway improvements under the CMIA and Highway 99 Bond programs, and to preserve the mobility gains of highway improvements funded through this program. The CTC adopted guidelines and a program of projects for funding. CSMPs are prepared based on the need to efficiently and effectively use all transportation modes and facilities in congested corridors so as to maximize mobility, improve safety and reduce delay costs.

Consistency with Strategic Growth Plan

CSMPs support the Governor's Strategic Growth Plan (SGP), which calls for an infrastructure improvement program that includes a major transportation component (GoCalifornia). The CMIA and other elements of the November 2006 transportation infrastructure bond are a down payment toward funding the most important of these infrastructure needs. The objectives of these investments are to decrease congestion, improve travel times and safety, and accommodate expected growth in the population and economy. The SGP is based on the premise that investments in mobility throughout the system will yield significant improvements in congestion relief.

The philosophy of system management is to make the most effective use of the transportation system. The system management pyramid represents a comprehensive range of strategies to improve mobility within a transportation corridor. It includes system monitoring at its base, followed by maintenance, smart land-use, technology and operational strategies, and traditional system expansion. Simply put, the value of any investment decision made higher up in the pyramid is limited without a good foundation from the strategies below.



The System Management Pyramid

CSMP Performance Measures

Caltrans worked with stakeholders to develop performance measures that together serve to focus directed action on desired corridor strategies and improvements. Performance Measures are illustrated in Table 1 below and were used in discussions with stakeholders.

Table 1: CSMP Performance Measures

Performance Measure	Performance Measure Description	Objective/ Desired
Mobility	Vehicle Hours of Delay (PeMS*, Probe Vehicles)	Reduce delay within the corridor
Reliability	Travel Time (PeMS, Buffer Index)	Reduce variation of travel time
Safety	TASAS** Data	Reduce accident and injury rate

*Freeway Performance Measurement System
**Traffic Accident Surveillance and Analysis System

Relationship to Other Plans

A number of Caltrans system planning documents were used as the foundation for the preparation of the CSMP. These included the 2005 *California Transportation Plan* (CTP), and the 1998 *Interregional Transportation Strategic Plan* (ITSP). Also, a number of related Caltrans system management documents were used including the 2006 *Strategic Growth Plan* (SGP), 2004 *Transportation Management System Master Plan* (TMSMP), and the 2004 *California ITS Architecture and System Plan* (SWITSA).

System and regional planning documents prepared by other agencies that influence CSMP development included the 2009 *RTP* (T2035) and the 2004 *Bay Area Regional ITS Plan.*

Most notably, the MTC FPI, a regional program, has influenced corridor-level performance-based decision making for the 2009 Regional Transportation Plan (RTP) (*T2035*). Important documents in this effort are the 2007 *FPI Performance & Analysis Framework* and the 2007 *FPI Prioritization Framework.*

The FPI corridor-specific documents are noted below:

- US-101 North (MRN/SON)
- US-101 Peninsula/South (SM/SCL)
- I-580 East (ALA)
- I-880 (ALA/SCL)
- SR-4 (CC)
- I-80 East (SOL)
- I-680 North (SOL/CC)
- I-680 South (ALA/SCL)

Complete Streets Implementation Action Plan

Caltrans policy through Deputy Directive 64 (Complete Streets[1]) is to view all transportation improvements (new and retrofit) as opportunities to improve safety, mobility and access for all travelers, including transit users, bicyclists and pedestrians. Such projects are coordinated with community goals, plans and values. Providing complete streets increases travel options, enabling environmentally sustainable alternatives to single-driver car trips. Implementing Complete Streets also supports local agency efforts required by the 2008 California Complete Streets Act (AB 1358), as well as expected efforts toward SB 375 goals to reduce greenhouse gas emissions through sustainable community strategies.

Stakeholder Engagement

Current and continuing CSMP development is dependent upon the close participation and cooperation of all major stakeholders. The strategies evaluated have the potential to impact the local arterial system, the transit service along the corridor, and the regional and local planning agencies within the corridor. The goal of the stakeholder engagement process is consensus among key stakeholder groups to develop the CSMP. The CSMP follows a workplan unique to the needs of the CSMP corridor and identified stakeholders. Each stakeholder category group has a role during the CSMP development process. The Core Stakeholder Group provides policy and technical guidance throughout the process. Additional planning agency partners review and comment at key junctures through the corridor TAC to provide additional guidance and help evaluate corridor improvement strategies.

[1] A “Complete Street” is a transportation facility that is planned, designed, operated and maintained to provide safe mobility for all users.

The stakeholder engagement process framework for the current CSMP considered stakeholders in two key categories:

I. Core Stakeholder Group: Agencies primarily responsible for conducting planning efforts on behalf of the corridor.

II. Planning Agency Partners: Additional agencies responsible for implementing and monitoring CSMP strategies.

District 4 CSMP Overview

- US-101 North (MRN/SON)
- US-101 Peninsula/South (SM/SCL)
- I-880 (ALA/SCL)
- I-80 West (ALA/CC)
- I-80 East (SOL)
- I-580 East (ALA)
- SR-4 (CC)
- SR-24 (ALA/CC)
- SR-12 (NAP/SOL)

Caltrans and MTC are committed to assist each other in the development of CSMPs and MTC's related FPI corridor studies. This cooperation is documented in MTC Resolutions 3792 and 3794. For the San Francisco Bay Area, Caltrans District 4, nine CSMPs were being developed as of May 2010. Figure 1 illustrates these nine CSMPs:

The SR-4 CSMP

This CSMP represents a cooperative commitment to develop a corridor management vision for the SR-4 corridor. The CSMP development process is a joint effort of Caltrans, MTC, and the Contra Costa Transportation Authority (CCTA). This Core Stakeholder Group is working with local planning agencies, through a corridor TAC. The goal is to achieve the highest mobility benefits to travelers across all jurisdictions and modes along the SR-4 CSMP corridor.

The SR-4 CSMP addresses State Highways, local parallel roadways/major arterials, the bicycle and pedestrian network, and regional transit services pertinent to corridor mobility. The CSMP also identifies gaps in the bicycle and pedestrian network and regional transit services and discusses opportunities for the future.

The limits of the SR-4 CSMP were determined, in collaboration with MTC, by identifying the key travel corridor segments in which CMIA-funded projects are located.

Figure 2 illustrates the SR-4 corridor limits and the scope of the CMIA-funded the SR-4 Widening from Somersville Road to SR-160 project.

SR-4 CSMP Corridor Team

The Core Stakeholder Group for the SR-4 CSMP corridor is identified as MTC, CCTA and Caltrans. Representatives met early in the CSMP development process to discuss the goals, objectives and schedule. This group met regularly to review and approve operational and simulation data collection and analysis methodology, technical reports, and identified additional planning agency partners for further CSMP development. This Stakeholder Group, and key planning agency partners along the corridor met as a TAC at regular intervals, providing valuable input on the analysis and recommended improvement strategies for the SR-4 CSMP corridor. The key stakeholders listed below were identified for involvement in the engagement process.

Key Stakeholders

Core Stakeholder Group

- Caltrans
- Metropolitan Transportation Commission
- Contra Costa Transportation Authority

Additional Planning Agency Partners

- City of Hercules
- City of Martinez
- City of Concord
- City of Pittsburg
- City of Antioch
- Contra Costa County
- West Contra Costa Transportation Advisory Committee (WCCTAC)
- Transportation Partnership and Cooperation Committee (TRANSPAC)
- East Contra Costa County Transportation Planning Committee (TRANSPLAN)
- Association of Bay Area Governments (ABAG)
- Bay Area Air Quality Management District (BAAQMD)
- Transit Agencies (BART, WestCAT, CCCTA, Tri-Delta Transit)

Figure 1. Caltrans District 4 CSMP Corridors May 2010).

Figure 2. SR-4 CSMP Corridor Limits & CMIA Project Location.

3. CORRIDOR DESCRIPTION

The SR-4 CSMP corridor is an east-west route approximately 31 miles in length providing interregional travel between the Central Valley and Bay Area for commute, recreational and commercial traffic. It also serves a significant level of locally generated demand from the cities located along the corridor such as Hercules, Martinez, Concord, Pittsburg, Antioch, Brentwood and Unincorporated Contra Costa County.

The SR-4 CSMP corridor is characterized by its rolling topography between I-80 and I-680. Its suburban land uses east ward of I-680 land uses and its proximity to the California Delta as it approaches SR-160 in Antioch.

The SR-4 CSMP corridor is on the National Highway System (NHS) as a basic route. It is functionally classified as both an Urban Principal Arterial and as expressway-freeway in different segments due to changes in access along its 31-mile stretch. The corridor lane configuration varies between four and seven mixed-flow lanes and approximately four miles of bi-directional High-Occupancy Vehicle (HOV) lanes.

Major Arterials

There is an extensive network of arterial roadways and local streets that provide access to SR-4 and serve local travel throughout the corridor. These include Willow Pass Road in Concord, The Pittsburg-Antioch Highway, West Leland Road and Buchanan Road in Pittsburg, and 18th Street. in Antioch. These arterials may also unofficially serve as alternative routings during major incidents on SR-4.

Goods Movement

The SR-4 corridor serves local and intercity truck and heavy vehicle travel for surrounding communities such as Hercules, Martinez, Concord, Pittsburg, Antioch, Oakley, and Brentwood. Additionally, it provides access to I-80, the second longest interstate route in the U.S., and a major route for interstate commerce.[2] Truck and heavy vehicle traffic makes up four to seven percent of daily vehicle trips along the SR-4 corridor.[3]

Transit

The SR-4 CSMP corridor includes interstate and regional rail, express and local bus service within Contra Costa County (specifically Antioch, Brentwood, Concord, Hercules, Martinez, and Pittsburg). The major providers are Amtrak, Bay Area Rapid Transit District (BART), West-CAT, Central Contra Costa Transit Authority (CCCTA) and Tri Delta Transit.

Bicycle and Pedestrian Network

The SR-4 CSMP corridor allows bicycle shoulder access between San Pablo Avenue and Cummings Skyway and Port Chicago Highway and Willow Pass Road, but no pedestrian access. Bicyclists and pedestrians may travel parallel to SR-4 on the remaining segments of SR-4 using local arterials. These provide access to local job centers, shopping centers, K-12 schools, colleges, and transit stations. Bicycle facility types include Class-I (multi-use). Class-II (bicycle lane) and Class-III (bicycle route). BART stations and Park and Ride lots within the corridor provide bicycle parking and storage facilities. Pedestrian walkways are present across SR-4 at Bailey Road, Railroad Avenue and Hillcrest Avenue in Pittsburg and Antioch.

Intelligent Transportation System (ITS) and Detection

Current ITS infrastructure within the SR-4 CSMP corridor includes Ramp Metering (RM) Stations, Traffic Monitoring Stations (TMS), Wireless Magnetometer Vehicle Detection Stations, Changeable Message Signs (CMS), Highway Advisory Radio (HAR), Extinguishable Message Signs (EMS), and Closed-Circuit Television (CCTV) cameras. Caltrans strives for traffic detection to be located at one-third to one half-mile intervals along the corridor. This has been recently achieved with the filling of key gaps in the detection network between I-80 and SR-242, and between Loveridge Road and SR-160. Figure 3 illustrates existing TMS along the SR-4 CSMP corridor.

[2]The Dwight D. Eisenhower National System of Interstate and Defense Highways. Federal Highway Administration (FHWA). November 2002. http://www.fhwa.dot.gov/reports/routefinder/index.htm

[3]2007 Truck AADT. Traffic Data Branch. Caltrans. http://www.dot.ca.gov/hq/traffops/saferesr/trafdata

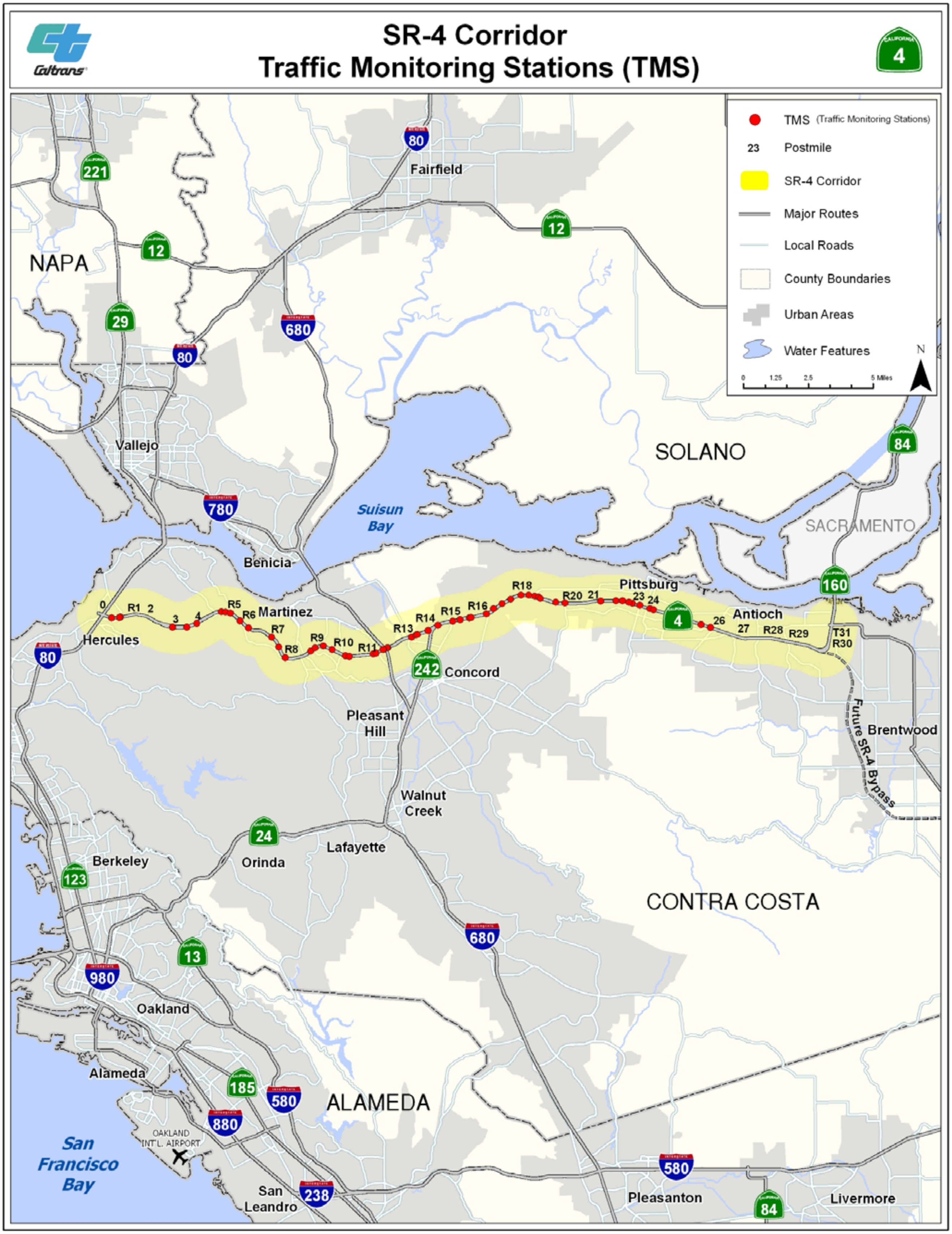


Figure 3. SR-4 Existing Traffic Monitoring Stations along the SR-4 CSMP Corridor.

SR-4 looking East towards 4 BP/160

Land Use-Major Traffic Generators

The SR-4 CSMP Corridor illustrates a variety of land-uses traveling between the Cities of Hercules and Antioch. Low-intensity commercial and residential land-uses are present throughout the suburban landscape of Hercules. As you travel east the landscape fluctuates between watershed, open space, and recreational uses before transitioning to low to moderate levels of residential, commercial and retail environments.

The SR-4 corridor is critical in accommodating longer vehicle trips through Contra Costa County. A larger proportion of vehicle trips along the corridor originate in the suburbs of East Contra Costa County with destinations outside the corridor. Destinations include job-centers, airports and entertainment centers located in Central Contra Costa County, Oakland and San Francisco. Land-uses featuring educational institutions, local and regional shopping centers and low-density commercial and retail along and adjacent to the corridor provide significant trip generation along the corridor. Other contributing factors to travel demand in the corridor include interregional and local routes providing network connectivity and access.

Environmental Constraints/Factors

Portions of SR-4 are in a 100-year flood plain, limiting allowable activities in floodplains unless it is the only practicable alternative. The SR-4 CSMP Corridor traverses many resource rich areas over its 31 miles. Nine historical bridges are identified along the corridor with a majority of them existing in the older eastern segments of the corridor. Hazardous Sites (underground tanks) are also identified along the corridor with the majority clustered around the refinery complexes found near the center and eastern segments of the Corridor. Numerous habitats supporting threatened or endangered species are present throughout the corridor with the largest concentrations found near the eastern segments of the corridor nearest the Delta. The Carquinez Strait Regional Shoreline Park and the Black Diamond Mines Regional Preserve are adjacent to the center and eastern segments of the corridor and are considered protected open-space. Figure 4 illustrates key SR-4 environmental factors.

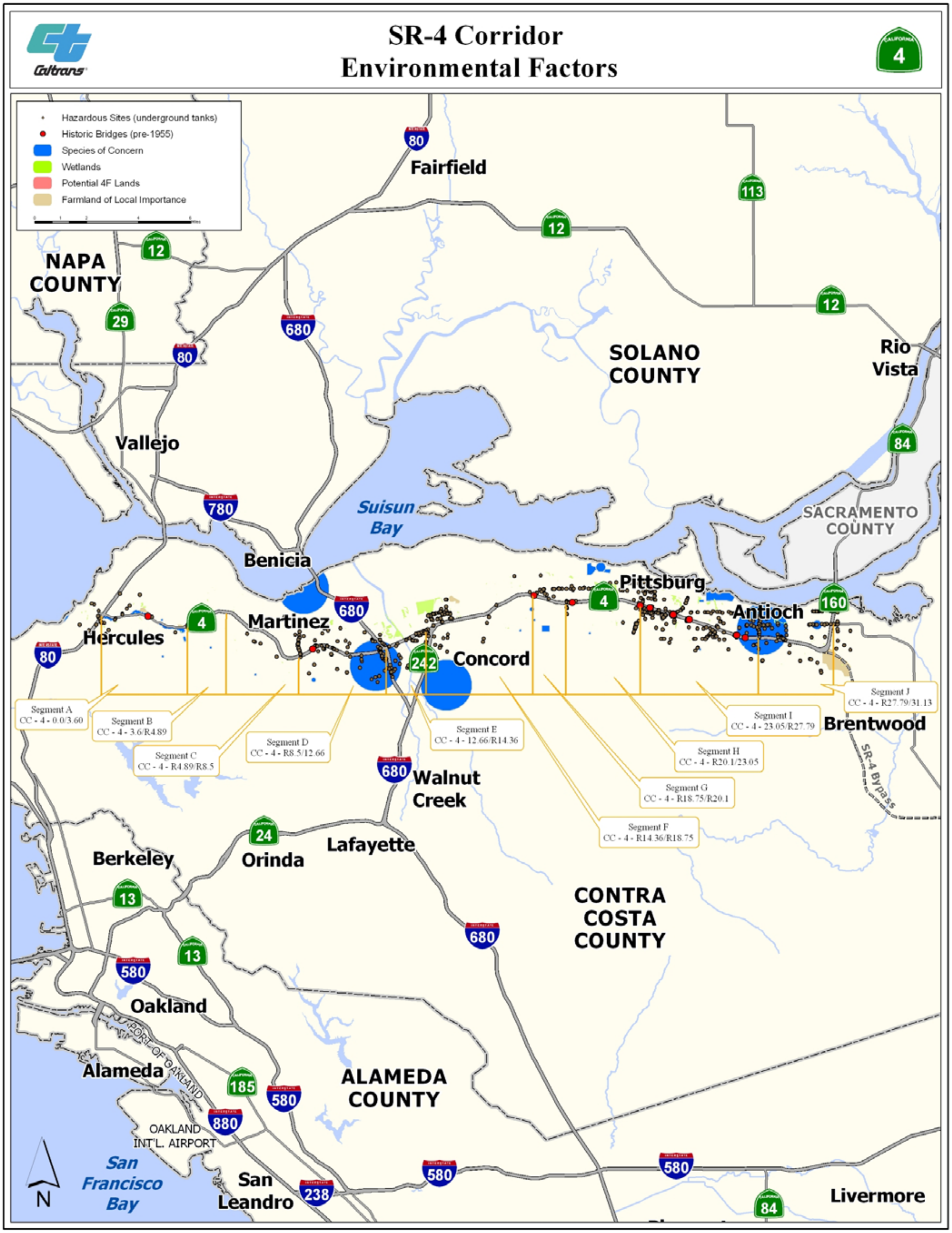


Figure 4. SR-4 CSMP Corridor Environmental Factors.

4. COMPREHENSIVE CORRIDOR PERFORMANCE ASSESSMENT

Freeway Performance Initiative (FPI)

A corridor performance assessment and technical analysis of the SR-4 CSMP Corridor was conducted through the FPI partnership between MTC and Caltrans. Current performance along the corridor, traffic bottlenecks and causes of performance problems were identified. Simulation modeling was used to forecast future travel conditions along the corridor, as well as analyze a variety of operational strategies and investment scenarios. Each scenario's performance was evaluated based on quantifiable criteria of mobility, reliability and safety.

Key Findings-Current Conditions

The traffic analysis of the SR-4 CSMP Corridor existing conditions concludes that existing congestion along the SR-4 CSMP Corridor is the result of a lack of corridor wide traffic management strategies, implementation of ITS and segments with inadequate capacity and weave-merge sections. Delay and congestion occur upstream of Willow Pass Road, Port Chicago Highway, Somersville Road, Loveridge Road and the I-680 and SR-242 interchanges. Table 2 lists and Figure 5 illustrates SR-4 AM bottlenecks and the resulting queues while Table 3 lists and Figure 6 illustrates SR-4 PM Bottlenecks and the resulting queues.

Table 2. SR-4 AM Bottleneck Locations.

Location	Bottleneck-Queue	Direction	Cause	VHD
1	Willow Pass Rd. to Port Chicago Hwy	WB	Insufficient Capacity - Merge	1,566
2	Somersville Rd. to Loveridge Rd.	WB	Insufficient Capacity	2,470

Source: SR-4 Final Existing Conditions Technical Memorandum. PBS&J February 17, 2009.

Figure 5. SR-4 AM Bottleneck Locations 2008.
Source: SR-4 Final Existing Conditions Technical Memorandum. PBS&J February 17, 2009.

Table 3. SR-4 PM Bottleneck Locations, 2008.

Location	Bottleneck-Queue	Direction	Cause	VHD
3	Loverridge Rd. to Somersville Rd.	EB	Insufficient Capacity	2,054
4	SR-242 to Port Chicago Hwy.	EB	Reduced mixed flow capacity –	318
5	I-680 to Solano Wy.	EB	Merge-Weave	N/A

Source: SR-4 Final Existing Conditions Technical Memorandum. PBS&J February 17, 2009.

Figure 6. SR-4 PM Bottleneck Locations 2008.
Source: SR-4 Final Existing Conditions Technical Memorandum. PBS&J February 17, 2009.

Future Conditions (2015-2030)

The findings of the future year analysis are based on forecasts of travel demand in the SR-4 Corridor and committed improvements that are assumed to be in-place by 2015, which for this corridor consists of the SR-4 East Widening Project (Loveridge Road to SR-160) and the SR-4 Bypass Project. The 2015 and 2030 forecasts findings suggest that increases in population and employment will be accompanied by corresponding increases in traffic demand along the SR-4 corridor. During the morning peak (westbound), the highest peak travel demands are expected to increase 31 percent or the equivalent of more than one additional lane of traffic demand.

Key Findings

- The Location 2 Westbound (WB) and Location 3 Eastbound (EB) bottlenecks between the Somersville Road and Loveridge Road will be completely mitigated in 2015 with completion of the SR-4 East Widening Project.
- In 2015, the Location 1 WB and Location 4 and 5 EB bottlenecks and queues between I-680 and Willow Pass Road will continue, due to future demand exceeding capacity in the peak direction.
- In 2015 and 2030 an EB bottleneck from Port Chicago Highway to SR-242 continues due to a complicated weave section, a reduction in capacity and a HOV lane extension in this segment.
- By 2030, bottlenecks and congestion will be largely focused on the section of SR-4 between I-680 and Willow Pass Road, due to demand outpacing capacity.

2015 Conditions

- A WB bottleneck between I-680 and Solano Way, Location 1, emerges with queues approaching Willow Pass Road.
- The WB bottleneck between Port Chicago Highway and Willow Pass Road, Location 2, continues with queues approaching L Street.
- The EB bottleneck between Willow Pass Road and Port Chicago Highway, Location 3, continues with queues approaching Morello Avenue.

Figure 7 summarizes the locations of recurrent congestion in 2015 below.

Figure 7. SR-4 2015 Locations of Recurrent Congestion.
Source: SR-4 Final Future Conditions Technical Memorandum (FCT). PBS&J July 17, 2009.

2030 Conditions

- The WB bottleneck between Solano Way and I-680, Location 1, will continue and join the upstream WB bottleneck from Port Chicago Highway to Willow Pass Road, Location 2.
- The WB bottleneck between Port Chicago Highway to Willow Pass Road, Location 2 will continue and increase with queues approaching Lone Tree Way.
- An EB bottleneck between Solano Way. and I-680 emerges and joins the queue from the EB bottleneck between Port Chicago Highway and Willow Pass Road.
- The EB bottleneck queue from the bottleneck between Port Chicago Highway and Willow Pass Road, and the EB between Solano Way and I-680, is projected to extend to I-80.

Figure 8 summarizes the locations of recurrent congestion in 2030.

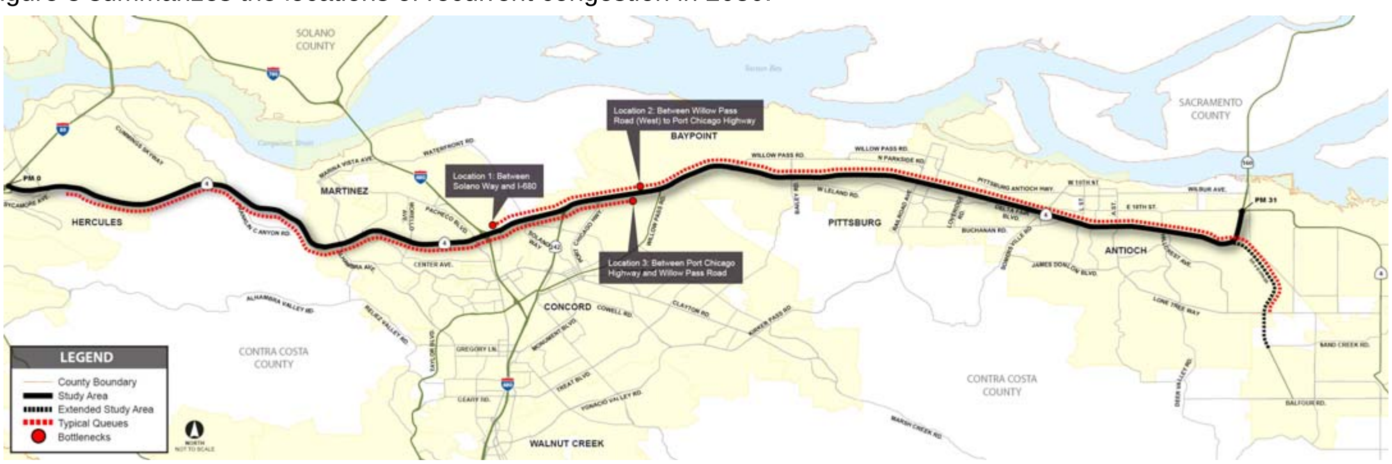


Figure 8. SR-4 2030 Locations of Recurrent Congestion.
Source: SR-4 Final Future Conditions Technical Memorandum (FCT). PBS&J July 17, 2009.

5. RECOMMENDED CORRIDOR MANAGEMENT IMPROVEMENT STRATEGIES

The improvement strategies recommended for the SR-4 CSMP Corridor address the existing and forecasted Mobility, Reliability, and Safety concerns identified through the comprehensive analysis. The recommended Mitigation Strategies include auxiliary lanes, ramp metering, and increasing capacity of existing lanes. The recommended transit improvement strategies for the SR-4 CSMP Corridor are listed separately. Figure 9 summarizes the proposed improvement strategies.

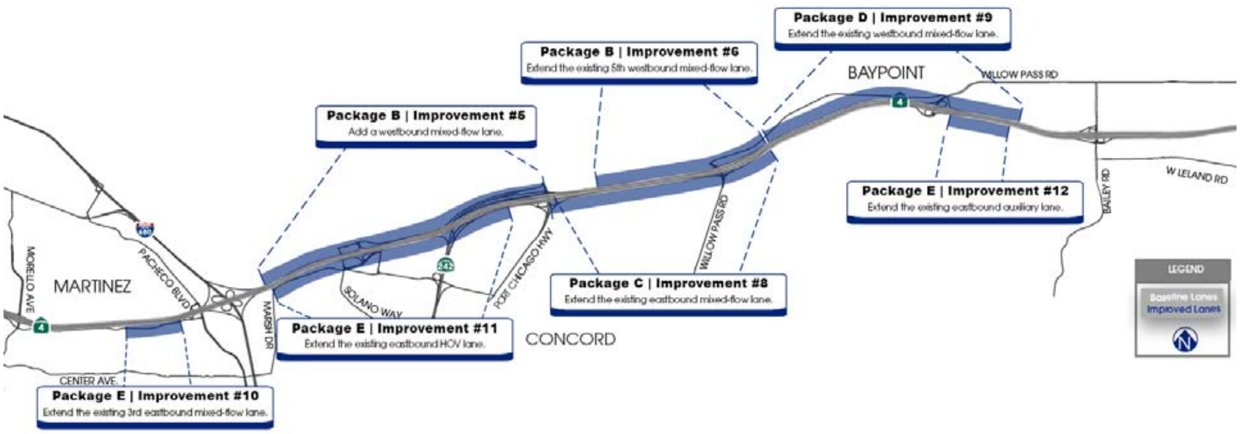


Figure 9. SR-4 CSMP Proposed Priority Mitigation Strategies.
Source: SR-4 Prioritized Congestion Mitigation Strategies Technical Memorandum. PBS&J November 9, 2009.

Recommended Short-Term Operations and Capacity Improvements

The performance assessment analysis identified approximately $140 million in short-term improvement packages (in addition to currently programmed projects expected to be in place by 2015). The short-term improvement packages are intended to preserve corridor mobility for single and high occupant vehicles and highway transit into 2015. The recommended short-term mitigation strategies are listed in Table 4. The reduction in peak direction delay as a result of the short-term mitigation strategies are illustrated in Figure 10.

Table 4. SR-4 CSMP 2015 Recommended Short-Term Mitigation Strategies.

Pkg	Year	Dir.	2015 Mitigation Improvement Strategies	Rank	Cost*
B	2015	WB	Implement Ramp Metering in the WB direction between SR-160 and I-680.	1	$58 M
			Add a mixed-flow lane from east of SR-242 off-ramp to the I-680 NB off-ramp. (Improvement # 5)		
			Extend the existing mixed-flow lane from the Willow Pass Rd. (West) off-ramp to the lane-add located 4,200 ft. west of the Willow Pass Rd. (West) on-ramp. (Improvement # 6)		
C	2015	EB	Implement Ramp Metering in the EB direction between Alhambra Blvd. and Willow Pass Rd. (east)	2	$31 M
			Add a mixed-flow lane from the lane drop 1,500 ft. west of Port Chicago Hwy. on-ramp to Willow Pass Rd. (west) on-ramp. (Improvement # 8)		
A	2015	WB+ EB	Activate existing ITS installations that currently are not fully operational.	3	$28 M
			Fill gaps in the current and programmed ITS installations as needed.		

Source: SR-4 Prioritized Congestion Mitigation Strategies Technical Memorandum. PBS&J November 9, 2009.

* The total costs associated with the proposed mitigation improvements to the corridor are capital costs (also known as construction costs or upfront costs) and operation and maintenance (O&M) costs (also known as ongoing costs). These costs are all presented in 2007 dollars using a discount rate of 4% per year is used to convert future values to present values.

Reduction in Peak-Direction Delay	Vehicle Hours	12,900 hrs. – 11,010 hrs = 1,890hrs	85% reduction
	Person Hours	14,800 hrs. – 12,820 hrs = 1,980 hrs	87% reduction

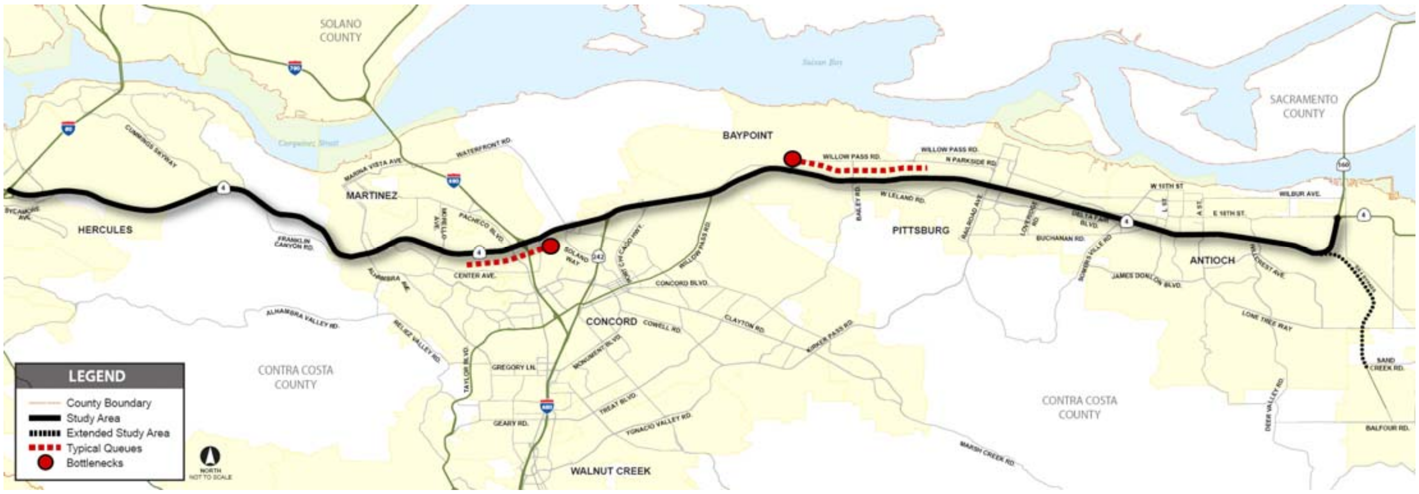


Figure 10. SR-4 CSMP Short-Term Mitigation Strategies Reduction in Peak Direction Delay.
Source: SR-4 Prioritized Congestion Mitigation Strategies Technical Memorandum. PBS&J November 9, 2009.

Recommended Long-Term Operations and Capacity Improvements

The performance assessment analysis identified approximately $70 million in long-term improvement packages (in addition to those improvements expected to be in place by 2015). The combined short and long term improvement packages are intended to extend corridor mobility for single and high occupant vehicles and highway transit into 2030. The recommended long-term mitigation strategies are listed in Table 5. The reduction in peak direction delay as a result of the long-term mitigation strategies are listed-illustrated in Figure 11.

Table 5. SR-4 CSMP 2030 Recommended Long-Term Mitigation Strategies.

Pkg	Yr	Dir	2030 Mitigation Improvement Strategies	Rank	Cost*
G	2030	EB	Implement ramp metering in the EB direction between I-80 and Alhambra Blvd, between Willow Pass Rd. (east) and SR-160 and the SR-4 Bypass.	1	$10 M
E	2030	EB	Extend the existing EB mixed-flow lane from the lane drop located 1,500 ft. west of the Pacheco Blvd. off-ramp to the Pacheco Blvd. off-ramp. (Improvement # 10)	2	$32 M
			Extend the existing EB HOV lane from the I-680 NB off-ramp to its start 1,500 ft. west of the Port Chicago Hwy. on-ramp. (Improvement # 11)		
			Extend the existing EB mixed-flow lane from the Willow Pass Rd. (east) on-ramp to the lane add located 4,000 ft. east of the Willow Pass Rd. (east) on-ramp. (Improvement #12)		
D	2030	WB	Extend the existing WB mixed-flow lane from the lane drop located 3,500 ft. east of the Willow Pass Rd. (east) off-ramp to the Willow Pass Rd. (west) off-ramp. (Improvement # 9)	3	$22 M
F	2030	WB	Implement ramp metering in the WB direction on the SR-4 Bypass and on SR-4 between I-680 and I-80.	4	$5 M

Source: SR-4 Prioritized Congestion Mitigation Strategies Technical Memorandum. PBS&J November 9, 2009

* The total costs associated with the proposed mitigation improvements to the corridor are capital costs (also known as construction costs or upfront costs) and operation and maintenance (O&M) costs (also known as ongoing costs). These costs are all presented in 2007 dollars using a discount rate of 4% per year is used to convert future values to present values.

Reduction in Peak-Direction Delay	Vehicle Hours	24,900 hrs. – 17,500 hrs. = 7,400 hrs.	70% reduction
	Person Hours	28,600 hrs. – 20,830 hrs. = 7,770 hrs.	73% reduction

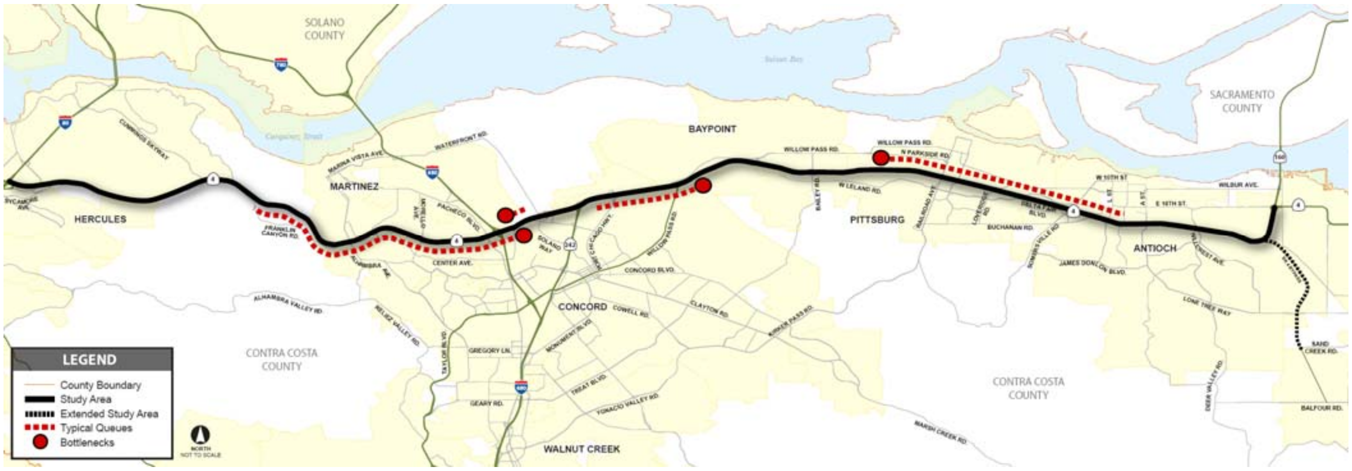


Figure 11. 2030 SR-4 CSMP Recommended Short and Long-Term Mitigation Strategies Reduction in Peak Direction Delay.
Source: SR-4 Prioritized Congestion Mitigation Strategies Technical Memorandum. PBS&J November 9, 2009.

Recommended Short- and Long-Term Transit Improvements

While the FPI analysis and CSMP development processes focus on freeway mitigation strategies, improved transit service was discussed by stakeholders along the SR-4 corridor. These recommended services related to transit include a general package of increased transit access strategies, including additional parking at BART stations along the corridor, enhanced bus feeder services, and operational enhancements to BART at a system-wide level that could accommodate ridership increases of 10 to 20 percent.

The transit mitigation strategies in Package H include both short-term and long-term strategies. Transit cost effectiveness could not be estimated for this report, and thus these transit mitigation strategies cannot be ranked against other mitigation strategies for which life-cycle benefits and costs were available. For this reason, no prioritized recommendations are offered on this set of transit strategies by this analysis. The recommended short and long-term transit improvements are listed in Table 6.

Table 6. SR-4 CSMP Recommended Transit Improvement Strategies.

Package	Recommended Transit Improvement Packages (2015-2030)
H	• Additional BART Parking Capacity • Increased bus transit access to the BART Stations • An expanded Pacheco Rd. Park & Ride facility • BART system-wide operational improvements

Source: SR-4 Prioritized Congestion Mitigation Strategies Technical Memorandum. PBS&J November 9, 2009.

SR-4 at Bailey-BART overlooking east

Express Lanes

In addition to the short and long-term freeway and transit prioritized mitigation strategies, a strategy, not within the scope of this analysis is the strategy of converting the HOV lanes on SR-4 to Express Lanes. MTC's 2009 RTP proposes a Regional Express Lane Network for the Bay Area, which includes Express Lanes on SR-4 between I-680 and SR-160. Legislation to authorize the creation of an 800-mile express lane network on Bay Area freeways is pending in the State Legislature. Should Express Lane-enabling legislation be signed into law in the future, significant further analysis and consultation with affected jurisdictions along the corridor will be required to determine the feasibility, user benefits, cost-effectiveness and appropriateness of converting HOV lanes to Express Lanes in the SR-4 Corridor. This process will inform whether and how (e.g., timing and phasing, design and operations policies) Express Lanes might be implemented in the corridor.

State Route 4

Section 1: CSMP Overview

1.1 DISTRICT 4 CSMP OVERVIEW

A Corridor System Management Plan (CSMP) is a transportation planning document "that identifies the facility based on comprehensive performance assessments and evaluations. The strategies are phased and include both operational and more traditional long-range capital expansion strategies. The strategies take into account transit usage and projections and interactions with arterial network and connection to State Highways." Each CSMP presents an analysis of existing and future traffic conditions and proposes traffic management strategies and capital improvements to maintain and enhance mobility within each corridor. The corridor management planning strategy is based on the integration of system planning and system management. They provide for the integrated management of travel modes and roadways so as to facilitate the efficient and effective mobility of people and goods within our most congested transportation corridors. Each CSMP will address State Highways, local parallel roadways, regional transit services, and other regional modes pertinent to corridor mobility.

CSMPs are being developed throughout the State for corridors within which funding is being used from the Corridor Mobility Improvement Account (CMIA) and Highway 99 Bond Programs created by the passage of the Highway Safety, Traffic Reduction, Air Quality, and Port Security Bond Act of 2006, approved by the voters as Proposition 1B in November 2006. The intent is to eventually develop CSMPs for all urban freeway corridors. The Metropolitan Transportation Commission (MTC) and the California Department of Transportation (Caltrans) have committed to assisting each other in the development of CSMPs and MTC's related Freeway Performance Initiative (FPI) corridor studies. This cooperation is documented in MTC Resolutions 3792 and 3794. Table 1.1.1. lists the nine CSMPs being developed in the San Francisco Bay Area (Caltrans District 4)as of May 2010.

Table 1.1.1. Caltrans District 4 CSMP Corridors (May 2010).

- US-101 North (MRN/SON)
- US-101 Peninsula/South (SM/SCL)
- I-880 (ALA/SCL)
- I-80 West (ALA/CC)
- I-80 East (SOL)
- I-580 (ALA)
- SR-4 (CC)
- SR-24 (ALA/CC)
- SR-12 (NAP/SOL)

The limits of each CSMP were determined by identifying the key travel corridor in which CMIA-funded projects were located in collaboration with MTC. In most cases the limits from District 4's Transportation Corridor Concept Reports (TCCRs) were used, as well as corridor limits used in the FPI. Figure 1.1.1. depicts the corridor limits for the CSMPs under development in District 4 as of May 2010.

Eight milestones have been identified by the California Transportation Commission (CTC) and Caltrans for monitoring the timely development of the required CSMPs, namely:

1. Define Corridor.
2. Assemble Corridor Team.
3. Develop Preliminary Corridor Performance Assessment.
4. Ensure Adequate Corridor Detection.
5. Conduct Comprehensive Corridor Performance Assessment.
6. Identify Causality of Corridor Performance Degradation.
7. Develop Corridor Simulation Model and Test Improvement Scenarios.
8. Develop Corridor System Management Plan.

Defining the CSMP transportation network includes, but is not limited to, State Highways, major arterials, intercity and regional rail service, regional transit services, and regional bicycle facilities. A team of corridor stakeholder agency staff is assembled to assist in finalizing the corridor definition and provide to oversight for ongoing tasks of the corridor team.

Preparing a corridor performance assessment begins with utilizing existing travel data; a comprehensive corridor performance assessment can take place once an adequate traffic detection system is in place along the corridor. This serves to evaluate existing system management practices and the causes of performance problems along the corridor using a set of common performance metrics. Modeling is also used to forecast future travel conditions along the corridor.

Figure 1.1.1. District 4 CSMP Corridor Limits (May 2010).

Traffic analysis methods are used to predict the impacts of a variety of operational strategies and investment scenarios, allowing the corridor team to evaluate and recommend operational strategies, needed capital improvement projects, and opportunities for transportation technology integration. A documented CSMP is then prepared for review and acceptance by the applicable stakeholder agencies. More detailed guidance regarding these CSMP milestones and performance measures is available from the *Caltrans 2007 Guidelines for Completing CSMP Milestones*.

1.2 CSMP PURPOSE AND NEED STATEMENT

The immediate purpose of preparing CSMPs is to satisfy the requirements to qualify for funding highway improvements under the CMIA and Highway 99 Bond programs. Both programs were established following the passage of Proposition 1B in the November 2006 election. The CTC has since adopted guidelines and adopted a program of projects for funding. The need for preparing CSMPs is based on the need to efficiently and effectively use all transportation modes and facilities in congested corridors so as to maximize mobility, improve safety and reduce delay costs.

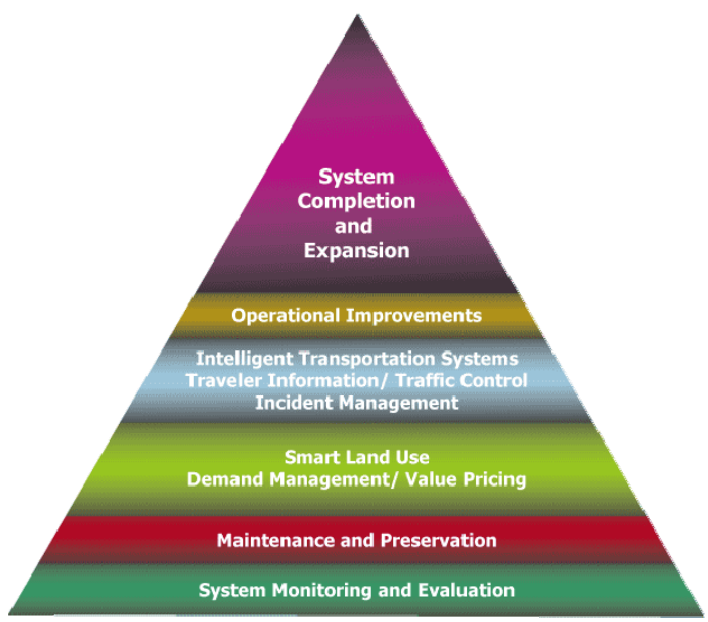
1.3 CONSISTENCY WITH STRATEGIC GROWTH PLAN

CSMPs are meant to support the Governor's Strategic Growth Plan (SGP), which calls for an infrastructure improvement program that includes a major transportation component (GoCalifornia). The CMIA and other elements of the November 2006 transportation infrastructure bond are meant as a down payment toward funding the most important of these infrastructure needs. The objectives of these investments are to decrease congestion, improve travel times and safety, and accommodate expected growth in the population and economy. The SGP is based on the premise that investments in mobility throughout the system will yield significant improvements in congestion relief. The system management pyramid outlines strategies to be used to achieve the outcome of reduced congestion. The base of the pyramid is as important as the apex. System monitoring and preservation are the basic foundation upon which the other strategies are built. System expansion and completion will provide the desired mobility benefits to the extent that investments and implementation of the strategies below it establish a solid platform.

1.4 RELATIONSHIP TO OTHER PLANS

There are a number of Caltrans system planning documents that have been used as the foundation for the preparation of this CSMP. The system planning documents prepared by Caltrans include the 2005 *California Transportation Plan* (CTP), the 1998 *Interregional Transportation Strategic Plan* (ITSP), and several Caltrans District 4 documents that include the preliminary draft *Transportation Corridor Concept Report* (TCCR) for SR-4 dated September 15, 2002.

In addition to the above-described planning documents, there are also a number of related Caltrans system management documents that have been utilized in the development of this CSMP. These documents include the 2006 *Strategic Growth Plan* (SGP), 2004 *Transportation Management System Master Plan* (TMSMP), 2004 *California ITS Architecture and System Plan* (SWITSA).



The System Management Pyramid

System and regional planning documents prepared by other agencies that have influenced CSMP development include MTC's 2005 and 2009 Regional Transportation Plans (RTP) and the 2004 *Bay Area Regional ITS Plan*. Most notably, the MTC Freeway Performance Initiative (FPI) is a regional program that has provided a foundation for corridor-level performance-based decision making for the 2009 RTP.

Important documents in this effort have been the FPI Performance & Analysis Framework, the FPI Prioritization Framework, and the FPI's corridor-specific documents noted below.

Table 1.4.1. MTC Bay Area FPI Corridors.

• US-101 North (MRN/SON)	• I-580 (ALA)
• US-101 Peninsula/South (SM/SCL)	• SR-4 (CC)
• I-880 (ALA/SCL)	• I-680 North (SOL/CC)
• I-80 West (ALA/CC)	• I-680 South (ALA/SCL)
• I-80 East (SOL)	

Additional studies utilized in this SR-4 corridor planning effort include:

- CCTA-sponsored Action Plans for Western, Central and Eastern Contra Costa County.
- The CCTA SR-4 Strategic Planning Study (2005), which examined funding issues tied to the implementation of programmed SR 4 improvements.
- The BART SR-4 East Transit Study (2001), which examined commuter rail along the corridor.
- The MTC SR-4 Major Investment Study (MIS) (1996), which examined capital and operational improvements to freeway operations.

Regional Blueprint Planning Program

The Regional Blueprint Planning Program supports the smart growth element of the Strategic Growth Plan by promoting smart land use choices at the regional and local levels. The Regional Blueprint Planning Program is a voluntary, competitive grant program that supports Metropolitan Planning Organizations (MPOs) and Regional Transportation Planning Agencies (RTPAs) in conducting comprehensive scenario planning. Using consensus-building and a broad-based visioning approach, the goal is to envision future land-use patterns and their potential impacts on a region's transportation system, housing supply, jobs/housing balance, resource management and other protections.

The blueprint planning effort in the San Francisco Bay Area is the Focus our Vision (FOCUS) program, which is led by the Association of Bay Area Governments (ABAG) and MTC with support from the Bay Area Air Quality Management District (BAAQMD), the Bay Conservation and Development Commission (BCDC) and Caltrans. These agencies and local governments have participated in the Regional Blueprint Planning Program since the program's inception in 2005.

Complete Streets Implementation Action Plan

Caltrans policy through Deputy Directive 64 (Complete Streets*) is to view all transportation improvements (new and retrofit) as opportunities to improve safety, mobility and access for all travelers, including transit users, bicycles and pedestrians. Such projects are coordinated with community goals, plans and values. Providing Complete Streets increases travel options, enabling environmentally sustainable alternatives to single-driver car trips. Implementing Complete Streets also supports local agency efforts required by the 2008 California Complete Streets Act—Assembly Bill (AB) 1358, as well as expected efforts toward Senate Bill (SB) 375 goals to reduce greenhouse gas emissions through sustainable community strategies.

1.5 STAKEHOLDER ENGAGEMENT

The development and successful implementation of the CSMP is dependent upon the close participation and cooperation of all major stakeholders. The strategies evaluated have the potential to impact the local arterial system, the transit services along the corridor, and the regional and local planning agencies that have the corridor within their jurisdiction. The goal of the stakeholder engagement process is consensus among key stakeholder groups to develop and implement the CSMP.

*A "Complete Street" is a transportation facility that is planned, designed, operated and maintained to provide safe mobility for all users.

The stakeholder engagement process framework for CSMPs considers stakeholders in these categories:

I. Core Stakeholder Group: Agencies primarily responsible for conducting planning efforts on behalf of the corridor.

II. Planning Agency Partners: Additional agencies responsible for implementing and monitoring CSMP strategies.

Each stakeholder category group has a role during the CSMP development process. Each CSMP follows a workplan unique to the needs of the CSMP corridor and identified stakeholders. Stakeholder involvement broadens as the CSMP development process advances. The Core Stakeholder Group provides policy and technical guidance throughout the process and monitors CSMP development milestones. Additional planning agency partners and other key stakeholder groups review and comment at key junctures, and help evaluate corridor improvement strategies.

SR-4 CSMP Corridor Team

The Core Stakeholder Group for the SR-4 CSMP Corridor is identified as MTC, Contra Costa Transportation Authority (CCTA) and Caltrans. Representatives met early in the development process to discuss the goals, objectives and schedule of the CSMP. The Core Stakeholder Group met regularly to review and approve operational and simulation data collection and analysis methodology, technical reports, and identified additional planning agency partners for further CSMP development. Planning Agency Partners provided valuable input on the analysis and recommended improvement strategies for the SR-4 CSMP Corridor. The key stakeholders listed below were identified for involvement in the engagement process.

Core Stakeholder Group

- Caltrans
- Metropolitan Transportation Commission
- Contra Costa Transportation Authority

Additional Planning Agency Partners

- City of Hercules
- City of Martinez
- City of Concord
- City of Pittsburg
- City of Antioch
- Contra Costa County
- West Contra Costa Transportation Advisory Committee (WCCTAC)
- Transportation Partnership and Cooperation Committee (TRANSPAC)
- East Contra Costa County Transportation Planning Committee (TRANSPLAN)
- Association of Bay Area Governments (ABAG)
- Bay Area Air Quality Management District (BAAQMD)
- Transit Agencies (BART, WestCAT, CCCTA, Tri-Delta Transit)

1.6 CORRIDOR PERFORMANCE MEASURES AND OBJECTIVES

Caltrans worked with stakeholders to develop performance measures and objectives that serve to focus directed action on desired corridor strategies and improvements. The performance measures, descriptions and corresponding objectives used in discussions with stakeholders are illustrated in Table 1.6.1 below.

- Mobility: reduce delay within the corridor;
- Reliability: reduce variation of travel time; and
- Safety: reduce accident and injury rate.

Table 1.6.1. CSMP Performance Measures

Performance Measure	Performance Measure Description	Objective/ Desired Outcome
Mobility	Vehicle Hours of Delay (PeMS*, Probe Vehicles)	Reduce delay within the corridor
Reliability	Travel Time (PeMS, Buffer Index)	Reduce variation of travel time
Safety	TASAS** Data	Reduce accident and injury rate

*Freeway Performance Measurement System

**Traffic Accident Surveillance and Analysis System

1.7 STAKEHOLDER ISSUES AND CONCERNS

Stakeholders expressed the following issues and concerns during review of the SR-4 CSMP technical analysis. Their concerns focused on SB 375 requirements, High Occupancy Toll Lanes (HOT), the reuse of the Concord Naval Weapons Station, implementation of a SR-4 Ramp Metering Strategy and the potential impacts of ramp metering on the local arterial network.

Sustainable Communities Strategy (SB 375)

The next update of the RTP in 2013 will include a Sustainable Community Strategy (SCS) as required by SB 375. Some stakeholders commented that the CSMP should include integrated land use and transportation, in the context of the future SCS, and take a more comprehensive look at transit and non-motorized travel strategies and options. Caltrans acknowledges that since this first cycle of corridor system management planning was launched in 2007 (first generation CSMPs), the statewide planning policy context has evolved significantly. The CTC has recently developed guidance on how the regions will develop Sustainable Community Strategies (SCS) in their next RTP cycle; MTC's next RTP is slated for completion in 2013. Second generation CSMPs will reflect the SCS and the 2013 RTP and will grapple with the issue of providing mobility within the context of a new regional planning framework.

Express Lanes/High Occupancy Toll (HOT) Lanes

The CCTA, WCCTAC, TRANSPAC and TRANSPLAN have expressed skepticism or opposition to HOT lanes on any highway corridors in Contra Costa County including SR-4.

The SR-4 CSMP technical analysis recommends further study regarding the conversion of existing and future HOV lanes to Express Lanes along the corridor since SR-4 is included in MTC's proposed Regional Express Lane network within the 2009 RTP. While the conversion of HOV lanes to HOT lanes is not within the scope of this first generation SR-4 CSMP, it will be further evaluated if enabling legislation for a regional HOT lane network becomes law.

Reuse of Concord Naval Weapons Station (CNWS)

TRANSPLAN and TRANSPAC expressed concern about the redevelopment of the CNWS and the impacts it could have on the operation of SR-4. CNWS was not included in the analysis model for the SR-4 CSMP because it

Eastbound SR-4 at Bailey Road looking east.

does not have an approved development proposal within a General Plan (and therefore not included within the CCTA Countywide Travel Demand Model). These stakeholders questioned how the technical analysis is useful if CNWS is not part of the analysis. However, TRANSPAC and TRANSPLAN are interested in utilizing the SR-4 CSMP project recommendations as mitigation to CNWS reuse, and are discussing with CCTA how to further evaluate and mitigate potential impacts of CNWS reuse.

Implementation of SR-4 Ramp Metering/Impact of Ramp Metering on Local Arterials

SR-4 stakeholders expressed concern regarding the development and implementation of an SR-4 ramp metering strategy. In particular, it was noted that the CSMP technical analysis demonstrated the benefits of a ramp metering strategy to the freeway mainline, but did not note the benefits or impacts to local arterials. Caltrans noted that recent ramp metering deployments in the Bay Area are operated with no local arterial impacts and provided significant benefit for all travelers. Within the SR-4 corridor, Caltrans, MTC and CCTA will convene a ramp metering technical committee to study SR-4 metering operational concepts in much more detail; this technical committee will include representatives from each jurisdiction along SR-4.

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Section 2: Corridor Description

2.1 CORRIDOR LIMITS/ROUTE DESIGNATION

The SR-4 CSMP Corridor in Contra Costa County is approximately 31 miles long. The western limit is the I-80/ SR-4 interchange in the City of Hercules, continuing eastward and ending at the SR-4/SR-160 interchange in the City of Antioch.

The SR-4 CSMP Corridor is on the National Highway System (NHS) as a basic route. SR-4 is functionally classified as both an Urban Principal Arterial and as expressway-freeway. The SR-4 CSMP Corridor is on the Surface Transportation Assistance Act (STAA) and the State Highway Extra Legal Load (SHELL) network. The CCTA characterizes SR-4 as a Route of Regional Significance. SR-4 falls within the jurisdiction of MTC and BAAQMD.

2.2 ROUTE SIGNIFICANCE

SR-4 is an east-west route providing interregional travel between the Central Valley and Bay Area for commute, recreational and commercial traffic. It serves a significant level of locally generated demand from the cities located along the corridor such as Hercules, Martinez, Concord, Pittsburg, Antioch, Brentwood and Unincorporated Contra Costa County. Beginning in the City of Hercules, SR-4 provides access to the interstate system connecting to I-80, I-680 and regional routes such as SR-242. When the SR-4 Bypass is completed, SR-4 will provide access between I-580 in the Tri Valley via the existing Byron Highway. SR-4 supports the movement of goods and services between the Central Valley and San Francisco East Bay. It is characterized by its topographical features, historic bridges and relatively high volumes of truck travel. It is a key goods movement corridor included in the STAA, Terminal Access and SHELL networks. It is also a Union Pacific (UP) rail corridor accompanying UP freight and Amtrak passenger travel. The Suisun Bay and San Joaquin River provide deep draw water ship channel access for maritime based cargo movements between the Pacific Ocean and the ports of Stockton, Sacramento and Pittsburg. Additionally, the corridor provides several break bulk, dry, liquid and neo-bulk cargo berths including a pipeline dock for the Conoco Phillips refinery and the Selby facility near Hercules, pipeline docks for the Shell Oil Refinery and Tesoro Refinery in Martinez, and the Port Chicago marine terminal (former Naval magazine delivery and storage facility) in Contra Costa County.

2.3 HIGHWAY SYSTEM

The SR-4 CSMP Corridor combines two facility types. The segments of SR-4 between I-80 and the Cummings Skyway/SR-4 interchange range is functionally classified as a Principal Arterial-Expressway (partial access). Its existing lane configuration varies between two and four lanes. The remaining segments of SR-4 between Cummings Skyway and the SR-4/SR-160 interchange are functionally classified as Expressway-Freeway (full access control). Its current lane configuration varies between four and seven lanes including an eastbound HOV lane approximately 4.4 miles long.

2.4 ARTERIAL NETWORK

There is an extensive network of arterial roadways and local city streets that provide access and alternatives to SR-4. The length of these streets vary among those that provide local access to those that allow for intercity travel. Local parallel arterials and regional connecting routes to the SR-4 CSMP Corridor are described below.

Sycamore Avenue

Sycamore Avenue in Hercules is a two-lane arterial that runs along the south side of SR-4 between San Pablo Avenue west of I-80 and ends as an SR-4 eastbound on-ramp at the Hercules city limit. Sycamore Avenue provides intercity travel between San Pablo and Hercules.

Franklin Canyon Road

Franklin Canyon Road, in unincorporated Contra Costa County, is a two-lane arterial that winds along the south side of SR-4 between Cummings Skyway and Alhambra Boulevard. Franklin Canyon Road provides access to a regional recreation site along SR-4.

Arnold Way

Arnold Way in Martinez is a two- to four-lane arterial that runs along the north side of SR-4 between Alhambra Boulevard and Port Chicago Highway in Concord. Combined with Industrial Way, this route provides local street access and intercity travel between Martinez and Concord.

Evona Road

Evona Road in Concord is a two-lane arterial that runs along the north side of SR-4 between the two Willow Pass Road interchanges in Concord and Pittsburg.

Willow Pass Road

Willow Pass Road in Concord is a two- to four-lane arterial that runs along the north side of SR-4 between SR-4 and Railroad Avenue in Pittsburg. Combined with Tenth Street and Port Chicago Highway, this route provides local street access and regional travel between Pittsburg and Antioch.

Leland Avenue

Leland Avenue in Pittsburg is a four-lane arterial that runs along the south side of SR-4 between Somerville Road and Bailey Avenue in Pittsburg. A planned extension of Leland Avenue, west to Willow Pass Road, will improve its utility as a parallel arterial to SR-4.

2.5 TRANSIT NETWORK AND FACILITIES

Five major transit operators provide service in the vicinity of the SR-4 corridor.

- Amtrak (Capitol Corridor and San Joaquin routes)
- Bay Area Rapid Transit District (BART)
- Western Contra Costa Transit (WestCAT)
- Central Contra Costa Transit Authority (CCCTA)
- Tri Delta Transit

Intercity, regional and interstate rail service providers offering service along and into the SR-4 corridor include BART and Amtrak (both the Capitol Corridor and San Joaquin routes). Both BART and Amtrak services operate seven days a week. The BART Pittsburg/Bay Point line serves the cities along the SR-4, SR-242, I-680 and SR-24 corridors with stations in Oakland, Orinda, Lafayette, Walnut Creek, Pleasant Hill, Concord, North Concord and Pittsburg/Bay Point. The Amtrak San Joaquin line provides service between Oakland and Bakersfield with rail connections to BART in Richmond; the Amtrak Capitol Corridor line serves the City of Martinez with bus bridges to other service areas. Regional Express Bus through the SR-4 corridor is provided by WestCAT, CCCTA and Tri Delta Transit.

WestCAT Route 30Z operates between Del Norte BART in El Cerrito, the Hercules Transit Center and the Martinez Amtrak station five days a week.

CCCTA offers two regional bus lines that run between Martinez Amtrak and BART. The 16 and 19 lines provide five-day service between Martinez Amtrak and the Concord BART station while the 18 line provides five-day service between Martinez Amtrak and Pleasant Hill BART.

Tri Delta Transit offers two regional bus lines along the SR-4 corridor. The 200 line offers five-day-a-week service between Martinez Amtrak and Pittsburg/Bay Point BART. The 300 line offers five-day-a-week service between the City of Brentwood and Pittsburg/Bay Point BART. Local routes 300, 380, 387, 388, 389, 390 and 391 lines offer service between Pittsburg/Bay Point BART and the Cities of Antioch, Brentwood and Oakley five days a week.

Multi Modal Facilities

Within the triangle formed by SR-4, I-680, SR-242 lies the Buchanan Field airport, owned and operated by Contra Costa County. This general aviation airport houses 480 aircraft ranging from single engine air planes to corporate jets. Take offs and landings average 256 per day with 57 percent of the traffic being transient and 41 percent of traffic generated locally. The facility features six runways varying in length from 844 to 5001 feet. Buchanan Field also supports aviation businesses offering repair and services as well as retail and low density commercial land uses.

Figure 2.5.1 Buchanan Field Airport.

Figure 2.5.2. Transit, Park and Ride Network in the SR-4 CSMP Corridor.

The park and ride lot network along and adjacent to the SR-4 CSMP Corridor operate as collection points for carpoolers and provide connectivity to transit providers. Table 2.5.1. lists park and ride lots by city; Figure 2.5.2 on the previous page illustrates the SR-4 Transit/Park-and-Ride network.

Table 2.5.1. Park and Ride Lots in the SR-4 CSMP Corridor by City.

Map #	City	Location	Transit	Spaces	Bikes	Usage
1	Hercules	Sycamore-San Pablo Ave.	WestCAT	252	Yes	100%
2	Hercules	Willow-I-80	WestCAT	85	No	80-90%
3	Martinez	Alhambra Blvd. & SR-4	CCCTA	24	No	80%
4	Martinez	Pacheco Blvd. & Blum Ave.	CCCTA	51	No	80%
5	Pittsburg	Bliss Ave. & Harbor Rd.	TriDelta Transit	175	No	20%
6	Antioch	Hillcrest Ave. & SR-4	TriDelta Transit	218	Yes	90%

2.6 BICYCLE AND PEDESTRIAN NETWORK

The bicycle and pedestrian network for this SR-4 CSMP consists of a network of local and regional bicycle facilities that intersect or are parallel (within approximately one mile radius) to the corridor. Existing bicycle and pedestrian facilities in Hercules, Martinez, Concord, Pittsburg, Antioch and unincorporated Contra Costa County are established along Multi-Use Trails (MUT), local arterials and on the State Highway System providing access to employment centers, shopping centers, colleges, and transit stations. At the heart of the bicycle and pedestrian network along and perpendicular to SR-4 are MUTs such as the Iron Horse Regional Trail, Contra Costa Canal Trail and Delta De Anza Trail which, when combined with local bike and pedestrian paths, creates connectivity to the cities along the SR-4 corridor as well as links to Alameda, Solano and San Joaquin Counties. Caltrans policy through Deputy Directive 64 (Complete Streets) is to view all transportation improvements (new and retrofit) as opportunities to improve safety, mobility and access for all travelers, including bicycles and pedestrians. Such projects on SR-4 would be coordinated with community goals, plans and values, and where possible would support or enhance the larger bicycle and pedestrian network in the corridor through improved connectivity.

Bicycle Network

According to the 2008 American Communities Survey (ACS) around 1.7% of residents in cities along the SR-4 CSMP Corridor commute by bicycle. The Contra Costa Countywide Bicycle Pedestrian Plan (CBPP) describes an existing and proposed Countywide Bicycle Network (CBN) consisting of a combination of Class 1 (multI-use bikeway), Class II (designated bike lane), and Class III (bike route) facility types providing access across and along the SR-4 corridor across west, central and east Contra Costa County. On the segments of SR-4 between Hercules and Martinez, and between Concord and Pittsburg, bicycles are allowed on the shoulders of SR-4. Interchanges along the corridor providing bicycle access across SR-4 include San Pablo Avenue, Cummings Skyway, North Concord and Pittsburg/Bay Point BART, Loveridge and Somersville Roads and Hillcrest Avenue. The CBN along SR-4 begins on the shoulders of SR-4 between Hercules (San Pablo Avenue) and the western edge of Martinez (Cummings Skyway) where it moves onto local streets south of SR-4, continues to Concord and then returns to the shoulders of SR-4 between Port Chicago Highway and Willow Pass Road in Pittsburg. Just west of the Pittsburg/Bay Point BART Station (Evona Road) the network returns to a series of local streets and roads passing through the cities of Pittsburg, Antioch and Oakley east of SR-160 (1st Street). Some barriers to improving the CBN along SR-4 include auto-oriented land uses and transportation infrastructure. The CPBB proposes to reduce the barriers and close gaps throughout the CBN with a combination of new off-street and on-street facilities (which would improve local connectivity between communities and close major gaps in the existing CBN such as those segments of the CBN, where cyclists use the shoulders of SR-4) and by constructing the missing segments of the CBN that could improve connectivity to the regional MUT trunk system (Iron Horse Trail and Delta De Anza Trail).

Table 2.7.1. Mode Split for Cities Along the SR-4 Corridor.

City	SOV	HOV	Transit	Walk	Other	Telecommute
Hercules	67.9%	17.1%	11.0%	0.4%	1.4%	2.2%
Martinez	16.5%	9.9%	5.0%	1.0%	1.7%	5.9%
Concord	67.7%	12.6%	10.9%	2.5%	1.8%	4.3%
Pittsburg	66.1%	19.7%	8.1%	1.4%	1.0%	3.7%
Antioch	71.3%	16.8%	6.0%	1.3%	1.7%	3.0%

Source: 2008 American Community Survey

Pedestrian Network

Up to 2.5% percent of residents along the SR-4 CSMP Corridor walk to work according to the 2008 ACS. The Contra Costa Countywide Bicycle and Pedestrian Plan (CBPP) describes an existing and proposed Pedestrian Network (PN) that consists of a combination of small local accessible nodes, short direct access routes and multi use trail (MUT) facilities providing pedestrian access across and along the SR-4 corridor across west, central and east Contra Costa County. Pedestrians are restricted from SR-4. Interchanges along the corridor providing pedestrian access across SR-4 include San Pablo Avenue, Willow Avenue, Alhambra Boulevard, Pine Street, Pacheco Boulevard, North Concord and Pittsburg/Bay Point BART, Loveridge and Somersville Roads and Hillcrest Avenue. Barriers to expanding the pedestrian network include auto-orientated land uses and transportation system infrastructure. Gaps in the PN exist because of a lack of connectivity between the hierarchy of pedestrian facilities (such as MUTs), interregional and local facilities, and the built landscape. The CBPP proposes reducing these barriers and closing gaps in the PN with a combination of Delta De Anza Trail, Iron Horse Trail and Contra Costa Canal Trail improvements, and closing gaps in PN infrastructure between Hercules and Martinez and Concord and Pittsburg and local networks in the PN throughout Contra Costa County.

2.7 CORRIDOR MODE SPLIT

Information on Corridor Mode Split was provided by the 2008 ACS for the San Francisco Bay Area, which compares data from the ACS with data from the 2000 Census, both provided by the U.S. Census Bureau. The ACS is the nine-county San Francisco Bay Area. Data is reported for geographic areas with a population greater than 65,000, including state's census-designated metropolitan areas and places. Table 2.7.1. reflects the modal split for means of transportation to work for cities along the SR-4 corridor, and is taken from the ACS Socio-Economic Characteristics by Bay Area Public Use Microdata Area (PUMA) of Residence summary.

2.8 LAND USE/MAJOR TRAFFIC GENERATORS

Overview of Land Use

From west to east, major land uses along SR-4 include agricultural, open space, single and multi-family residential, industrial and commercial. These land uses are briefly described in Table 2.8.1.

Major Traffic Generators

The SR-4 CSMP Corridor is primarily suburban in nature. Along the corridor there are various educational facilities including Hanna Ranch Elementary in Hercules, John Muir Middle School in Martinez, Deer Valley High School in Antioch and Los Medanos Community College in Brentwood.

Local and regional retail centers along the SR-4 CSMP Corridor include North Park Plaza Sun Valley Mall, and Somerville Plaza-Auto Mall. Emergency medical facilities along the SR-4 CSMP corridor include John Muir Medical Center in Martinez and Sutter Delta Medical Center in Antioch.

Many local-, county- and state-operated parks and cultural-historical centers exist along the length of the SR-4 CSMP Corridor. These include Refugio Valley Park in Hercules, the John Muir Historical Landmark in Martinez, Mount Diablo State Park and Black Diamond Mines Regional Park in Antioch.

Table 2.8.1. SR-4 CSMP Corridor Land Uses.

Segment Information	Land Use
Segment A CC 0.00-3.60	Multi-Family Residential, Open Space, Public and Agricultural–north side. Single-Multi-Family Residential & commercial–south side.
Segment B CC 3.60-4.89	Single-Family Residential, Agriculture, Commercial & Industrial–north side. Recreation, Agriculture and Open Space–south side.
Segment C CC 4.89-8.50	Open Space, Agricultural, Recreation and Public–north and south sides.
Segment D CC 8.50-12.66	Single and Multi-Family Residential, Commercial and Open Space–north side. Single and Multi-Family Residential, Commercial and Open Space–south side.
Segment E CC 12.66-14.36	Light-Heavy Industrial, Single-Family Residential, Open Space, Public–north side. Single and Multi-Family Residential, Public (Buchanan Field) Commercial–south side.
Segment F CC 14.36-18.75	Light Industrial, Recreational, Public, and Agricultural–north side. Single-Family Residential, and Agricultural–south side.
Segment G CC 18.75-20.1	Multi-Family Residential, Light-Heavy Industrial, Commercial–north side. Single and Multi-Family Residential, Commercial, Mixed Use (BART)–south side.
Segment H CC 20.1-23.06	Single and Multi-Family Residential, Recreational–north side. Single and Multi-Family Residential, Landfill, Recreational, Open Space–south side.
Segment I CC 23.06-27.79	Single-Family Residential, Light-Heavy Industrial, Business Park-Commercial, Public–north side. Single and Multi-Family Residential, Commercial, Open Space, Recreational–south side.
Segment J CC 27.79-31.13	Single and Multi-Family Residential, Business-Commercial, Heavy Industrial, Open Space, Recreational–north side. Single-Multi-Family Residential, Open Space, Recreational–south side.

Priority Development Areas

The Focus Our Vision (FOCUS) program was developed by ABAG and seeks to work with local governments and others in the Bay Area to collaboratively address issues such as high housing costs, traffic congestion, and protection of natural resources. As the Regional Blueprint Planning Program for the Bay Area, the primary goal of FOCUS is to encourage future growth near transit and in the existing communities that surround the San Francisco Bay. The goal is to enhance existing neighborhoods and provide housing and transportation choices for all residents.

In the summer of 2007, local governments in the Bay Area were invited to apply for regional designation of an area within their community as a Priority Development Area (PDA). PDAs are infill development opportunities within existing communities. These communities welcome more residents; they are committed to creating more housing choices in locations easily accessible to transit, jobs, shopping and services. In order to become a planned PDA, an area needs to be within an existing community, near existing or planned fixed transit or served by comparable bus service, and planned for more housing. A potential PDA area may be envisioned as a potential planning area that is not currently identified in a plan or may be part of an existing plan that requires changes. Table 2.8.2. lists the potential and planned PDAs along the SR-4 CSMP Corridor.

Table 2.8.2. SR-4 CSMP Corridor PDAs, 2009

PDA	Designation
City of Hercules: *Central Hercules and Waterfront District*	Planned
City of Martinez: *Downtown Martinez Intermodal Station Area*	Planned
City of Pittsburg: *Downtown*	Planned
Contra Costa County: *Pittsburg/Bay Point BART Station Area*	Planned
City of Concord: *Community Reuse Area*	Potential
City of Pittsburg: *Railroad Avenue eBART Station Area*	Potential
City of Antioch: *Hillcrest eBART Station Area and Rivertown Waterfront*	Potential
City of Oakley: *Downtown and Employment Focus Area–Potential Planning Area*	Potential

2.9 ENVIRONMENTAL CHARACTERISTICS/ CONSTRAINTS

Environmental Setting

It is important to note that the CSMP is general in concept. Potential environmental issues affecting soil and air characteristics, storm water drainages, sensitive habitats (such as designated creeks, wetlands, coastal and delta areas, as well as cultural resources) would need more detailed scoping and coordination when project development activities occur. Studies would have to be initiated to see if any potential resources would be disturbed or affected. To ensure compliance with environmental regulations, project developers should also seek consultation for any potential impact to endangered species, especially since mitigation costs for impacts to these species' habitats are high and the limited availability of mitigation sites may impose additional constraints to any corridor-specific improvements. Consultation with regulatory and permitting agencies, when required, can affect project scheduling. These agencies can include, but are not limited to, the US Army Corps of Engineers, US Fish and Wildlife Service, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, California Department of Fish and Game, Bay Conservation and Development Commission (BCDC) and the California Coastal Commission.

Community impact, including environmental justice and relocations, growth-inducing/indirect effects, cumulative impacts, Caltrans' emphasis on Context Sensitive Solutions and farmland conversion impacts must be considered. Caltrans and partner agencies will need to consider evolving state policy on assumed sea level rise as an impact of global climate change. The Caltrans Office of Planning and Research, Technical Advisory dated June 19, 2008 provides guidance to California Environmental Quality Act (CEQA) lead agencies by suggesting they identify potential greenhouse gas (GHG) emissions, assess any potential impacts, identify appropriate and feasible alternatives and recommend mitigation where appropriate.

Historic properties could be in the general area (within one-half mile) of the SR-4 CSMP Corridor, and possible impacts to other historic architectural resources, that are more distant to the Corridor, may also need to be evaluated. Every attempt is made to identify culturally significant resources during project planning stages. Native American monitors observe archaeological excavations or construction activity in areas that have been mutually agreed upon to be sensitive. Transportation project field elements such as poles, sign structures, etc. within the freeway right of way, could represent a visual intrusion within a scenic corridor. These elements may have little overall visual impact in the urbanized setting, but the need for visual impact assessment would be determined if and when such elements were specifically proposed.

Environmental Factors

The natural environment surrounding the SR-4 CSMP Corridor is highly diversified in terms of its resources and related sensitivities. Since portions of SR-4 are in a 100-year floodplain, measures will be taken in compliance with Executive Order 11988 (Floodplain Management). This order directs all federal agencies to refrain from conducting, supporting or allowing actions in floodplains unless it is the only practicable alternative. Over its 31.13-mile course the SR-4 CSMP Corridor traverses many resource-rich areas. Nine historic bridges are identified along the corridor with a majority of them existing in the older eastern segments of the corridor. Hazardous sites (underground tanks) are also identified along the corridor with the majority of them being clustered around the refinery complexes found near the center and eastern segments of the corridor. Numerous habitats supporting threatened or endangered species are present throughout the corridor with the largest concentrations found near the eastern segments of the corridor nearest the Delta. The Carquinez Strait Regional Shoreline Park and the Black Diamond Mines Regional Preserve are adjacent to the central and eastern segments of the corridor and are considered protected open space. Figure 2.9.1 and Table 2.9.1. list and illustrate these environmental factors by segment.

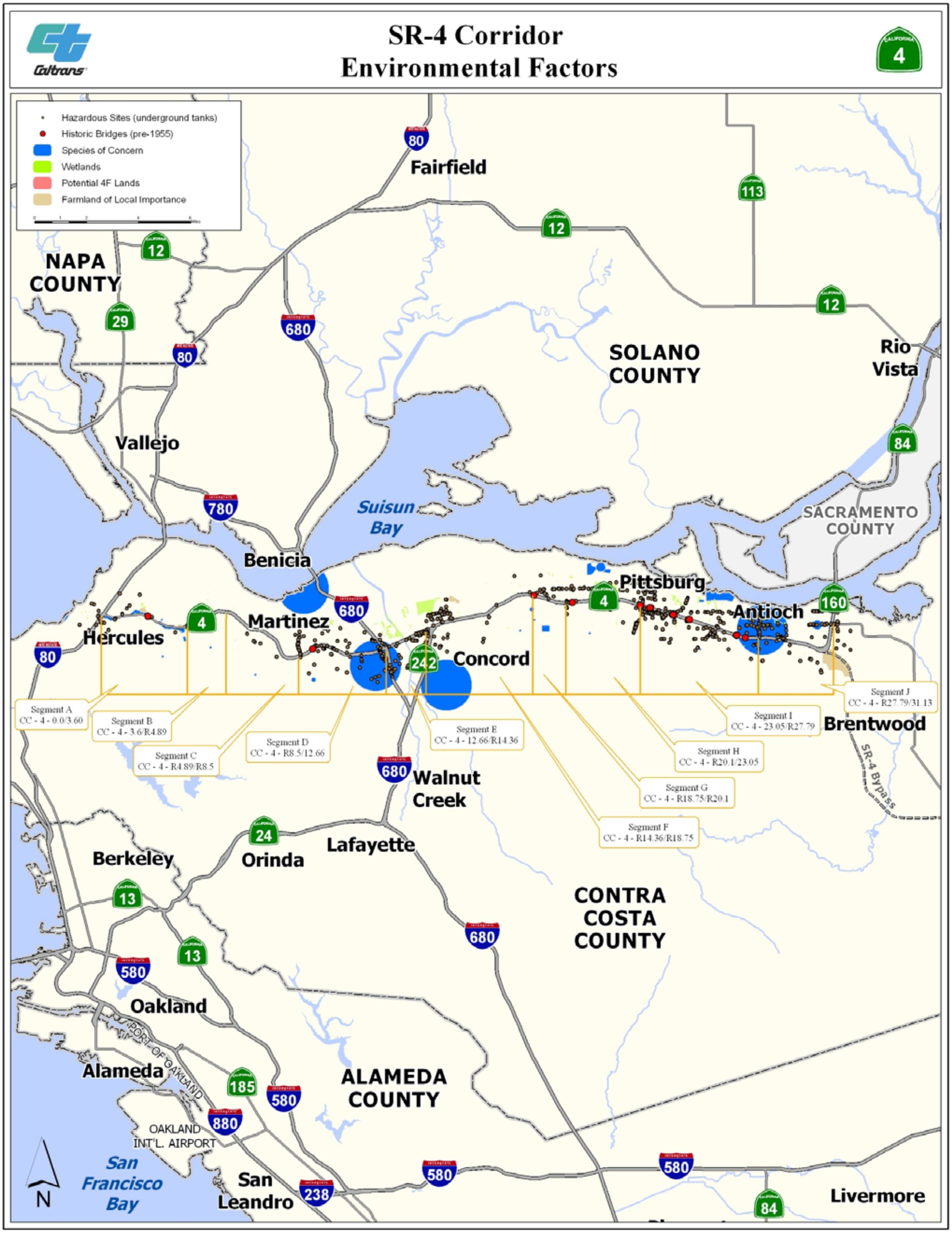


Figure 2.9.1. Environmental Factors within the SR-4 CSMP Corridor.

Table 2.9.1. Summary of Environmental Factors within the SR-4 CSMP Corridor.

SR-4 CSMP Segment	Historic Bridges	Wetlands	Species of Concern	Protected Open Space
Segment A – CC PM 0.00 – 3.60	X	X	X	
Segment B – CC PM 3.60 – 4.89				
Segment C – CC PM 4.89 – R8.5			X	X
Segment D – CC PM R8.5 – 12.66	X		X	
Segment E – CC PM 12.66 – R14.36		X	X	
Segment F – CC PM R14.36 –R18.75			X	
Segment G – CC R18.75 – R20.1	X		X	
Segment H – CC R20.1 – 23.05	X		X	X
Segment I – CC R 23.05 – R27.79	X	X	X	X
Segment J – CC R27.79 – R31.13		X	X	

Sources: National Register of Historic Places (NRHP), National Wetlands Inventory, CA Natural Diversity Database (CNDDB)

Federal and State Regulations

Table 2.9.2. references federal and state regulations related to environmental factors and potential environmental issues along the SR-4 CSMP Corridor.

Table 2.9.2. Federal and State Environmental Regulations.

Federal/State Regulation	Description/Purpose
Clean Air Act (latest amendment 2004) *(federal)*	Reduction of smog and air pollution; enforces clean air standards. Defines Environmental Protection Agency (EPA) responsibilities for protecting and improving the nation's air quality and the stratospheric ozone layer.
(Specific to Permits) Clean Water Act of 1977 and 1987–Section 401, 402, 404 *(federal)*	401: Permit required for discharge of pollutants into waters of the U.S. and is issued by the Regional Water Quality Control Board. 402: Restore and maintain the chemical, physical, biological integrity of the nation's waters through prevention and elimination of pollution. Oversees National Pollutant Discharge Elimination System (NPDES) permit program; regulates storm water; 404: Permits required for dredging or fill into water of the U.S. including wetland issued by US Army Corps of Engineers.
Bay Conservation and Development Commission (BCDC) and California Coastal Commission	California's two designated coastal management agencies that administer the federal Coastal Zone Management Act (CZMA) in California. Involves federal activities and federally licensed, permitted or assisted activities, wherever they may occur (i.e., landward or seaward of the respective coastal zone boundaries fixed under state law) if the activity affects coastal resources.
Department of Transportation Act of 1966, Section 4(f) of USC 49 Section 303 *(federal)*	Preserve publicly owned public parklands, recreation areas, waterfowl and wildlife refuges, and significant historic sites.
Endangered Species Act of 1973 *(federal)*	Protect critically imperiled species from extinction as a "consequence of economic growth and development untempered by adequate concern and conservation."
Executive Order 11988, Floodplain Management (1977) (*federal*)	Refrain from conducting, supporting or allowing actions in floodplains unless it is the only practicable alternative.
Executive Order 11990, Protection of Wetlands (1977) *(federal)*	Avoid adverse impacts on wetlands wherever there is a practicable alternative.
Executive Order 13112, Invasive Species (1999) *(federal)*	Prevent the introduction of invasive species; and provide for their control; and to minimize the economic, ecological, and human health impacts that invasive species cause (plant species).
Executive Order 12898 (1994): Environmental Justice *(federal)*	Avoid disproportionately high and adverse impacts on minority and low-income populations with respect to human health and environment.

Eastbound SR-4 at Sycamore Avenue overcrossing.

Table 2.9.2. Federal and State Environmental Regulations. (continued)

Federal/State Regulation	Description/Purpose
Farmland Protection Policy Act of 1981 *(federal)*	Minimize impacts on farmland and maximize compatibility with state and local farmland programs and policy.
National Environmental Policy Act (NEPA) *(federal)*	Established a U.S. national policy promoting the enhancement of the environment; procedural requirements for Environmental Assessments (EAs) and Environmental Impact Statements (EISs) that contain statements of the environmental effects of proposed actions. Law applies to any project, federal, state or local, that involves federal funding or work performed by the federal government.
National Historic Preservation Act of 1966, as amended – Section 106 (*federal*)	Declares national policy and procedures regarding historic properties, defined as districts, sites, buildings, structures, and objects included in or eligible for the National Register of Historic Places.
Resource Conservation and Recovery Act of 1976 *(federal)*; CA Health and Safety Code Hazardous Waste	Regulates the handling of hazardous waste sites for protection of human health and the environment.
Title VI of the Civil Rights Act of 1964, as amended *(federal)*	Prohibits discrimination, on grounds of race, color, national origin, age, sex, or disability, under any program or activity receiving federal funds.
The California Environmental Quality Act (CEQA) *Guidelines* 15355, 40 CFR 1508.7, 15358(a)(2)	Requires cumulative impacts be mitigated where identified and requires mitigation for reasonably foreseeable indirect or secondary effects related to changes in the pattern of land use, population density or growth rate and effects on air, water and other natural systems.
California Department of Conservation, Natural Resource Conservation Service (NRCS)	Regulates farmlands or Farmlands of Local Importance in California.
California Fish and Game Code, Section 1602	Any action from a public project that substantially diverts stream, or lake or uses material from a streambed must be previously authorized by the Department of Fish and Game (DFG).
Global Warming Solutions Act of 2006 (AB 32) *(California)*	Reduce California's greenhouse gas emissions to 1990 levels by 2020, and emissions to 80 percent below 1990 emission levels by 2050.
Senate Bill 375 *(California)*	Requires greenhouse gas emission targets for automobiles and light trucks for 2020 and 2035. Must accurately account for the environmental benefits of more compact development and reduced vehicle miles traveled.

Air Quality

The San Francisco Bay Area Air Basin covers California's second largest metropolitan area. The counties in the air basin include: Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara, the southern half of Sonoma County and the southwestern portion of Solano County. The unifying feature of the Basin is the San Francisco Bay which is oriented north-south and covers about 400 square miles of the Basin's total 5,545 square miles. Approximately 20 percent of California's population resides in this air basin.

- Carbon Monoxide (CO) emissions have been declining in the basin over the last 25 years, and this trend is expected to continue. Motor vehicles and other mobile sources are the largest sources of CO emissions in the air basin. Due to stringent control measures, CO emissions from motor vehicles have been declining.
- Particulate Matter (PM 2.5) consists of very small liquid and solid particles suspended in the air, and includes fine particles smaller than 2.5 microns in diameter (PM 2.5). U.S. Environmental Protection Agency (EPA) lowered the federal 24-hour PM 2.5 standard from 65 µg/m 3 to 35 µg/m 3 in 2006 and subsequently designated the Bay Area as non-attainment for the 35 µg/m 3 PM 2.5 standard in 2008.
- Emissions of Ozone (O3) precursors of (Nitrogen Oxides (NOx) and Total Organic Gasses (TOG), have decreased over the years and are projected to continue declining. This is primarily the result of strict motor vehicle controls.

The San Francisco Bay Area air quality attainment status based on state and federal standards for CO, PM2.5, and O3 are listed below. These are three criteria pollutants for which the region is designated Nonattainment or Maintenance status based on state or federal air quality standards.* Table 2.9.3 lists the Bay Area's Air Quality Attainment Status.

Table 2.9.3. San Francisco Bay Area Air Quality Attainment Status

	National Standard	State Standard
CO	Maintenance	Attainment
PM 2.5	Nonattainment	Nonattainment
O_3	Marginal nonattainment	Nonattainment 1 hour

Plan and Program (regional) and project-level air quality conformity is demonstrated through interagency consultation. Regional conformity analysis is conducted by MTC during the RTP process. Project-level conformity is usually demonstrated by showing that a project comes from a conforming Plan and Program (the regional conformity analysis) with substantially the same "design concept and scope." The project must show it will not cause localized exceedances of CO, PM2.5 and/or PM10 standards.

Greenhouse Gas Emission Measures

California passed the Global Warming Solutions Act of 2006 (AB 32) which seeks to reduce California's GHG emissions to 1990 levels by 2020, and emissions to 80 percent below 1990 emission level by 2050. SB 375 builds on AB 32 by requiring GHG emissions targets for California's automobiles and light trucks for 2020 and 2035.

A California Climate Action Team was established with representatives from key state agencies responsible for implementing reduction strategies. AB 32 will establish a program of regulatory and market mechanisms to achieve quantifiable reductions of GHG and dictates that the California Air Resources Board (CARB) be responsible for monitoring and planning for GHG reductions. The California Environmental Protection Agency (CalEPA) is required to prepare a greenhouse gas emission reduction report card describing state agency actions to reduce GHG.

The transportation sector, at 38 percent, is the largest contributor of California's gross GHG emissions.** The state's strategy to lower emissions from transportation will likely focus on working with Congress to allow California to set higher vehicle efficiency and mileage standards, lower the levels of carbon in transportation fuels

*Sources: California Air Resources Board: http://www.arb.ca.gov/adam/cgi-bin/db2www/adamtop4b.d2w/start , Air Quality Status Summary: http://pd.dot.ca.gov/env/air/html/areadesig/SummAQStatMPORTA.htm, Bay Area 2005 Ozone Strategy (01/06)

**Climate Change Scoping Plan: A Framework for Change. California Air Resources Board. December 2008.

and transition the state to cleaner-burning alternative and renewable fuels. Other strategies could include a multi-state cap-and-trade program, or regional initiatives to focus development in transit-rich corridors (i.e. priority development areas).

On June 30, 2009, the EPA granted a waiver that enables California authority to adopt and implement greenhouse gas emissions standards for new motor vehicles, overturning the previous administration's ruling prohibiting such actions. ARB has subsequently approved a regulation that will implement a Low Carbon Fuel Standard calling for the reduction of greenhouse gas emissions from California's transportation fuels by 10 percent by 2020.*

The next update of the Regional Transportation Plan in 2013 will include a Sustainable Community Strategy (SCS), as required by SB 375. The SCS will lay out how GHG emissions reduction targets will be met for cars and light trucks.

Sea Level Rise

Sea level rise and storm surge, along with frequency and severity of heat waves, and multiple changes concerning precipitation, are among the three anticipated climate changes of particular significance to the transportation system. Caltrans emphasizes a dual approach to managing climate risks, with measures to reduce GHG emissions from transportation and to minimize the impacts on the essential transportation infrastructure through adaptation strategies.**

Adaptation strategies related to corridor planning include:

- Prioritize long-term improvements needed to reduce vulnerability.
- Identify at-risk facilities on particular route segments.
- Evaluate climate impact on travel, modes, and emergency response.
- Integrate information on climatic events into transportation operational systems.

According to Caltrans' Vulnerability of Transportation Systems to Sea Level Rise Preliminary Assessment (February 2009), portions of SR-4 would be at risk given a 55-inch sea level rise. Caltrans will need to factor and consider the effects of global climate change when planning for future SR-4 development.

*Source: California Air Resources Board - http://www.arb.ca.gov/fuels/lcfs/lcfs.htm.
**California's Changing Climate Assessing Potential Risks and Adaptation Strategies for the State Transportation Infrastructure Preliminary Report, Final Draft. California Department of Transportation. February 2009.

Habitat and Biological Resource Issues

The 31 miles of the SR-4 CSMP Corridor houses several different species listed on federal and state lists as threatened and endangered species. Corridor limits are within areas of urban development and adjacent to heavily trafficked roads. At some locations, landscaped portions may house sensitive biotic species.

Table 2.9.4. Threatened or Endangered Fauna and Flora in the SR-4 CSMP Corridor.

	Common Name	Scientific Name
Fauna	Alameda whipsnake	*Masticophis lateralis euryxanthus*
	Burrowing owl	*Athene cunicularia*
	California red-legged frog	*Rana draytonii*
	California tiger salamander	*Ambystoma californiense*
	Cooper's hawk	*Accipiter cooperii*
	Hurd's metapogon robberfly	*Metapogon hurdi*
	Suisun song sparrow	*Melospiza melodia maxillaris*
	Vernal pool fairy shrimp	*Branchinecta lynchi*
	Western pond turtle	*Actinemys marmorata*
	Western red bat	*Lasiurus blossevillii*
	White-tailed kite	*Elanus leucurus*
Flora	Antioch Dunes evening-primrose	*Oenothera deltoides ssp. howellii*
	Big tarplant	*Blepharizonia plumosa*
	Brewer's western flax	*Hesperolinon breweri*
	Bridges' coast range shoulderband	*Helminthoglypta nickliniana bridgesi*
	California linderiella	*Linderiella occidentalis*
	Congdon's tarplant	*Centromadia parryi ssp. congdonii*
	Contra Costa goldfields	*Lasthenia conjugens*
	Diablo helianthella	*Helianthella castanea*
	Diamond-petaled California poppy	*Eschscholzia rhombipetala*
	Hoover's cryptantha	*Cryptantha hooveri*
	Mt. Diablo buckwheat	*Eriogonum truncatum*
	Mt. Diablo manzanita	*Arctostaphylos auriculata*
	Round-leaved filaree	*California macrophylla*
	Showy madia	*Madia radiata*

Table 2.9.4 lists the threatened and endangered Fauna and Flora species on Federal and/or California lists from a general query of the California Natural Diversity Database (CNDDB), (those quadrants within the corridor segments). In addition, the California Department of Fish and Game considers all bat species as species of special concern.

Historic and Cultural Resources

There are properties listed on the National Register of Historic Places (NRHP) located within and around the SR-4 corridor. Native American archaeological sites are likely to be buried beneath the ground surface. Archaeological sites dating to the historic period within the SR-4 corridor are typical of those found in rural settings where homesteads, ranches, or farms were once present. Architectural properties located within the corridor will most likely be associated with the agricultural history of the area. There are nine historic bridges (pre-1955) that cross the SR-4 corridor. There is also the possibility of state or locally listed historic properties being located in the general vicinity of the SR-4 corridor. Studies would have to be initiated to see if any potential resources would be disturbed or affected. Historic properties could be in the general area (within 1/2 mile) of the SR-4 corridor. Possible impacts to other historic architectural resources that are more distant from the SR-4 corridor may also need to be evaluated. Sensitive archeological sites are also known to exist along the length of the SR-4 corridor. Waterway routes in the SR-4 corridor are of particular interest and need to be respected.

Table 2.9.5. Park/Open Space in the SR-4 Corridor.

Regional and Local Parks and Preserves	
East Bay Regional Park District	***City of Concord***
Crockett Hills Carquinez Strait Shoreline Regional Park Martinez Shoreline Regional Park Briones Regional Park Black Diamond Mines Regional Park Contra Loma Regional Park	Sun Terrace Park Bayview Circle Park Hillcrest Park ***City of Pittsburg*** Ambrose Park ***City of Antioch***
City of Hercules	Contra Loma Park
Foxboro Liverpool Park	***Preserves***
City of Martinez John Muir Park	Franklin Hills Open Space Martinez Open Space

Based on preliminary review, protected open space located along the SR-4 corridor is listed in Table 2.9.5.

Visual/Aesthetics

The SR-4 CSMP corridor is not eligible nor designated as State Scenic Highway. Field elements of transportation projects typically include built elements such as poles, sign structures, electrical equipment, etc. within the freeway right-of-way. Within the context of this urbanized setting, these elements could represent a visual intrusion within a scenic corridor; however in this setting, these elements may have little overall visual impact. The need for a Visual Impact Assessment (VIA) would be determined on a project-specific basis to evaluate and assess potential adverse effects of the project. The required level of documentation required for a VIA would be determined by the scope and complexity of the project.

2.10 MAINTENANCE

Pavement and roadside maintenance are critical components of protecting and preserving the investment in the State Highway System.

Pavement Maintenance

The maintenance of pavement at Caltrans is accomplished using a variety of resources and projects which include state and federally programmed maintenance projects that are in the Pavement Maintenance Five-Year Plan. Rehabilitation projects are suggested where pavement condition has deteriorated beyond desired levels. Rehabilitation and Capital Preventive Maintenance (CAPM) projects are included within the SHOPP (State Highway Operation and Protection Plan) Ten-Year Plan. Pavement maintenance activities include: routine maintenance by state forces (day-to-day maintenance of roadway) and major maintenance (planned work which is generally done by contract). Major maintenance projects can be of preventive maintenance nature pavement preservation, meaning that treatments are applied when the pavement distress is minimal to extend the service life or corrective maintenance (where the pavement has deteriorated beyond preventive, but is not considered rehabilitation). Maintenance activities keep the facility safe and serviceable until rehabilitation is needed. Pavement rehabilitation improves the facility, brings it up to current design standards and is designed to provide 20 to 40 years of service.

Existing Pavement Conditions

Several tools have been developed to monitor the condition of existing pavement:

- State of the Pavement Report
- PCR-Pavement Condition Report
- GIS-Based Mapping

The State of the Pavement Report is updated every two years and describes pavement condition by district. More detailed data is contained in the PCR including pavement condition by post mile segment in specific corridors.

GIS-based mapping depicts corridor pavement status throughout the state and is based on the PCR. Figure 2.10.1 depicts current SR-4 CSMP Corridor pavement condition by Damage Priority Group (DPG). The DPG legend for those shown on the map is:

RED: Major Damage—Rehab is scheduled.

GREEN: Minor Damage—Rehab is needed, not yet scheduled.

BLUE: Bad Ride Only—Surface is rough, but repair not required.

Pavement Management Plans

District 4 has developed detailed 10-year pavement management plans for all the principal routes in the district. Currently programmed pavement improvement projects along the SR-4 CSMP Corridor are listed in Table 2.10.1. The 10-Year Pavement Management Plan for SR-4 is located in Appendix A6.

Table 2.10.1. Currently Programmed Pavement Improvement Projects in the SR-4 CSMP Corridor.

Year	Location	Project Description
2009	Antioch PM 16.8-17.5	Minor A – EA 268701
2009	Antioch PM R28.4-R28.9	Add Aux lane and widen EB off-ramp - STIP
2009	Antioch PM 31.1-32.4	Widen Highway - STIP
2010	Antioch PM 26.0-29.6	Widen to 8 lanes - STIP
2013	Pacheco PM R10.5-R15.1	I-680 IC Improvement - STIP

Source: 10-Year Pavement Management Plan, Caltrans District 4 Maintenance, 2008.

Other Maintenance Tasks

In addition to pavement management, District 4 Division of Maintenance performs other important functions in the SR-4 CSMP Corridor. Major activities in the corridor include:

- **Vegetation control**—A significant portion of the roadside management and maintenance effort is devoted to activities associated with vegetation control. The need for vegetation control is driven primarily by safety issues such as minimizing fire concerns, promoting visibility of traffic and promoting good drainage.
- **Landscaping upkeep**—The maintenance of landscape vegetation includes irrigation, planting, plant removal and replacement. A fully landscaped planted area provides traffic screening and improves both aesthetic value and the stability of roadside slopes.
- **Litter control**—Maintenance workers remove litter, debris, and sediment to maintain traffic safety (for both motorized and non-motorized travelers), protect water quality, ensure drainage, and provide an attractive facility for travelers and local communities. Graffiti is also removed from signs and other structures "as soon as reasonably possible." (Streets and Highways Code Section 96).
- **Drainage control**—Maintenance includes the repair, replacement and cleaning of drainage features.
- **Bridges**—Bridge maintenance includes work such as repairing damage or deterioration in various bridge components. Although there are no moveable span bridges in the SR-4 corridor, maintenance of electrical and mechanical equipment on moveable span bridges, and operation of this type of bridge, are parts of maintenance duties.
- **Safety devices**—Safety devices are provided and maintained for the protection and guidance of the traveling public. These devices include Roadside Delineator Posts, Guardrail, Median Barriers and Vehicle Energy attenuators (energy dissipaters).

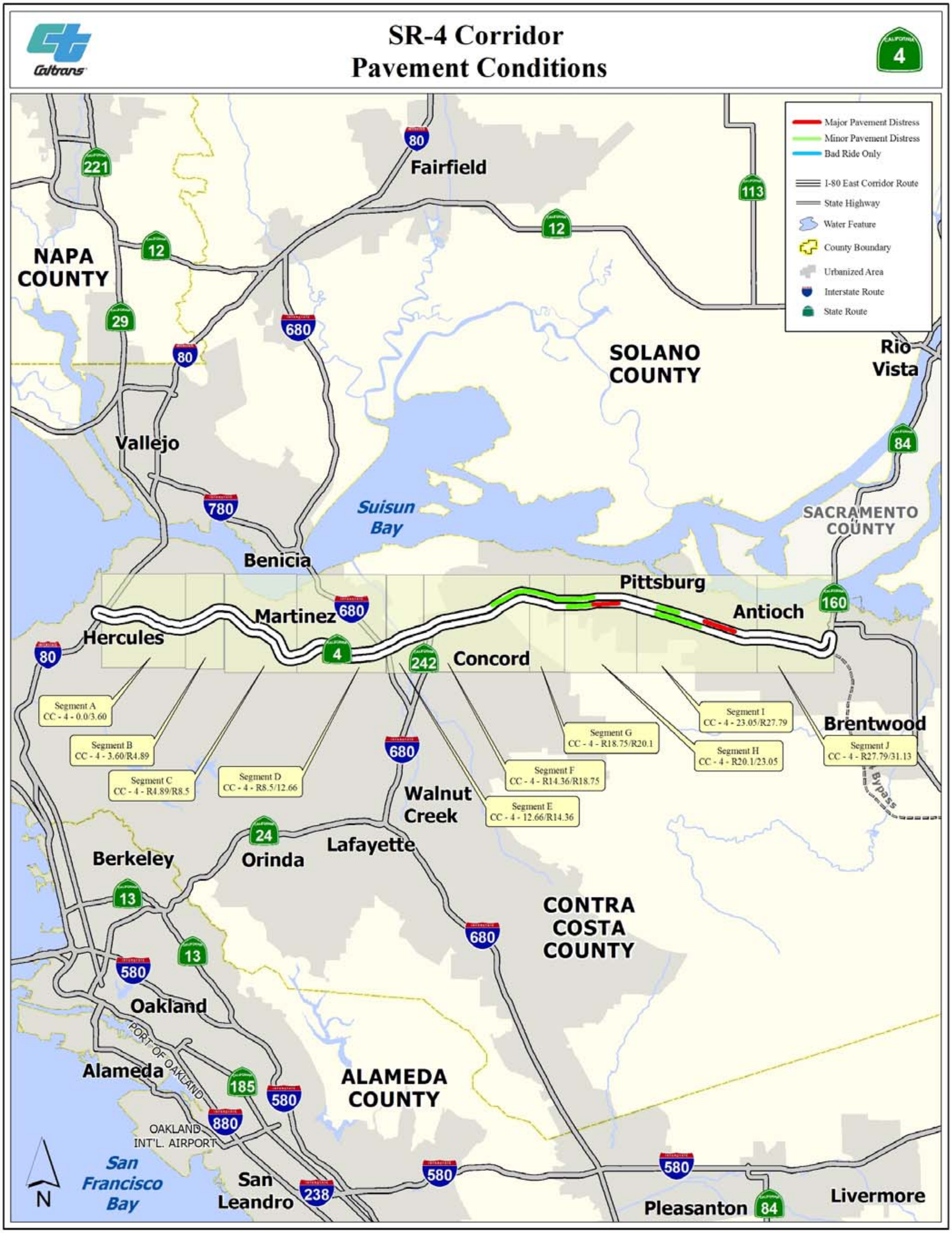
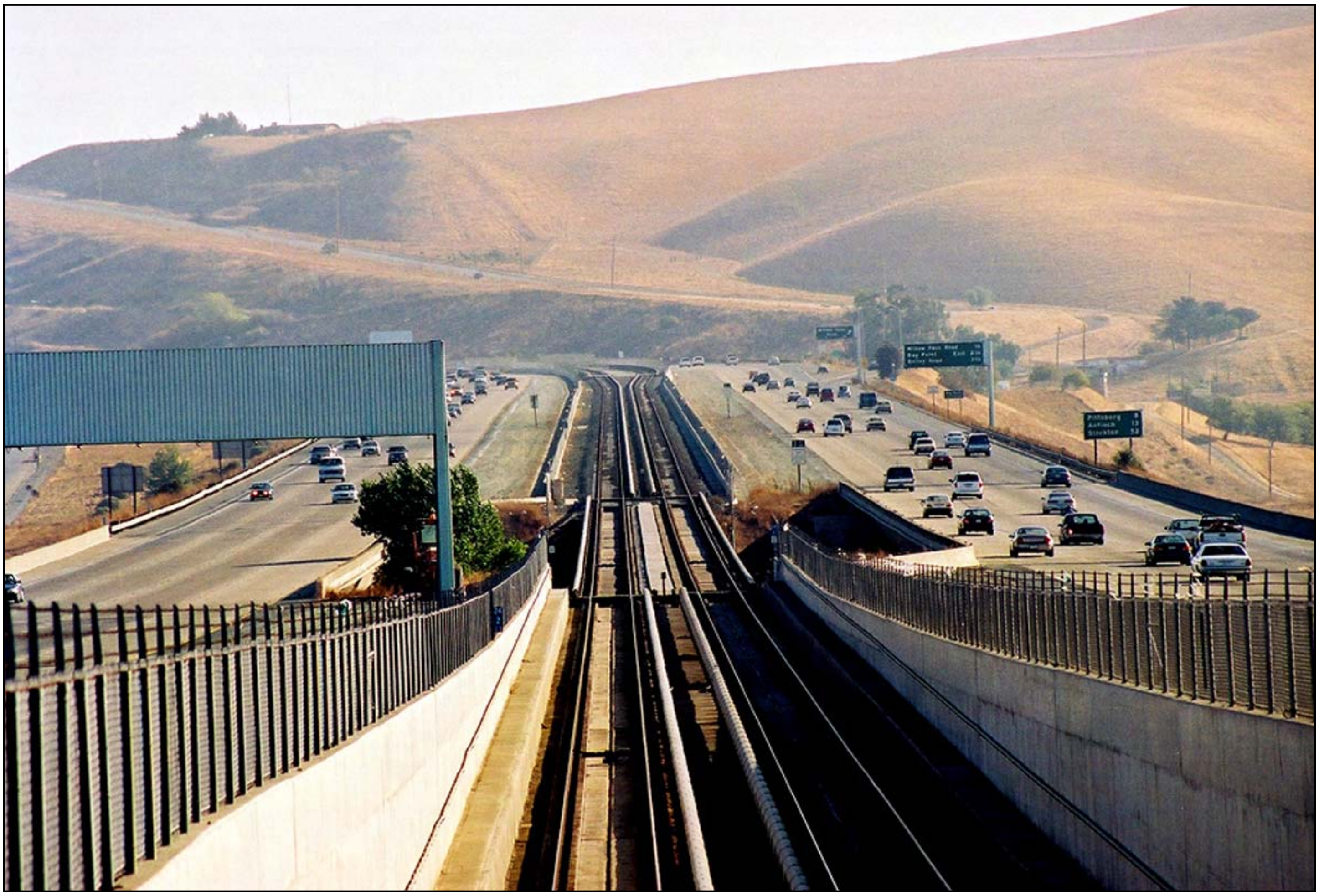


Figure 2.10.1. SR-4 CSMP Corridor Pavement Conditions.



SR-4 west of Bailey Road looking west.

- **Lighting**—Highway lighting and sign illumination is provided to improve visibility and to promote safe and efficient use of special roadway facilities. Maintenance of highway lighting and sign illumination includes all work performed on highway electrical facilities used for control of traffic with traffic signal systems, highway and sign lighting systems, Traffic Management System (TMS) Field Elements, Intelligent Transportation Systems (ITS), count stations, and other related systems.
- **Signs**—The maintenance of signs typically includes work such as the placement of signs, identification of damaged or inadequate signs, cleaning of dirty signs and general inspection duties.

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Section 3: Performance Assessment

The following technical memorandum presents a summary of the existing conditions analysis prepared for the State Route 4 (SR-4) corridor in Contra Costa County from the I-80 Interchange to the SR-160 Interchange. The primary objectives of the existing conditions analysis are 1) to present a clear and concise description of the SR-4 Corridor's existing conditions and 2) to identify specific locations and causes of congestion along the corridor.

Attached Document

- **SR-4 Corridor in Contra Costa County**
  Existing Conditions Technical Memorandum (ECT)
  Final - February 17, 2009
  Prepared by PBS&J under FPI contract with Metropolitan Transportation Commission

Metropolitan Transportation Commission

SR 4 Corridor in Contra Costa County

Existing Conditions Technical Memorandum (ECT)

Prepared by: PBS&J
For: Metropolitan Transportation Commission
Final
February 17, 2009

Table of Contents

Metropolitan Transportation Commission

SR 4 Corridor in Contra Costa County

Existing Conditions Technical Memorandum (ECT)

Prepared by: PBS&J
For: Metropolitan Transportation Commission
Final
February 17, 2009

Introduction

The following technical memorandum presents a summary of the existing conditions analysis prepared for the State Route 4 (SR 4) corridor in Contra Costa County from the I-80 Interchange to the SR 160 Interchange. The methods and performance measures used in this analysis are based on those set forth in the *Freeway Performance Initiative (FPI)/Corridor System Management Plan (CSMP) Contra Costa SR 4 Corridor and Alameda/Contra Costa SR 24 Draft Workplan, Schedule and Budget (September 2008)* and the *Freeway Performance Initiative Traffic Analysis: Performance and Analysis Framework* (April 2007). Consistent with the guidance provided by these documents, the primary objectives of the existing conditions analysis are 1) to present a clear and concise description of the SR 4 Corridor's existing transportation conditions and 2) to identify specific locations and causes of congestion along the corridor. The existing conditions technical memorandum is presented in three sections:

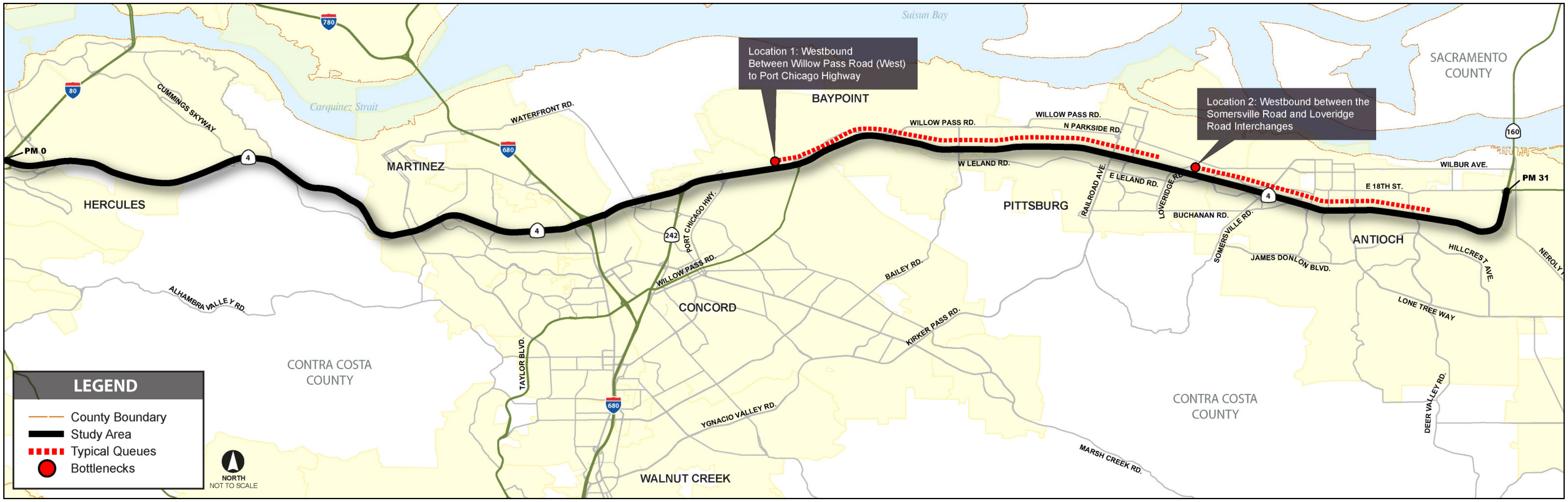
- **Section 1: Description of the SR 4 Corridor:** A summary of the basic features of the corridor including information on travel markets served, alternative modes of travel, parallel routes and intelligent transportation systems (ITS).
- **Section 2: Traffic Characteristics of the SR 4 Corridor:** An evaluation of existing traffic data along the corridor with respect to seasonal and weekly variation. This evaluation establishes key analysis periods for the corridor and presents information on truck and heavy vehicle traffic use in the corridor.
- **Section 3: Performance Evaluation of the SR 4 Corridor:** An evaluation of corridor performance based on vehicle delay and congestion. This section describes the methodology and measures used to identify existing congested areas and bottlenecks; provides an evaluation of performance measures; provides the analysis of travel time reliability; and provides an assessment of accidents and incidents for the corridor.

Key Findings

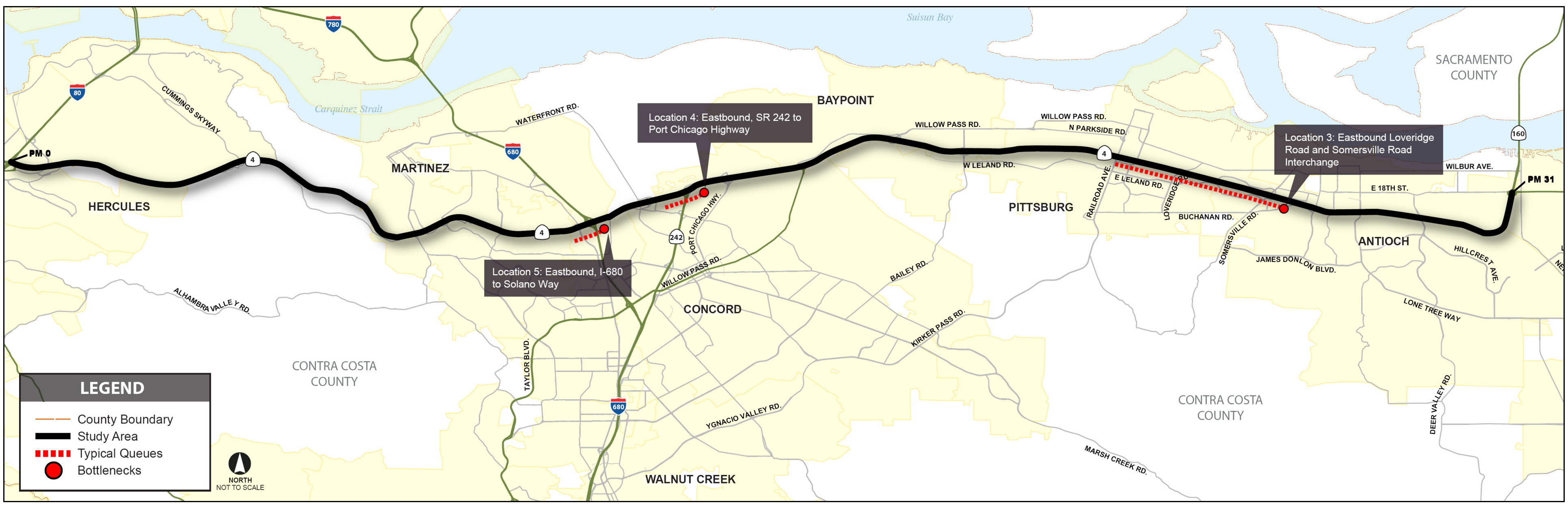
The existing conditions technical memorandum characterizes existing travel conditions, assesses freeway performance and identifies locations and causes of congestion in the SR 4 Corridor in Contra Costa County. For the purposes of this analysis, traffic congestion is defined as vehicle operating speeds of 35 mph or less over a period of 15 minutes or more. The term "bottleneck" refers to the location that is the cause of congestion. Based on this analysis, the bottleneck locations identified in the SR 4 Corridor are shown in the following figures and described below:

- **Location 1 – <u>Willow Pass Road (West) to Port Chicago Highway (Westbound AM):</u>** The controlling bottleneck at this location is the 4-lane section (3 mixed-flow lanes plus 1 HOV lane) between these interchanges where the existing traffic demand exceeds the capacity of the cross section. Field observations also indicate that HOV-lane users crossing two to three mixed- flow traffic lanes along this segment to exit at SR 242 or enter at Willow Pass Road contribute to the congested conditions. The speed data and field observations indicate that this bottleneck and the congestion approaching it extends over a 2.5-hour period that begins just after 6:00 AM and results in a queue that extends approximately 6 miles to the segment of SR 4 between Loveridge Road and Railroad Avenue in Pittsburg. The morning peak period delay associated with this bottleneck is 1,566 vehicle hours.

Map of Recurrent Congestion Locations – AM Peak Hour



Map of Recurrent Congestion Locations – PM Peak Hour



- **Location 2 – <u>Somersville Road Westbound to Loveridge Road (Westbound AM):</u>** The controlling bottleneck at this location on SR 4 is due the high westbound traffic demand that exceeds the capacity of this 2 lane mixed-flow section. In addition, the data shows evidence of upstream embedded bottlenecks west of the A Street, G Street and L Street on-ramps. The duration of the congestion approaching these bottlenecks is about 5 hours beginning before 5:00 AM and extending to 10:00 AM. Queues approaching these bottlenecks typically extend about 2.5 miles east to the vicinity of the Hillcrest Avenue Interchange. The total peak period delay associated with the controlling bottleneck and the upstream embedded bottlenecks is 2,470 vehicle hours.

- **Location 3 – <u>Loveridge Road to Somersville Road Interchanges (Eastbound PM):</u>** This bottleneck is caused by eastbound traffic demand that exceeds the capacity of this 2 lane mixed-flow section of SR 4. There is also evidence of a downstream bottleneck that periodically develops between the Somersville Road on-ramp and the L Street off-ramp. The data and observations also indicate that, in some instances, the congestion approaching these bottlenecks can last for nearly 4 hours between about 3:00 PM and 6:50 PM and queues typically extend to the Railroad Avenue Interchange, 3 miles to the west. The afternoon peak period delay for approaching vehicles is 2,054 vehicle hours.

- **Location 4 – <u>SR 242 and Port Chicago Highway (Eastbound PM):</u>** This bottleneck occurs between the SR 242 and the Port Chicago Highway Interchanges where the number of lanes on SR 4 is reduced from 5 mixed-flow lanes that originate where the SR 242 three-lane ramp joins SR 4, to 4 mixed-flow lanes, just before the eastbound HOV lane is introduced. While the congestion at this location is generally limited to the area of the bottleneck itself, queues approaching the bottleneck typically extend one-half mile west of the SR 4/SR 242 Interchange. Eastbound congestion approaching this bottleneck occurs in the afternoon between 4:50 PM and 6:50 PM and the resulting peak period delays are estimated at 318 vehicle hours.

- **Location 5 – I-680 to Solano Way <u>(Eastbound PM):</u>** This bottleneck develops between the I-680 northbound on-ramp and the Solano Way off-ramp where high on-ramp volumes from the I-680 northbound on-ramp merge with the SR 4 eastbound mainline. While the congestion at this location is generally limited to the area of the bottleneck itself, queues approaching the bottleneck typically extend 0.9 miles to the west. Eastbound congestion approaching this bottleneck occurs in the afternoon between 3:45 PM and 6:00 PM.[1]

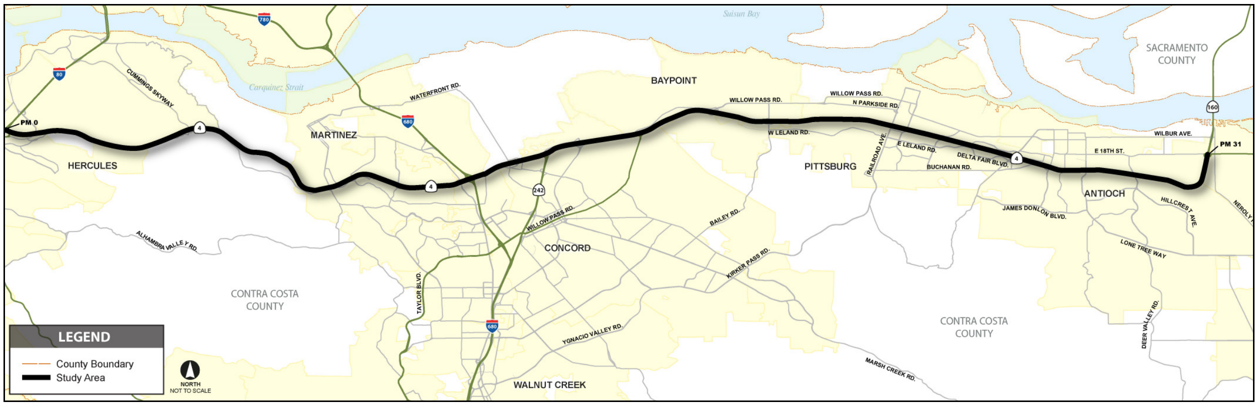
It should also be noted that during the morning peak period, the ramp from eastbound SR 4 to southbound I-680 is often congested due to back-ups on southbound I-680. While this does have an affect on SR 4 operations, the affect cannot be measured in this report because there is no PeMS or tach run data at this location.

[1] The resulting peak period delays are unknown for this bottleneck location due to a lack of data.

Section 1: Description of the SR 4 Corridor

This section provides a description of the corridor's physical characteristics including existing roadway and transit networks as well as ITS infrastructure. The SR 4 Corridor Study Area extends 31 miles in Contra Costa County from the I-80 Interchange to the SR 160 Interchange (PM_{ABS} 0 to PM_{ABS} 31). Exhibit 1.1 shows the SR 4 Corridor Study Area.

Exhibit 1.1: SR 4 Corridor Study Area



Characteristics of the SR 4 Corridor

The SR 4 Corridor serves the local and intercity travel needs to and through Contra Costa County. As such, the Contra Costa Transportation Authority (CCTA) identifies SR 4 as a Route of Regional Significance (*East County Action Plan for Routes of Regional Significance*, August 2008).[2]

The SR 4 Corridor supports several travel markets including daily commuter trips, local freight and goods movements, recreational trips, regional trips, and intercity/local travel. It is a major east-west freeway serving a significant amount of locally-generated traffic in cities located along the corridor such as Hercules, Martinez, Concord, Pittsburg, Antioch, Oakley, Brentwood, and unincorporated Contra Costa County. SR 4 provides a major freeway connection between the northeast Bay in Contra Costa County, the I-80 Corridor, and the Central Valley, and carries an average of 40,000 to 160,000 vehicles per day.[3] The truck traffic component is four to seven percent of the total traffic volumes.[4]

SR 4 begins at the I-80 Interchange in Hercules to the west and is characterized as an expressway (partial access control) until Cummings Skyway, approximately 4.5 miles to the east.[5] SR 4 becomes a freeway (full access control) at Cummings Skyway and terminates at SR 160 in Antioch to the east. There are generally two travel lanes in each direction between Hercules and Martinez, three travel lanes in each direction between Martinez and the Glacier Drive overpass (west of the I-680 Interchange), two travel lanes in each direction between the Glacier Drive overpass and the SR 242 Interchange, three lanes plus one 2+ High-Occupancy Vehicle (HOV) lane in each direction between the SR 242 Interchange and Railroad Avenue (Pittsburg), and two lanes in each direction from Pittsburg to SR 160. In the western segment of SR 4 between Hercules (I-80) and Martinez (I-680), there are eight interchanges and they are located at Willow Avenue, Sycamore Avenue, Cummings Skyway, Franklin Canyon Road/McEwen Road, Alhambra Avenue, Pine Street/Center Avenue, Morello Avenue, and Pacheco Boulevard. In the central segment of SR 4 between the I-680 Interchange and Pittsburg, there are six interchanges and they are located at: Solano Way, SR 242, Port Chicago Highway, Willow Pass Road, San Marcos Boulevard, and Bailey Road. In the eastern segment of SR 4 between Pittsburg and SR 160, there are nine interchanges and they are located at: Railroad Avenue, Loveridge Road,

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2 Routes of Regional Significance are roadways that meet one or more of the following criteria: connect two or more "regions" of Contra Costa County; cross County boundaries; carry a significant amount of through-traffic; provide access to a regional highway or transit facility (e.g., a BART station or freeway interchange).
3 2007 AADT. Traffic Data Branch. Caltrans. http://www.dot.ca.gov/hq/traffops/saferesr/trafdata/
4 2007 Truck AADT. Traffic Data Branch. Caltrans. http://www.dot.ca.gov/hq/traffops/saferesr/trafdata/
5 There is no southbound I-80 to eastbound SR 4 connector at the interchange.

Somersville Road, L Street/Contra Loma Boulevard, G Street, A Street/Lone Tree Way, Hillcrest Avenue, SR 4 Bypass, and E. 18th Street/Main Street. Exhibit 1.2 depicts mainline lanes by post mile (PM_{ABS}), and interchange locations.

Major capacity improvements to the SR 4 Corridor system are either planned or under construction within the corridor.[6] These projects include:

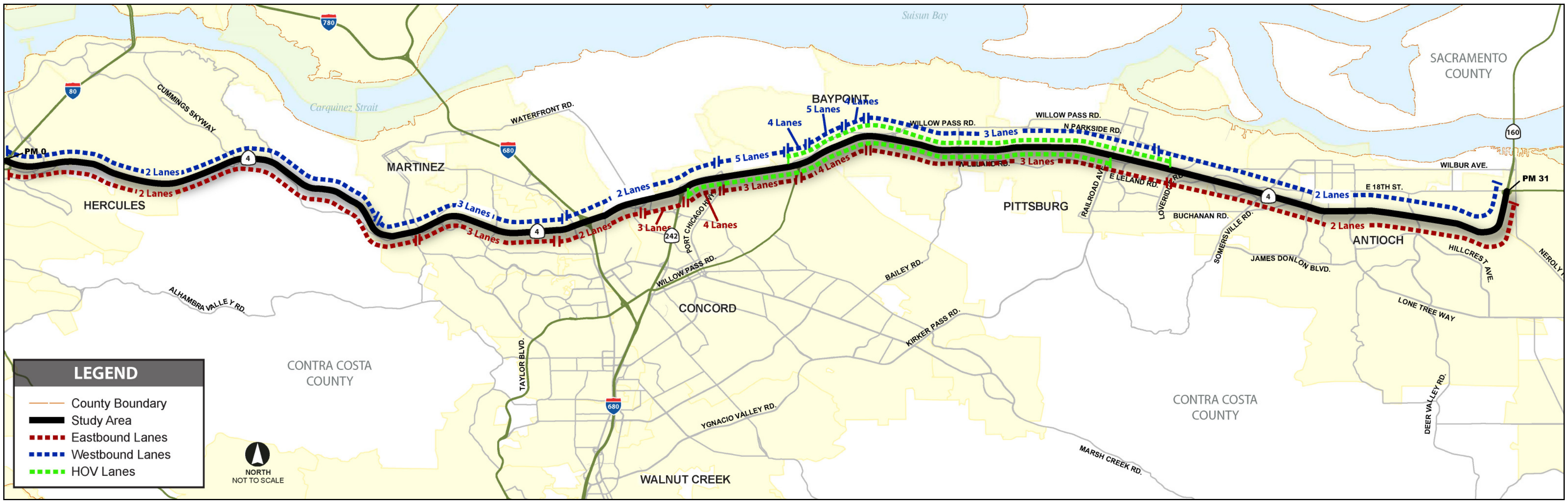
- SR 4 East Widening Project (Loveridge Road to SR 160) is a proposed freeway widening project that will widen SR 4 from the existing four lanes to eight lanes. The widened freeway would consist of one HOV lane and three mixed-flow lanes in each direction. This project will reserve sufficient width in the SR 4 median to accommodate future public transit improvement (eBART) and will reconstruct interchanges at Loveridge Road, Somersville Road, Contra Loma Boulevard/L Street, Lone Tree Way/A Street, and Hillcrest Avenue.
- SR 4 Bypass Segment 3B is a proposed extension of the recently constructed two-lane expressway from Balfour Road to Marsh Creek Road (Segment 3A) south of Marsh Creek Road to Vasco Road, which will be designated as a County road.
- eBART is a proposed BART system expansion into East Contra Costa County. The eBART Proposed Project would extend the BART system in the median of SR 4 approximately ten miles eastward from the existing Pittsburg/Bay Point BART station to a new station at Railroad Avenue in Pittsburg and a terminus station east of Hillcrest Avenue in Antioch. Self- propelled rail cars, also known as Diesel Multiple Unit (DMU), are the proposed vehicle technology for eBART.

The SR 4 Bypass connects the communities of Oakley and Brentwood to the SR 4 Corridor. Segment 1 of this facility, completed in 2008, is a four- to six-lane freeway located between the former SR 4/SR 160 Interchange and Lone Tree Way. Apart from the two interchanges at the segment's termini, there is one interchange located at Laurel Road. Segment 2 of the SR 4 Bypass, completed in 2002, is a two-lane expressway located between Lone Tree Way and Balfour Road. Along this segment, there is one signalized access point located at Sand Creek Road. The total length of these two segments is five miles. For the purposes of this memorandum, the SR 4 Bypass is not being evaluated.[7]

As can be seen in Exhibit 1.2, there is an extensive network of arterial roadways and local streets that provide access to SR 4, especially in the eastern segment of the Study Area connecting the cities of Pittsburg and Antioch. While these streets can provide alternatives to SR 4 for local travel, these routes are not viable options for the longer intercity and regional trips that use SR 4. In other words there is no single route, or continuous network of streets that provide a competitive alternative to SR 4. This is due to topographical constraints, namely the northern tip of the Diablo Range that crosses the SR 4 Corridor between Concord and Pittsburg. The main benefit of the network of arterials and local streets to the SR 4 Corridor is the potential to serve as alternative routings as part of the incident management plans for the SR 4 Corridor.

6 Measure C Growth Management Program and Measure J Expenditure Plan, *Contra Costa County Comprehensive Transportation Plan*, 2004.
7 The SR 4 Bypass will be included in the evaluation of Future Conditions.

Exhibit 1.2: Characteristics of the SR 4 Corridor



Public Transportation in the SR 4 Corridor

Current public transportation service in the SR 4 Corridor provides important mobility options to the automobile. Three major public transit operators provide service within or adjacent to the study area, BART, Tri Delta Transit, and County Connection. Additionally, WestCAT operates limited service in the western segment of the SR 4 Corridor. Additionally, six park-and-ride lots at the following locations support public transit operations in the corridor: 1) Hercules @ Sycamore – 252 parking spaces; 2) Hercules @ Willow – 85 parking spaces; 3) Martinez @ Alhambra – 24 parking spaces; 4) Martinez @ Pacheco – 51 spaces; 5) Pittsburg @ Bliss – 185 spaces; and 6) Antioch @ Hillcrest – 218 spaces.[8]

Amtrak service is not included in this public transportation inventory. The San Joaquin Line provides very limited service through the area (approximately 4 trains/day), and operates too far to the north of SR 4 to provide a viable alternative. The Capitol Corridor Line provides more frequent service, but only serves Martinez and again, does not travel close enough to SR 4 to provide a viable alternative.

In addition to the transit service providers noted above, a comprehensive transportation demand management program is operated by 511 Contra Costa. This agency promotes alternatives to the single occupant vehicle and is sponsored by all twenty jurisdictions in Contra Costa County through the four regional transportation planning committees. Examples of the types of commute alternative projects that are implemented by 511 Contra Costa staff encourage carpooling, vanpooling, telecommuting, biking, transit, and walking.

Exhibit 1.3 presents the service characteristics of transit providers operating in the SR 4 Corridor (based on transit agency records). Exhibit 1.4 presents public transportation services within and adjacent to the SR 4 Corridor.

8 County Connection is currently working with Caltrans to expand the Martinez @ Pacheco park-and-ride facility. The new facility will be a transit hub with six bus bays and 116 parking spaces. Construction of this facility is expected to begin in spring 2009.

Exhibit 1.3: Weekday Transit Service in the SR 4 Corridor

Transit Agency/Route	Average Weekday Ridership	Weekday Service Frequency (in minutes)		
		Morning	Midday	Evening
BART Pittsburg/Bay Point – SFO Line	15,600	5-15	15	5-15
Tri Delta Transit				
Route 200 Martinez/Pittsburg	230	60-75	60	60-75
Route 201 Concord Route	340	30-60	60	30-60
Route 300 Pittsburg BART/ Brentwood	1,210	20	30	15-30
Route 379 Antioch Deer Valley	n/a	35-60	60-75	60
Route 380 Pittsburg BART/Hillcrest Park & Ride	2,450	20-60	5-75	20-60
Route 383 Hillcrest Park & Ride/Oakley	210	55-70	60	5-80
Route 385 Brentwood/Antioch	140	60	60-85	60
Route 387 Pittsburg BART/Tri Delta Antioch	860	50-80	50-70	60
Route 388 Pittsburg BART/Hillcrest Park & Ride	1,210	10-45	30-80	30-120
Route 389 Pittsburg BART/Bay Point	420	60	60	60
Route 390 Pittsburg BART/Hillcrest Park & Ride	240	5-30	--	15-30
Route 391 Pittsburg BART/ Brentwood Park & Ride	1,400	30-60	60	15-75
Route DX Martinez Antioch	50	1 bus	--	1 bus
County Connection				
Route 108 North Concord/Martinez BART – Amtrak	510	20-55	55-70	50-55
Route 118 Concord BART – Amtrak	640	20-60	20-60	45-60
Route 980 Walnut Creek – Amtrak	360	30	45	30-45
WestCAT				
Route 30Z Martinez Link	270	30	60	30

Source: www.trideltatransit.com; www.bart.gov; www.cccta.org;

Notes:

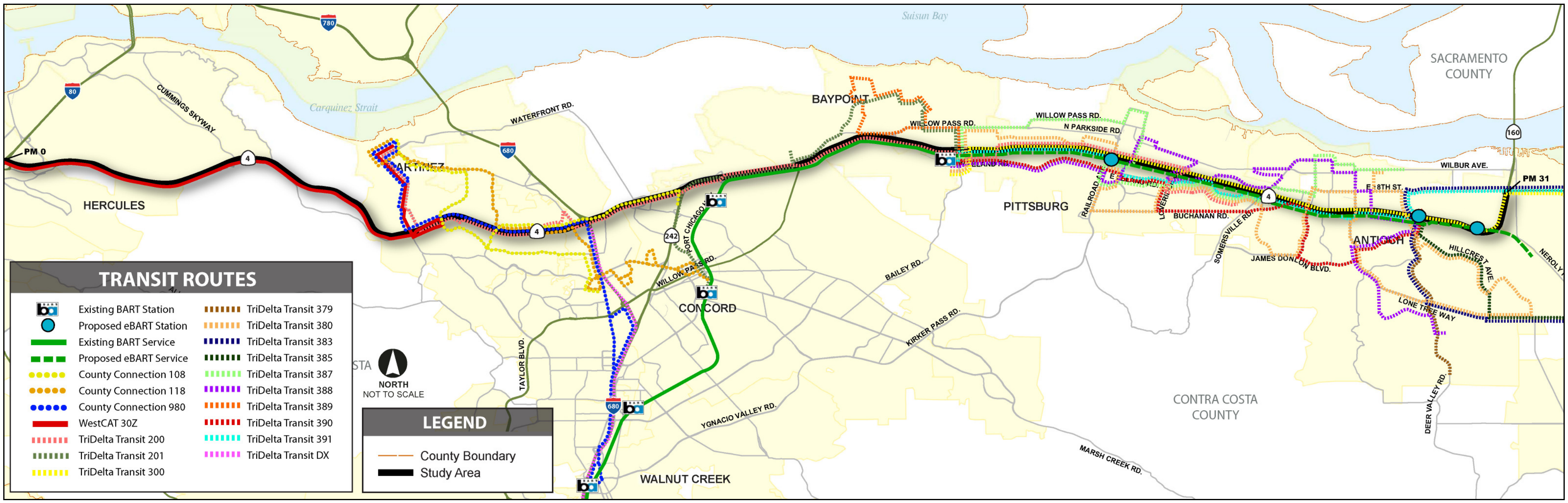
a. BART ridership is based on July-September 2008 weekday average exits for the North Concord/ Martinez and Pittsburg/Bay Point stations.

b. Tri Delta Transit ridership is based on FY 2007/2008 total passengers carried. To convert annual to daily, a factor of 254 was used.

c. County Connection ridership is based on October 2008 Productivity.

d. WestCAT ridership is based on 2007 Annual Ridership. To convert annual to daily, a factor of 254 was used.

Exhibit 1.4: Public Transportation in the SR 4 Corridor as of October 2008



BART

BART is a heavy-rail transit service that connects Central and Eastern Contra Costa County with the areas west of the Caldecott Tunnel, and provides an alternative to SR 4. The Pittsburg/Bay Point BART service terminates at the southwest quadrant of the SR 4/Bailey Road Interchange. The SFO – Pittsburg/Bay Point line, also referred to as the Concord Line, provides direct service to and from San Francisco and runs from 4:00 AM to 12:00 AM daily. Service frequency ranges from every 5 minutes to every 15 minutes, depending on the time of day. The Pittsburg/Bay Point Station is the only station located in the Study Area and is located within the SR 4 median; however, the North Concord/Martinez Station is also included in this analysis because it is located just a half-mile south of SR 4 on Port Chicago Highway. These stations can be accessed through on-site park-and-ride lots and through numerous County Connection and Tri-Delta Transit bus routes.

Current average load factors on BART are determined based on existing train loads and average train capacity. Exhibit 1.5 shows the existing average number of passengers per car for the AM and PM peak hour and peak direction for the two stations located in the Study Area. BART's operations staff have determined that an average load of 112 passengers per car represents a realistic measure of practical train capacity.[9] While loads higher than 112 passengers per car are possible and occur regularly, sustained loads above this level have been observed to result in serious delays in passenger boarding and alighting. These loading delays result in delays in train service which interfere with the on-time performance of the BART system and result in overcrowding and bunching of trains.

Due to the fact that the two stations analyzed for this study are located at the terminus of the SFO – Pittsburg/Bay Point line, the average passengers per car are relatively low, as most passengers have already exited (eastbound) or have not yet boarded (westbound). Additionally, the North Concord/Martinez Station has been identified by BART as significantly underutilized, with the lowest average daily ridership in the entire system. During the AM peak hour in the westbound direction, the highest average passengers per car experienced in the Study Area is at the North Concord/Martinez Station, with 29 passengers per car. In the PM peak hour eastbound direction, the highest observed average passengers per car is 33, also occurring at the North Concord/Martinez Station. Current peak hour average passengers per car are significantly below the threshold of 112 passengers per car.

Exhibit 1.5: BART Existing Average Passengers per Car on the Pittsburg/Bay Point – SFO Line

Station	Westbound AM Peak	Eastbound PM Peak
Pittsburg/Bay Point[(b)]	--	25
North Concord/Martinez	29	33

Source: *East Contra Costa BART Extension Draft EIR*, PBS&J, September 2008.
Notes:
a. The average passengers per car measure represents the load of the trains arriving at the station. For this reason, there are no loads shown at Pittsburg/ Bay Point westbound.

As noted previously, each of the two BART stations located within the Study Area provide park-and-ride facilities for BART customers. These facilities currently do not charge a fee for commuter parking and also offer other parking options such as Monthly Reserved, Extended Weekend, and Airport Parking.[10] On-site parking capacities are approximately 1,977 spaces at the North Concord/Martinez Station and 2,036 spaces at the Pittsburg/Bay Point Station.[11] According to the BART website, during the AM peak period, the Pittsburg/Bay Point park-and-ride facility fills-up by 6:25 AM, while the North Concord/Martinez park-and-ride facility remains below capacity throughout the day.

9 An average load of 112 passengers per car is approximately 67 persons seated and 45 persons standing.
10 www.bart.gov
11 Pittsburg/Bay Point Station - *East Contra Costa BART Extension Draft EIR*, PBS&J, September 2008; North Concord/Martinez Station – Bill Hurrell, Wilbur Smith Associates, telephone conversation December 9, 2008.

Tri Delta Transit

Tri Delta Transit is a service of the Eastern Contra Costa County Transit Authority that serves east Contra Costa County including the cities of Pittsburg, Antioch, Oakley, and Brentwood; and the unincorporated areas of East County, along with Bay Point. Tri Delta Transit operates 16 local bus routes from Monday to Friday, including four express services, and three local bus routes during weekends and holidays. BART regional rail service can be accessed from the Tri Delta Transit local and express bus service. Paratransit ("Dial-A-Ride") service is also provided by Tri Delta Transit. The Dial-A-Ride service utilizes a computerized dispatch system to match van routing with passenger trip requests.

Tri Delta Transit reports on its website that it has an annual fixed route ridership of over 2.5 million boardings. Route 380, a weekday local route from the Pittsburg/Bay Point BART Station through the Hillcrest Park-and-Ride Lot into Antioch, carried the largest volume of riders, and was one of the most productive routes in terms of passengers per revenue hour. Route 300, a service between Brentwood and the Pittsburg/Bay Point BART Station, which also passes through the Antioch Park-and-Ride Lot, had the highest ridership among the weekday express services.

County Connection

The County Connection Transit Service, operated by the Contra Costa County Transit Authority (CCCTA), serves most Central and Southern Contra Costa County cities, with limited service to East County areas. County Connection operates Route 980 through Pittsburg, which originates in Walnut Creek and travels on Ygnacio Valley Road/Kirker Pass Road to Buchanan Road. The other two County Connection routes that operate in the SR 4 Corridor are 108 and 118, which provide service between Concord and the Martinez Intermodal Station.

WestCAT

WestCAT is a service of the Western Contra Costa Transit Authority, which provides local, express, and regional service to the cities of Pinole and Hercules and the unincorporated communities of Montalvin Manor, Tara Hills, Bayview, Rodeo, Crockett, and Port Costa. Additionally, WestCAT operates regional service between Martinez and the El Cerrito del Norte BART station and between the Hercules Transit Center and Contra Costa College. Route 30Z, operating between the El Cerrito del Norte BART Station and the Martinez Intermodal Station, is the only WestCAT route providing service in the SR 4 Corridor.

Transit Summary

The capacity of BART (and the future eBART extension) and its associated parking facilities is key to existing and future mobility in the SR 4 Corridor, due to the fact that most feasible freeway widening and extension projects have already been completed or are currently being designed or constructed. Based on the average passenger loads described above, there are not currently any capacity constraints on the BART trains; however, trains do fill up further down the line and there is adequate track capacity for additional trains to be added or the implementation of a new line (e.g., Pittsburg/Bay Point – Fremont).

Local Action Plans and other recent studies conducted along the corridor suggest that, in addition to expanding on-site parking facilities, BART accessibility in the SR 4 Corridor can be improved by enhancing BART station access via alternative travel modes. This would include increased connectivity between BART and local service providers (e.g., Tri Delta Transit, County Connection) and improved and/or new sidewalk/bikeway facilities between the BART stations and adjacent land uses and communities. The route coverage of transit providers that currently serve the SR 4 Corridor is fairly comprehensive and their service is focused on transporting passengers to/from major transit hubs; however, schedules can be modified to provide more frequent service during both peak-commute times and off-peak times subject to the availability of additional resources.

Intelligent Transportation Systems (ITS) Features of the SR 4 Corridor

ITS plays an important role in the operations of a transportation network by collecting travel information and disseminating it to system users to improve the overall utility of the system. In addition, ITS infrastructure is a critical component of incident detection and recovery, which is critical to reduce non-recurrent delays due to incidents and accidents along the SR 4 Corridor.

The *Bay Area ITS Architecture* is the ITS planning framework for the Bay Area that was developed and currently maintained by MTC in cooperation with partner agencies, including Caltrans. Similarly, the *California ITS Architecture and System Plan* references the existing and developing regional ITS plans and architectures from all over the state. It focuses on interregional coordination and state-level needs, and identifies common transportation challenges and services. It also includes a 10-year system plan that describes the blueprint for deployment of specific projects that fall within the statewide and interregional services category.[12]

An inventory of ITS infrastructure in the SR 4 Corridor was provided by Caltrans District 4 and is depicted graphically in Exhibit 1.6 (see Appendix A for additional detail and a map of non-operable ITS infrastructure). As shown in the exhibit, the existing, fully operational ITS infrastructure in the SR 4 Corridor is almost exclusively located within the eastern segment of the freeway between I-680 and SR 160.

Caltrans' vision for ITS in the Bay Area describes an electronic communications system that can be used to collect, process, disseminate and act on information in real time to improve the operation, safety or convenience of the corridor transportation system.[13] To achieve these goals, ITS infrastructure in the SR 4 Corridor should maintain, at a minimum, the following characteristics:

- One closed-circuit television camera (CCTV) per mile;
- Changeable Message Signs (CMS) at the approaches to all freeway-to-freeway interchanges;
- Traffic monitoring stations (TMS) located every one-third to one-half mile along the corridor; and
- Ramp metering at all local access interchanges.

Based on the existing deployments in Contra Costa County, the SR 4 Corridor does not meet these requirements, especially in the western section. In the 31-mile SR 4 Corridor there is/are:

- three fully operational CCTVs in the westbound direction and none in the eastbound direction, a deficit of approximately 60 CCTVs throughout the SR 4 Corridor;
- two fully operational CMSs throughout the SR 4 Corridor, but neither are located at the approaches to interchanges along SR 4. Therefore, there is a deficit of approximately five CMSs along the SR 4 Corridor.[14]
- 20 fully operational TMSs, a deficit of 57 TMSs for the eastbound direction and 58 for the westbound direction. The largest gap of TMSs is between I-80 in Hercules and I-680 in Martinez, a distance of approximately 12 miles. There are approximately eight TMSs that exist but are not fully functional due to either the absence of a power connection or the lack of communication capabilities with the Traffic Management Center (TMC); and
- ramp metering equipment on a total of fifteen on-ramps located at the I-680 Interchange and at the following seven local access interchanges: Solano Way (eastbound on-ramp only), Port Chicago Highway (eastbound on-ramp only), Willow Pass Road, Willow Pass Road/San Marco Boulevard (loop ramps and diagonal ramps), Bailey Road (eastbound on-ramp only), Railroad Avenue, and Loveridge Road (eastbound on-ramp only).[15] Therefore, there is a deficit of approximately 28 ramp meters along the SR 4 Corridor.

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12 *California ITS Architecture and System Plan*. Caltrans, October 2004.

13 *Bay Area Regional Intelligent Transportation System Plan.* Iteris, Inc. for Metropolitan Transportation Commission, June 2004.

14 CMSs are needed at the westbound approach to I-80, the eastbound and westbound approaches to I-680, and the eastbound and westbound approaches to SR 242. The existing CMSs are located in the eastbound and westbound directions near Loveridge Road, nearly 10 miles from the closest freeway-to-freeway interchange.

15 None of the ramp meters in the SR 4 Corridor are currently activated/operational.

Exhibit 1.6: Existing ITS Deployment in the SR 4 Corridor – Fully Operational as of October 2008

ITS Component Summary	ITS Component	# Fully Operational
	Changeable Message Signs	2
	Closed Circuit TV Cameras	3
	Extinguishable Message Signs	0
	Highway Advisory Radio	0
	Traffic Monitoring Stations	20

[1] ITS Components that are not fully operable include components under construction, without power, damaged, or without communication to the Traffic Monitoring Center (TMC).

Section 2: Traffic Characteristics of the SR 4 Corridor

Traffic characteristics were evaluated at three representative locations along the SR 4 Corridor to assess seasonal and daily variations in traffic volumes, or flow rates. Six data locations (three eastbound and three westbound) were chosen for this analysis. Data locations were chosen to (a) provide typical traffic characteristics from all segments of the SR 4 Corridor and (b) provide reliable, measured data based on 80 percent or higher detector health. The central segment of the SR 4 Corridor between I-680 and Bailey Road has the best detection coverage in the Study Area. The locations chosen were:

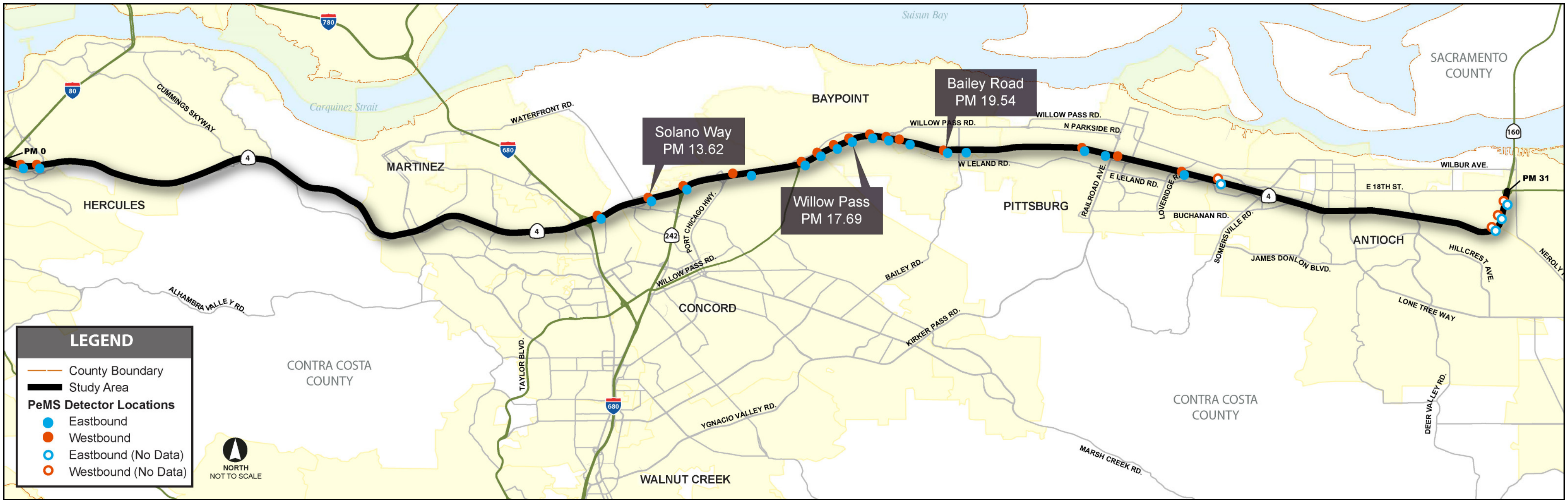
- Solano Way – Located in Concord, Contra Costa County between I-680 and SR 242.
- Willow Pass Road – Located in Bay Point, Contra Costa between the two interchanges for Willow Pass Road.
- Bailey Road – Located in Pittsburg, Contra Costa County, just west of the Bailey Road Interchange.

The source of the data used to evaluate traffic characteristics was the Freeway Performance Measuring System (PeMS), which was developed jointly by Caltrans and the Partners for Advanced Transit and Highways (PATH) at the University of California, Berkeley. PeMS was used to extract detection data, and the detection coverage area for the SR 4 Corridor is shown in Exhibit 2.1. While Caltrans strives for traffic detection to be located within one-third to a half-mile along the corridor, this has not yet been fully achieved. Key detection gaps exist between the I-80 and I-680 interchanges and between the City of Pittsburg and SR 160. Caltrans is currently installing new detection which will be place by August 2009. The three eastbound and three westbound detection locations that were used to evaluate traffic characteristics for the SR 4 Corridor are highlighted in the exhibit.

For each of the locations studied, hourly traffic volumes from PeMS were downloaded for the 52-week period from January 2, 2007 to December 27, 2007. There is a significant gap in detection coverage along the SR 4 Corridor in the western segment of the Study Area between I-80 and I-680, as well as the eastern segment of the Study Area between Bailey Road and SR 160.[16] As such, data in these subareas will be substituted with available tach runs (a.k.a. floating car runs, travel time runs).

[16] Although there are several detection locations in the eastern segment of the SR 4 Corridor between Bailey Road and SR 160, most of them have poor detector health (<80%) and were, therefore, not included in the analysis.

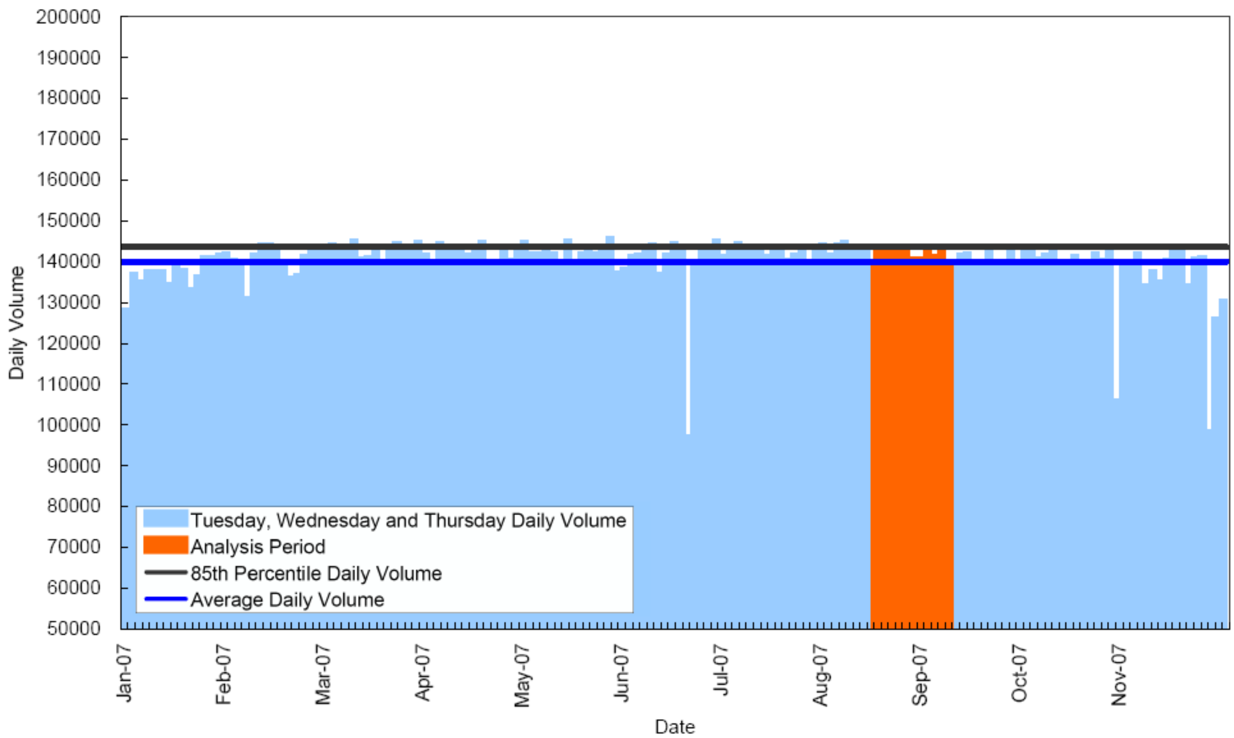
Exhibit 2.1: Detection Locations



Seasonal Variation of Weekday Traffic

In order to account for any seasonal variation along the SR 4 Corridor, existing daily weekday traffic volumes were reviewed over a 52-week period at the three selected locations along the corridor: Solano Way, Willow Pass Road, and Bailey Road. An example of the analysis that was performed is provided in Exhibit 2.2. This exhibit illustrates variations in weekday traffic volumes at the Willow Pass Road location. For the purposes of this study, the weekday traffic volumes were analyzed for Tuesdays, Wednesdays, and Thursdays, which are representative of typical commuter traffic in the SR 4 Corridor. Seasonal variation data at the other locations may be found in Appendix B of this document.

Exhibit 2.2: Seasonal Variations in Weekday Traffic Volumes (Willow Pass Road)



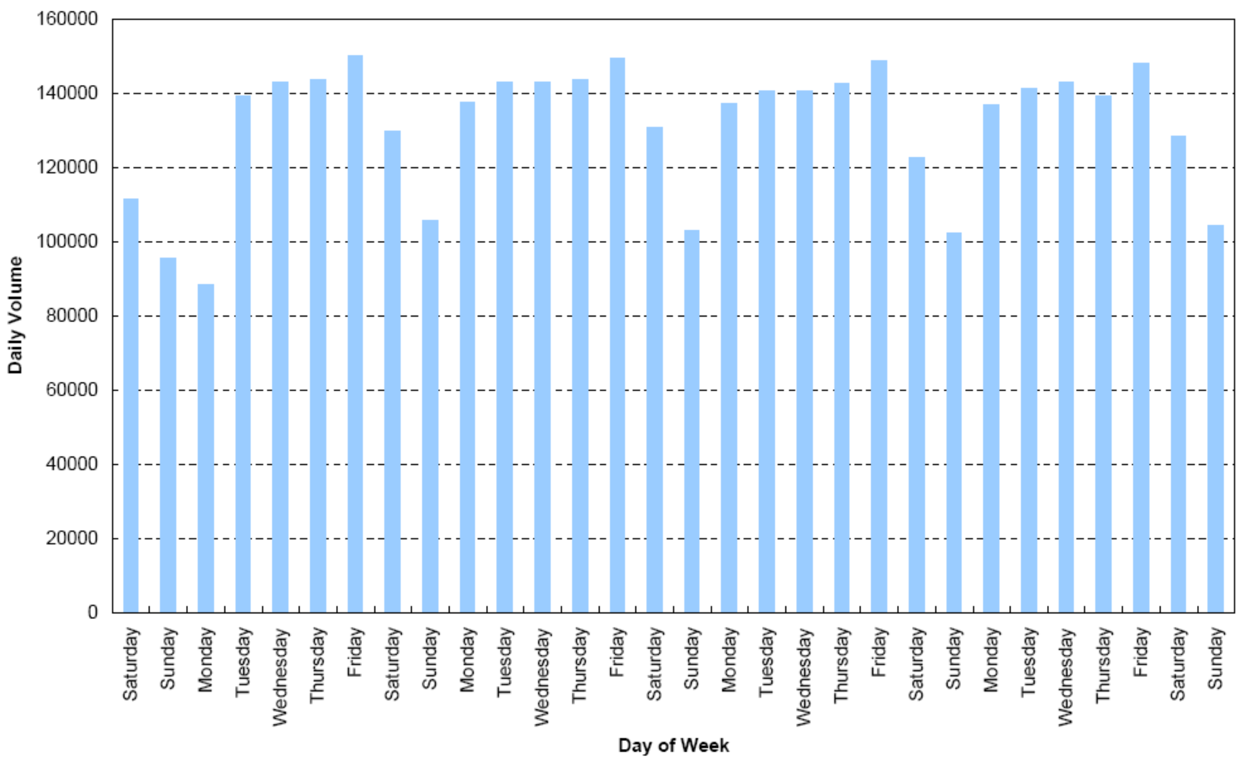
In general, traffic volumes at each of the three selected locations are 0.6 to 1.2 percent higher during the spring season (April 2007) than in the fall season (September 2007). In order to evaluate typical variations in travel patterns, the study team collected and reviewed all available data sources including detection data and tach runs from Caltrans. Although traffic volumes are slightly higher in the spring season at the selected detection locations, the study team selected the fall season for analysis because the fall tach run data showed heavier congestion, and the fall detection data was available at more locations than the spring detection data. The study team selected the period from September 1, 2007 through September 30, 2007 for analysis that provided:

- a representative period of average travel conditions;
- a period where all days of the week were considered typical;
- a period within the school year;
- available data to supplement detection data gaps; and
- consistent data available for performance measures and travel time evaluations.

Daily Traffic Variation

As described in Section 1, the SR 4 Corridor serves commuter and intercity travel markets. This corridor is the primary travel route providing home-to-work and work-to-home travel for residents living in the Contra Costa County communities of Hercules, Martinez, Concord, Pittsburg, Antioch, Oakley, and Brentwood traveling to/from other East Bay locations and San Francisco. To determine the impact of commuter travel along this corridor, daily traffic volumes from the September 1, 2007 to September 30, 2007 time period were evaluated. Exhibit 2.3 illustrates variations in weekday traffic volumes by day of the week at the Willow Pass Road data location in Bay Point. Daily traffic data at the other locations may be found in Appendix C of this document. As shown in the exhibit, higher traffic volumes occur during the weekdays from Monday through Friday with significantly reduced vehicle volumes for weekend days (Saturday and Sunday). These daily traffic variations are representative of typical commuter traffic patterns with occasional higher traffic demand on Fridays.

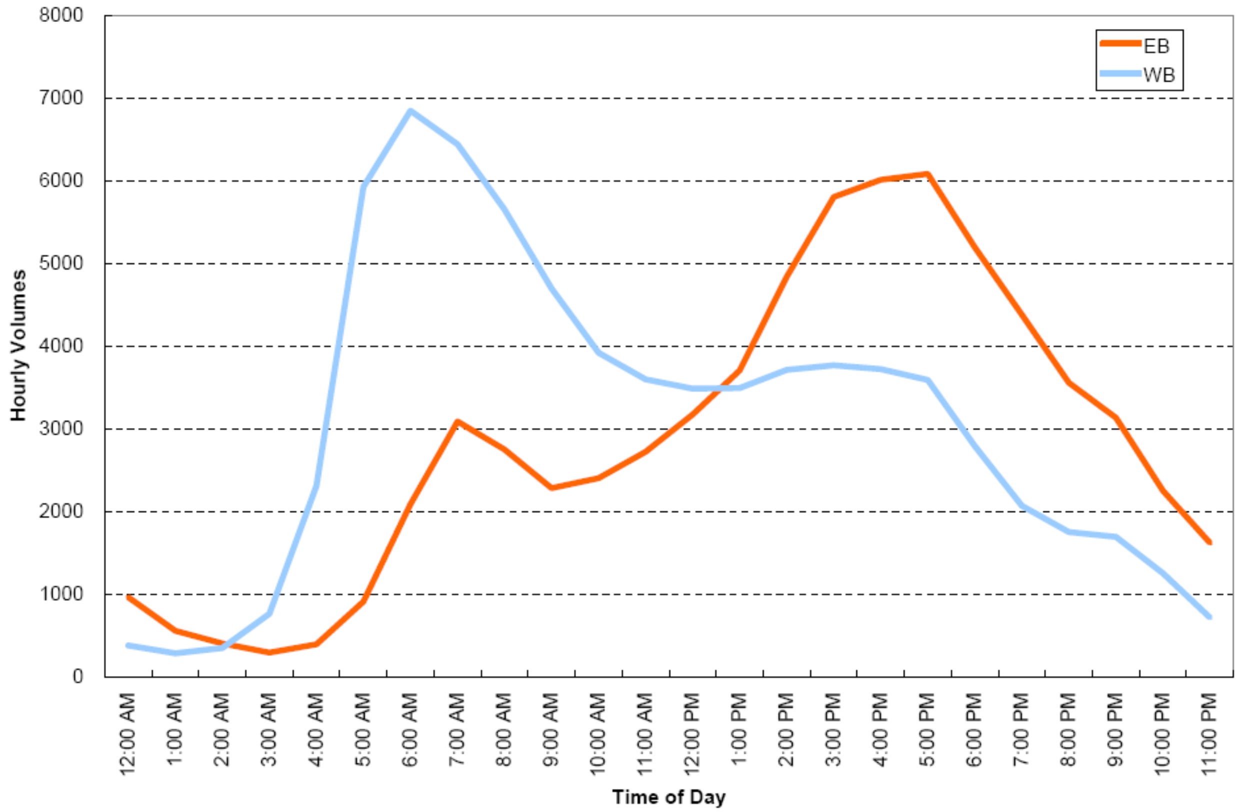
Exhibit 2.3: Daily Variations in Traffic Volumes
(Willow Pass Road) September 1, 2007 – September 30, 2007



Hourly Traffic Volumes

Exhibit 2.4 presents a summary of eastbound and westbound weekday (Tuesday, Wednesday and Thursday) traffic volumes averaged for the September 1, 2007 to September 30, 2007 analysis period at the Willow Pass Road location where detection data was evaluated. The hourly profiles for weekday traffic at this location are representative of hourly distributions typical of a corridor that serves local, commute, and longer-distance intercity travel. More specifically, these profiles show a concentrated morning peak in the westbound direction, and an afternoon peak in the eastbound direction, while demand during the midday is moderate. Hourly profiles for the other locations along the SR 4 Corridor can be found in Appendix D of this document.

Exhibit 2.4: Weekday Hourly Traffic Volumes (Willow Pass Road) September 1, 2007 – September 30, 2007



HOV Lane Utilization

According to Caltrans' *Year 2007 Annual HOV Lane Report*, approximately 1,250 vehicles currently utilize the westbound HOV lane between Loveridge Road and Port Chicago Highway on SR 4 during the morning peak hour. Approximately 1,100 vehicles utilize the eastbound HOV lane between Port Chicago Highway and Railroad Avenue during the afternoon peak hour. These volumes are well below the 1,650 vehicle-per-hour maximum capacity (75 percent of the maximum capacity for a standard mixed- flow freeway lane) that the California Air Resources Board (CARB) and Caltrans have set as a standard for ideal HOV operating conditions. The average vehicle occupancy is 2.1 persons per vehicle for both peak hours and both directions.

Truck and Heavy Vehicle Traffic

The SR 4 Corridor serves local and intercity truck and heavy vehicle travel for surrounding communities such as Hercules, Martinez, Concord, Pittsburg, Antioch, Oakley, and Brentwood. Additionally, it provides access to I-80, the second longest interstate route in the U.S., and a major route for interstate commerce.[17] Truck and heavy vehicle traffic makes up four to seven percent of daily vehicle trips along the SR 4 Corridor.[18]

17 *The Dwight D. Eisenhower National System of Interstate and Defense Highways.* Federal Highway Administration (FHWA). November 2002. http://www.fhwa.dot.gov/reports/routefinder/index.htm

18 2007 Truck AADT. Traffic Data Branch. Caltrans. http://www.dot.ca.gov/hq/traffops/saferesr/trafdata/

Section 3: SR 4 Corridor Performance Evaluation

The measures used to evaluate the SR 4 Corridor are based on the *MTC Freeway Performance Initiative Traffic Analysis: Performance and Analysis Framework* (April 2007), which describes a methodology for freeway performance evaluation. These measures ensure that a common set of performance criteria are applied to all corridors under study as part of the MTC Freeway Performance Initiative. The existing corridor performance evaluation relies upon the use of available collected data and field observations rather than modeling or simulation tools. This section presents an analysis of existing conditions with a focus on identifying congested areas, bottlenecks and the causes of these delays. The following topics are included in the existing conditions performance analysis:

- **Analysis Methodology:** A discussion of the methods and tools used to identify congestion and causes along the corridor.
- **Mobility:** An evaluation of travel time, speed and delay along the corridor.
- **Reliability:** An analysis of the relative predictability of travel time along the corridor.
- **Safety:** An evaluation of accidents and accident rates for segments of the corridor.

Analysis Methodology

The analysis periods and traffic data inputs for the SR 4 Corridor performance evaluation are documented in Section 2 of this document. The methodology used for the evaluation began with a review of existing data sources for the corridor including PeMS data and tach runs.[19] PeMS data was used for the analysis where sufficient coverage and adequate (greater than 80 percent) detector health was available. Where PeMS data was not available or reliable, tach run data was used instead. Where neither PeMS data nor tach run data was available or reliable, field reviews were conducted during the peak periods. As a result of the differences in data availability throughout the Study Area, the SR 4 Corridor was divided into four segments. These segments and their analysis tools are described below:

- **Between I-80 and I-680 (PM 0.00 and 12.56)** – PeMS coverage insufficient. No tach run data. Field reviews and assessments of available traffic count data during peak periods showed no delay on this segment of the corridor; therefore, no additional analysis was conducted on this segment.
- **Between I-680 and Bailey Road (PM 12.56 and 19.90)** – PeMS coverage sufficient.
- **Between Bailey Road and Hillcrest Avenue (PM 19.90 and 28.54)** – PeMS coverage insufficient. Tach run data available.
- **Between Hillcrest Avenue and SR 160 (PM 28.54 and 31.00)** – PeMS coverage insufficient. No tach run data. Field reviews and assessments of available traffic count data during peak periods showed no delay on this segment of the corridor; therefore, no additional analysis was conducted on this segment.

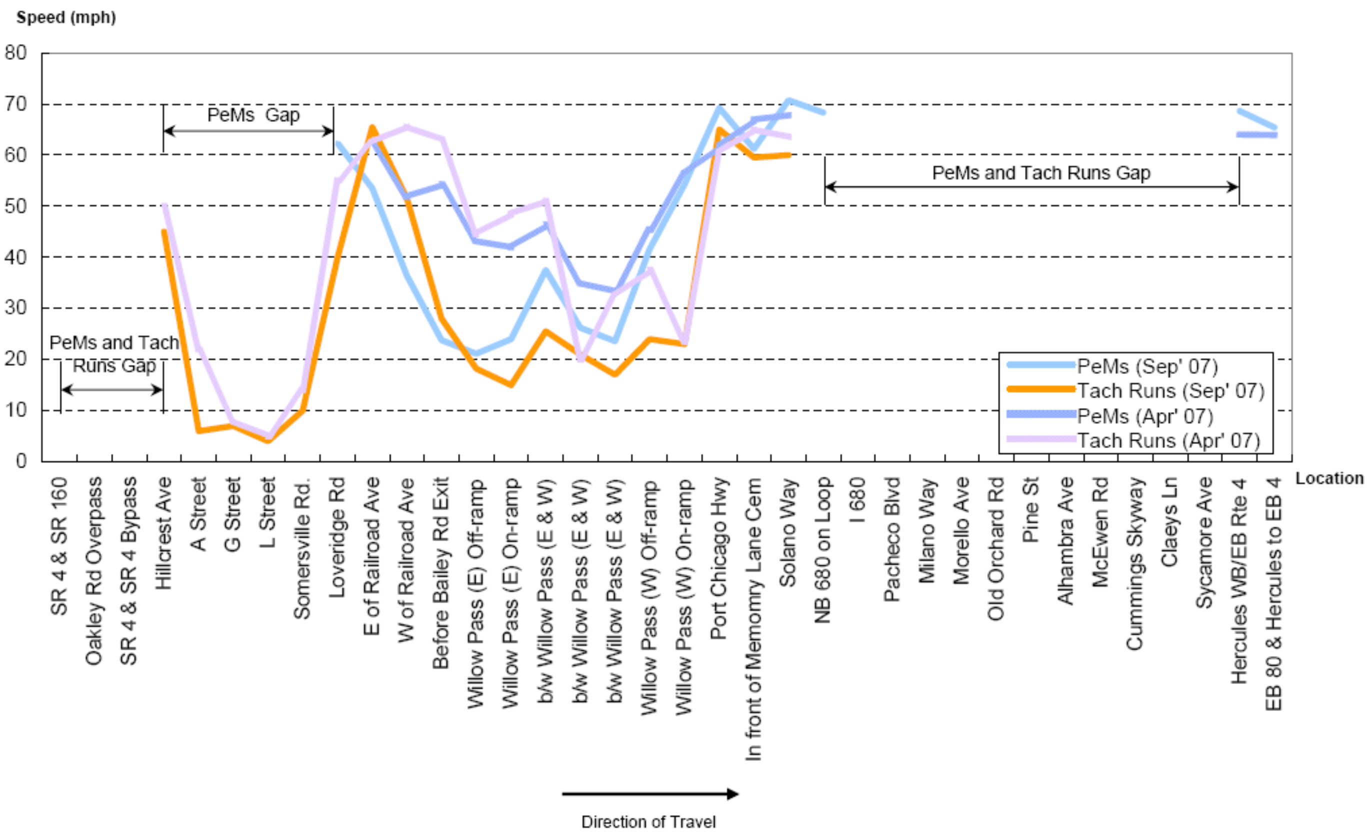
Tach runs used in the analysis were conducted in segments, during morning and afternoon peak directions of travel, on weekdays, and during the months of April and September in 2007.

PeMS data and tach run data was validated to ensure the accuracy and consistency of the data for the analysis locations and time period. Validation of PeMS data and tach run data was accomplished by completing two types of comparisons: 1) In areas with available PeMS data – tach run data was compared to PeMS data; 2) In areas without PeMS data – tach run data was compared to other tach run data from different days.

[19] Also known as travel time runs or floating car runs. Tach runs were provided by Caltrans, including tach runs from the 2007 HICOMP Report.

Exhibit 3.1 represents a comparison of travel speeds from the available data sources (PeMS and tach runs) for the SR 4 Corridor. Average travel speeds from PeMS data as compared to available tach run data shows minor variations among the two data sources. In the eastern segment of SR 4 where a gap exists in PeMS data, the comparison of average travel speeds for different days of tach runs indicates a consistent pattern with reasonable variations. The comparison presented in Exhibit 3.1 illustrates that existing data sources are consistent with tach run data for this segment of the corridor. Since the PeMS data source is the most readily available and provides a robust set of tools that allows the data to be efficiently and effectively evaluated, the analysis uses PeMS as the primary source of data for evaluating the SR 4 Corridor, supplemented with tach runs where PeMS is not available. Comparative travel speeds for SR 4 Eastbound can be found in Appendix E of this document.

Exhibit 3.1: Comparative Travel Speeds from Various Data Sources – SR 4 Westbound – AM Peak Hour (6:00 AM - 7:00 AM)



In summary, the analysis methods described above are used to address mobility, travel times, reliability and safety in the corridor. The PeMS data and tach run data along with analysis tools will be used to evaluate speeds, bottlenecks and congestion in the corridor; as well as to generate overall performance measures such as travel times, reliability, vehicle-hours of travel (VHT) and vehicle-miles of travel (VMT). Caltrans accident and incident data by corridor segment are used to assess safety and to calculate segment accident rates.

Mobility in the SR 4 Corridor

The primary measures of mobility in a freeway corridor are travel time, speed, and delay. As stated previously, this study defines recurrent delay due to congestion as vehicle operating speeds of 35 mph or less over a period of 15 minutes or more. To identify bottlenecks and congested areas, detection data extracted from PeMS and tach runs for the September 2007 analysis period is plotted as speed contours by direction of travel for the average weekday.[20] Bottleneck locations were identified by evaluating this PeMS data, travel time data, traffic counts and field observations of the SR 4 Corridor.[21]

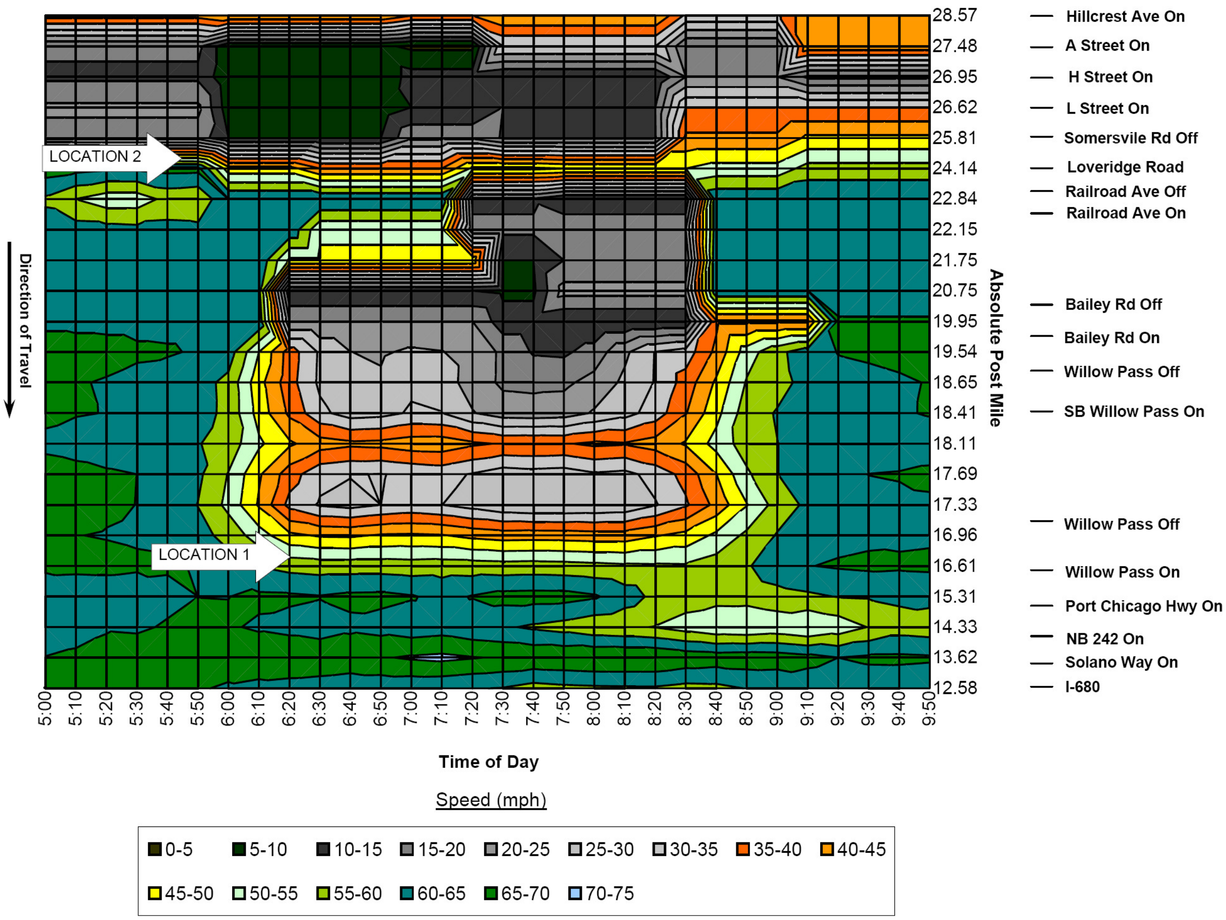
[20] PeMS data analysis period is September 1, 2007 to September 30, 2007. Tach run data analysis period is September 19, 2007 and September 20, 2007.
[21] Field review of SR 4 was conducted on Thursday, November 6, 2008.

AM Peak Period

Exhibit 3.2 illustrates the speed contours for the morning peak period (5:00 AM – 10:00 AM) in the westbound direction of travel. The coverage shown in the exhibit is from Hillcrest Avenue in Antioch west to Pacheco Boulevard, which is located just west of the I-680 Interchange in Concord. This coverage coincides with the limits of data availability from PeMS and the available travel time runs for the corridor.

The areas outside of the coverage presented in Exhibit 3.2 were reviewed in the field and assessed using the available traffic count data. No significant congestion was observed on SR 4 from I-80 to Pacheco Boulevard or east of Hillcrest Avenue in Antioch. This conclusion is also supported by the traffic count data. Based on this finding, the bottlenecks identified in the SR 4 Corridor are limited to the area of coverage depicted in this exhibit.

Exhibit 3.2: PeMS Speed Contours – SR 4 Westbound – AM Peak Period



As shown In Exhibit 3.2, the bottlenecks and congestion approaching these bottlenecks are generally consistent with the Caltrans *2008 State of the System* report for SR 4 in Contra Costa County. Specifically, delays are indicated from the SR 242 and Port Chicago Highway Interchanges to Hillcrest Avenue.[22] [23] Two bottlenecks within these limits are controlling bottleneck locations in the morning peak period, westbound direction of travel. These are discussed in more detail in the Key Findings section of this report and are labeled in the exhibit as Location 1 and Location 2 as follows:

- **Location 1 – <u>Willow Pass Road (West) Westbound to Port Chicago Highway</u>**
- **Location 2 – <u>Somersville Road Westbound to Loveridge Road</u>**

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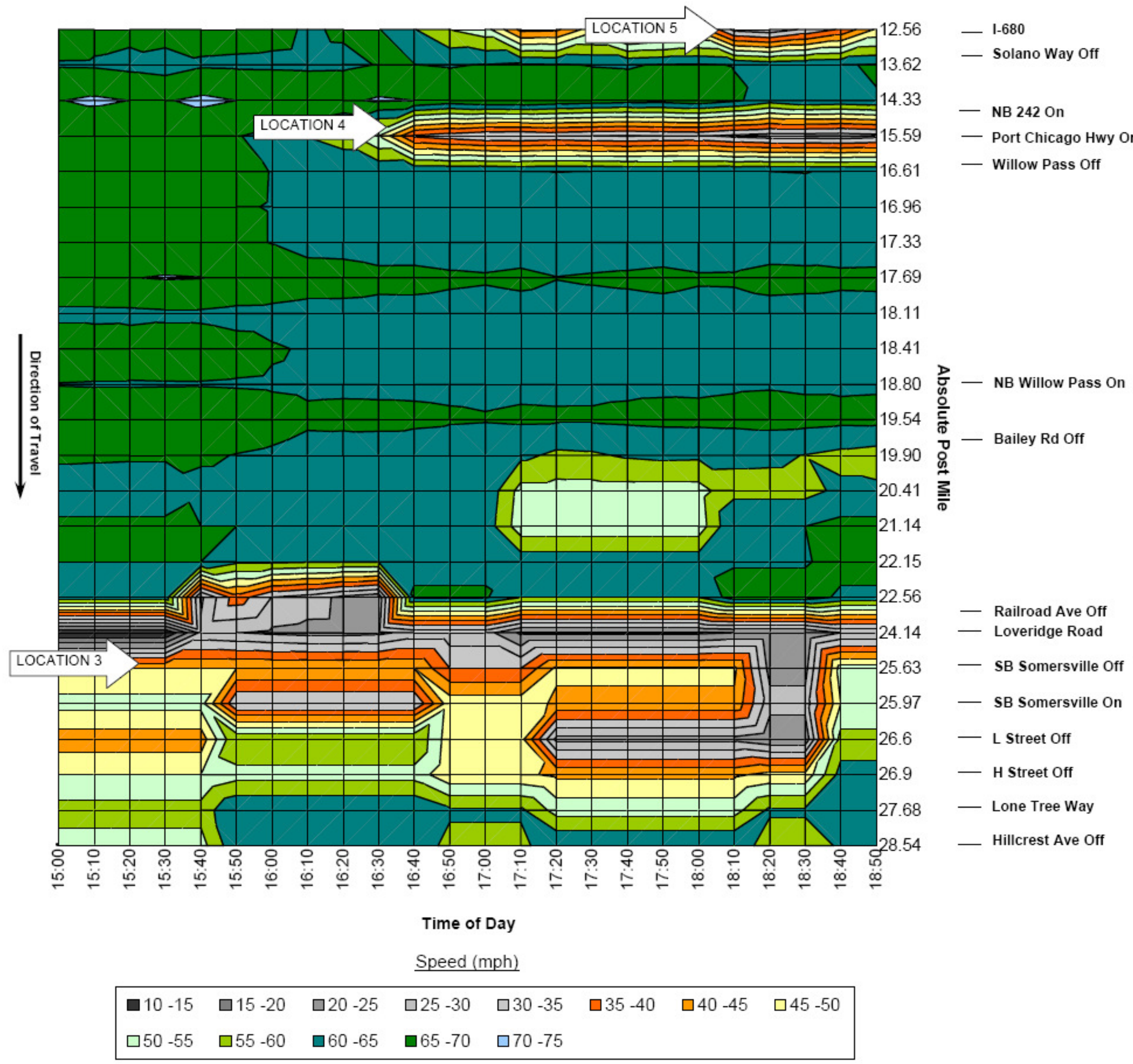
22 "Congested Freeway Locations - Morning and Evening Commutes, 2007"; Caltrans, 2008. http://www.mtc.ca.gov/library/state_of_the_system/2008/am_pm_peak_period_congestion.pdf

23 Hillcrest Avenue is located just east of the A Street/Lone Tree Way location reported in the *2008 State of the System*

PM Peak Period

Exhibit 3.3 illustrates the speed contours for the afternoon peak period (3:00 PM – 7:00 PM) in the eastbound direction of travel. As discussed above for the AM peak period, the coverage of the speed contour extends through the limits of the available PeMS and travel time data, while the remainder of the corridor was evaluated through field observations and reviews of available traffic count data. These reviews confirmed that the existing bottleneck locations and associated congestion are located within the limits of that shown in the exhibit.

Exhibit 3.3: PeMS Speed Contours – SR 4 Eastbound – PM Peak Period



The data depicted in Exhibit 3.3 show delays that are generally consistent with the *2008 State of the System* report. Controlling bottleneck locations are indicated in this exhibit and are discussed in more detail in the Key Findings section of this report. The eastbound bottlenecks in the PM peak period are:

- **Location 3 – Eastbound between Loveridge Road and Somersville Road**
- **Location 4 – Eastbound between SR 242 and Port Chicago Highway**
- **Location 5 – Eastbound between I-680 and Solano Way**

Performance Measures

Exhibits 3.4 and 3.5 summarize VMT, VHT, total delay, and congestion delay for the SR 4 Corridor for the morning peak period, afternoon peak period, and daily. Note that daily data is only presented where there was available PeMS data and congestion delay was also only calculated where there was available PeMS data. For this analysis, vehicle hours of delay are measured by observed travel time on the corridor, less the travel time under non-congested conditions (i.e., at free flow speed). Congestion delay is a calculation of delay based on a threshold speed of 35 mph or less, consistent with Caltrans' use of this threshold to identify areas where traffic flows are unstable.

Exhibit 3.4: SR 4 Corridor Performance Measures – AM & PM Peak Periods

Performance Measure	Segment	Post Mile	Tuesday - Thursday	
			Eastbound 3:00 PM – 7:00 PM	Westbound 5:00 AM – 10:00 AM
Vehicle-Mile of Travel (VMT)	I-80 to I-680	PM 0.0 0 – PM 12.56	N/A [1]	N/A [1]
	I-680 to Bailey Rd.	PM 12.56 – PM 19.90	133,058	156,728
	Bailey Rd. to Hillcrest Ave.	PM 19.90 – PM 28.54	83,300	184,892
	Hillcrest Ave. to SR 160	PM 28.54 – PM 31.00	N/A [2]	N/A [2]
Vehicle-Hours of Travel (VHT)	I-80 to I-680	PM 0.00 – PM 12.56	N/A [1]	N/A [1]
	I-680 to Bailey Rd.	PM 12.56 – PM 19.90	2,364	3,594
	Bailey Rd. to Hillcrest Ave.	PM 19.90 – PM 28.54	2,571	8,560
	Hillcrest Ave. to SR 160	PM 28.54 – PM 31.00	N/A [2]	N/A [2]
Total Delay (VHT below 60 mph)	I-80 to I-680	PM 0.00 – PM 12.56	N/A [1]	N/A [1]
	I-680 to Bailey Rd.	PM 12.56 – PM 19.90	418	1,264
	Bailey Rd. to Hillcrest Ave.	PM 19.90 – PM 28.54	2,278	5,310
	Hillcrest Ave. to SR 160	PM 28.54 – PM 31.00	N/A [2]	N/A [2]
Congested Delay (VHT below 35 mph)	I-80 to I-680	PM 0.00 – PM 12.56	N/A [1]	N/A [1]
	I-680 to Bailey Rd.	PM 12.56 – PM 19.90	228	687
	Bailey Rd. to Hillcrest Ave.	PM 19.90 – PM 28.54	N/A [3]	N/A [3]
	Hillcrest Ave. to SR 160	PM 28.54 – PM 31.00	N/A [2]	N/A [2]

[1] Performance measure data not available between I-80 (PM 0.00) and I-680 (PM 12.56)
[2] Performance measure data not available between Hillcrest Ave. (PM 28.54) and SR 160 (PM 31.00)
[3] Congestive delay data not available between Bailey Rd. (PM 19.90) and Hillcrest Ave. (PM 28.54)

Exhibit 3.5: SR 4 Corridor Performance Measures - Daily

Performance Measure	Segment	Post Mile	Tuesday-Thursday	
			Eastbound	Westbound
Vehicle-Miles of Travel (VMT)	I-80 to I-680	PM 0.00 – PM 12.56	N/A [1]	N/A [1]
	I-680 to Bailey Rd.	PM 12.56 – PM 19.90	443,439	426,460
	Bailey Rd. to Hillcrest Ave.	PM 19.90 – PM 28.54	277614	503096
	Hillcrest Ave. to SR 160	PM 28.54 – PM 31.00	N/A [2]	N/A [2]
Vehicle-Hours of Travel (VHT)	I-80 to I-680	PM 0.00 – PM 12.56	N/A [1]	N/A [1]
	I-680 to Bailey Rd.	PM 12.56 – PM 19.90	7,124	7,846
	Bailey Rd. to Hillcrest Ave.	PM 19.90 – PM 28.54	7748	18686
	Hillcrest Ave. to SR 160	PM 28.54 – PM 31.00	N/A [2]	N/A [2]
Total Delay (VHT below 60 mph)	I-80 to I-680	PM 0.00 – PM 12.56	N/A [1]	N/A [1]
	I-680 to Bailey Rd.	PM 12.56 – PM 19.90	547	1,461
	Bailey Rd. to Hillcrest Ave.	PM 19.90 – PM 28.54	2985	6140
	Hillcrest Ave. to SR 160	PM 28.54 – PM 31.00	N/A [2]	N/A [2]
Congestion Delay (VHT below 35 mph)	I-80 to I-680	PM 0.00 – PM 12.56	N/A [1]	N/A [1]
	I-680 to Bailey Rd.	PM 12.56 – PM 19.90	248	745
	Bailey Rd. to Hillcrest Ave.	PM 19.90 – PM 28.54	N/A [3]	N/A [3]
	Hillcrest Ave. to SR 160	PM 28.54 – PM 31.00	N/A [2]	N/A [2]

[1] Daily performance measure data not available between I-80 (PM 0.00) and I-680 (PM 12.56)
[2] Daily performance measure data not available between Hillcrest Ave. (PM 28.54) and SR 160 (PM 31.00)
[3] Congestive delay data not available between Bailey Rd. (PM 19.90) and Hillcrest Ave. (PM 28.54)

Total SR 4 Corridor delay is 5,550 hours in the morning peak period (7:00 AM to 10:00 AM) and 2,362 hours in the afternoon peak period (3:00 PM to 7:00 PM). Congestion and recurrent delay along the SR 4 Corridor is greatest in the eastbound direction during the afternoon peak period, which is consistent with the data presented in the *2008 State of the System.*[22]

Reliability

Reliability is a measure of how mobility (travel time and speed) varies from day to day along a given travel mode or corridor. The SR 4 Corridor reliability is assessed using the "Buffer Index" method, as described in the *MTC Freeway Performance Initiative Traffic Analysis: Performance and Analysis Framework* (April 2007). For this analysis, the buffer index was calculated for the eastbound and westbound directions of travel through the Study Area for the average weekday. The buffer index was only calculated where there was available PeMS data. The buffer index is defined as the extra time that travelers must add to their average travel time when planning trips to ensure on-time arrival with a 95 percent confidence level. For example, a buffer index of 40 percent means that, for a trip that usually takes 20 minutes, a traveler should budget an additional 8 minutes to ensure on-time arrival most of the time due to recurrent and non-recurrent congestion caused by factors such as seasonal traffic volumes, incidents, accidents, and weather.

As shown in Exhibit 3.6, the buffer index for SR 4 eastbound from I-680 to Bailey Road during the afternoon peak hour is approximately 0.15 corresponding to a buffer time equal to 15 percent of the average commute time to ensure on-time arrival. As shown in Exhibit 3.7, the buffer index for SR 4 westbound from Bailey Road to I-680 during the morning peak hour is approximately 0.4 corresponding to a buffer time equal to 40 percent of the average commute time to ensure on-time arrival. This buffer index of 0.4 is higher (trip is less reliable) than the buffer index for the eastbound direction during the afternoon peak hour, which is 0.15. The higher buffer index in the westbound direction corresponds with the higher recurrent delay also experienced in this direction.

Exhibit 3.6: SR 4 Corridor Travel Time and Buffer Index – Eastbound – I-680 to Bailey Road (MP 12.56 to 19.9)

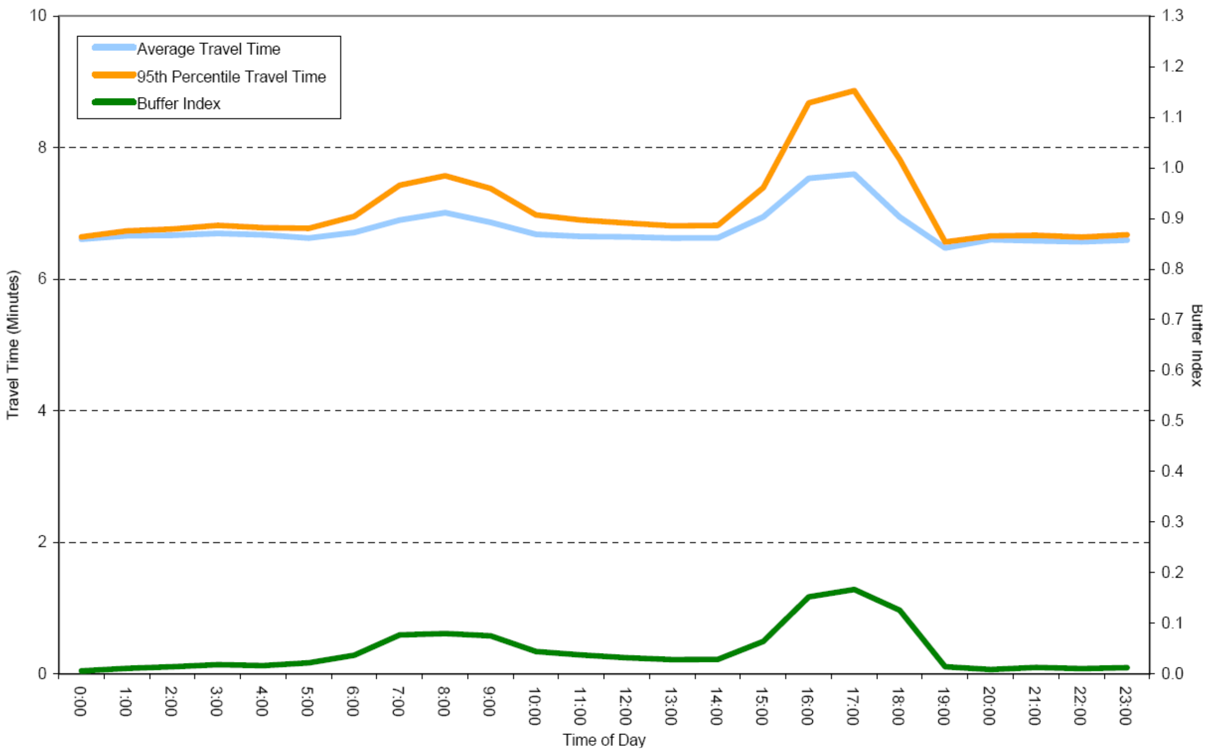


Exhibit 3.7: SR 4 Corridor Travel Time and Buffer Index – Westbound – Bailey Road to I-680 (MP 19.54 to 12.58)

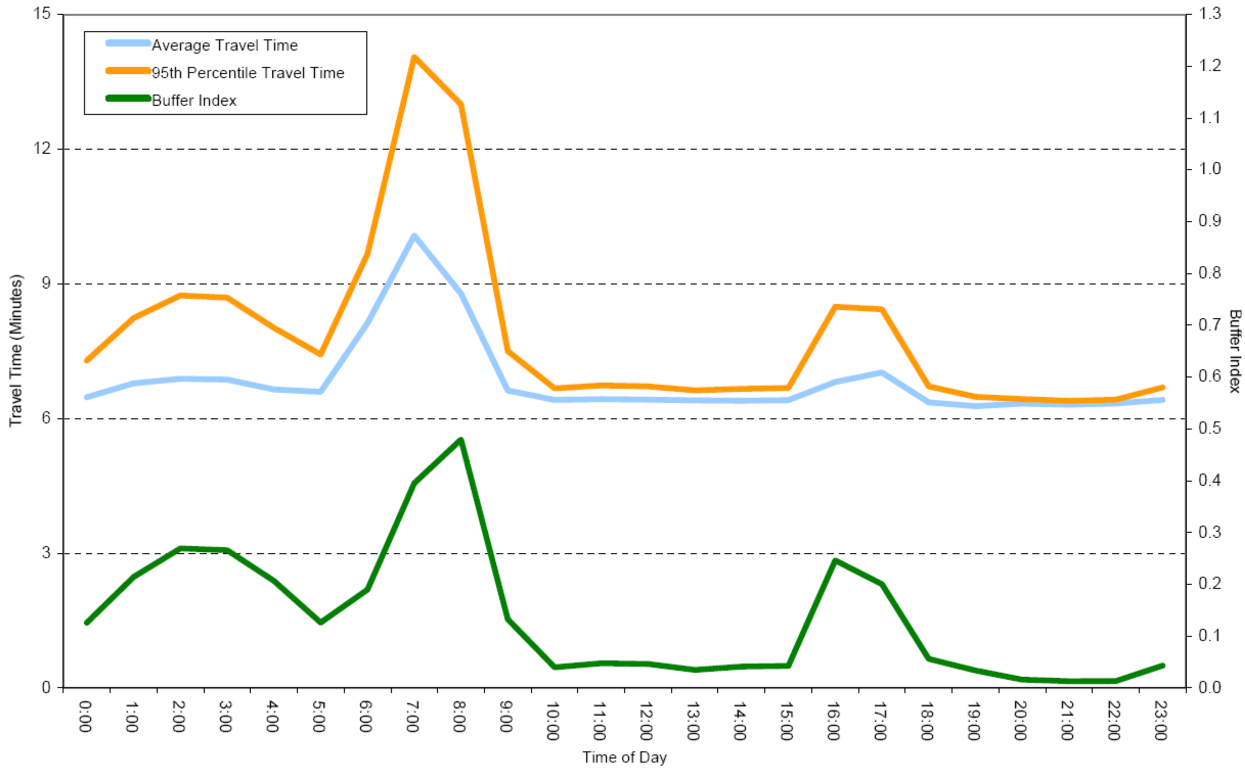


Exhibit 3.8 summarizes the average time it takes to travel the central segment of the corridor from I-680 (PM 12.56) to Bailey Road (PM 19.90), a distance of approximately 7.34 miles. This exhibit also shows the travel time under 95th percentile conditions, which is equal to the average travel time plus buffer time to ensure on-time arrival with 95 percent confidence, and the travel time under free flow conditions. For instance, on a weekday traveling westbound, the 7.34-mile trip from I-680 to Bailey Road would take 10 minutes under average peak hour conditions with an average travel speed of 44 mph. To ensure with 95 percent confidence an on-time arrival for the same trip, a motorist would need to allow 14 minutes with an average speed of 31 mph.[24]

Exhibit 3.8: Travel Time Variability for the SR 4 Corridor

Section	Direction	Corridor Travel Times		
		Free Flow Conditions	Average Conditions	95th Percentile Conditions
Between I-680 and Bailey Rd (PM 12.56 to 19.90)	Eastbound (PM Peak Hour)	7 min	8 min	9 min
	Westbound (AM Peak Hour)	7 min	10 min	14 min

24 Note that travel time was only calculated were there was available PeMS data.

Safety

To potential safety concerns along the SR 4 Corridor, accident data was reviewed along segments of the corridor to identify any trends in accident rates. Accident data from September 1, 2004 to August 31, 2007 was evaluated for ten different segments of the SR 4 Corridor in both directions and is summarized in Exhibit 3.9. There were a total of 2,846 accidents reported along the SR 4 Corridor during this three-year period.[25] Of the 2,846 accidents, 896 were reported as injury accidents and 23 were reported as fatalities. Based on this data, there is an average of 2.6 accidents per day along the SR 4 Corridor.

Exhibit 3.9: Accident Summary – September 2004 through August 2007

SR 4 Segments			Direction	Segment Length (miles)	Number of Accidents				Million Vehicle-Miles Traveled (MVM)
					Severity			Total	
					Fatality	Injury	Property Damage Only (PDO)		
I-80	to	Christie Rd	EB & WB	3.45	1	32	66	99	149.09
Christie Rd	to	Cummings Skyway	EB & WB	1.24	0	10	29	39	56.14
Cummings Skyway	to	Alhambra Ave	EB & WB	4.08	2	39	70	111	213.8
Alhambra Ave	to	I-680	EB & WB	3.53	2	78	167	247	298.92
I-680	to	SR 242	EB & WB	1.74	0	40	89	129	162.68
SR 242	to	Willow Pass Rd	EB & WB	4.38	3	179	339	521	686.65
Willow Pass Rd	to	Bailey Rd	EB & WB	1.35	1	63	109	173	212.42
Bailey Rd	to	Railroad Ave	EB & WB	2.93	6	144	340	490	400.63
Railroad Ave	to	Lone Tree Way	EB & WB	4.74	6	241	621	868	566.15
Lone Tree Way	to	SR 160	EB & WB	3.35	2	70	97	169	200.18
Estimated Total on SR 4 Corridor					**23**	**896**	**1,927**	**2,846**	**2,946.66**

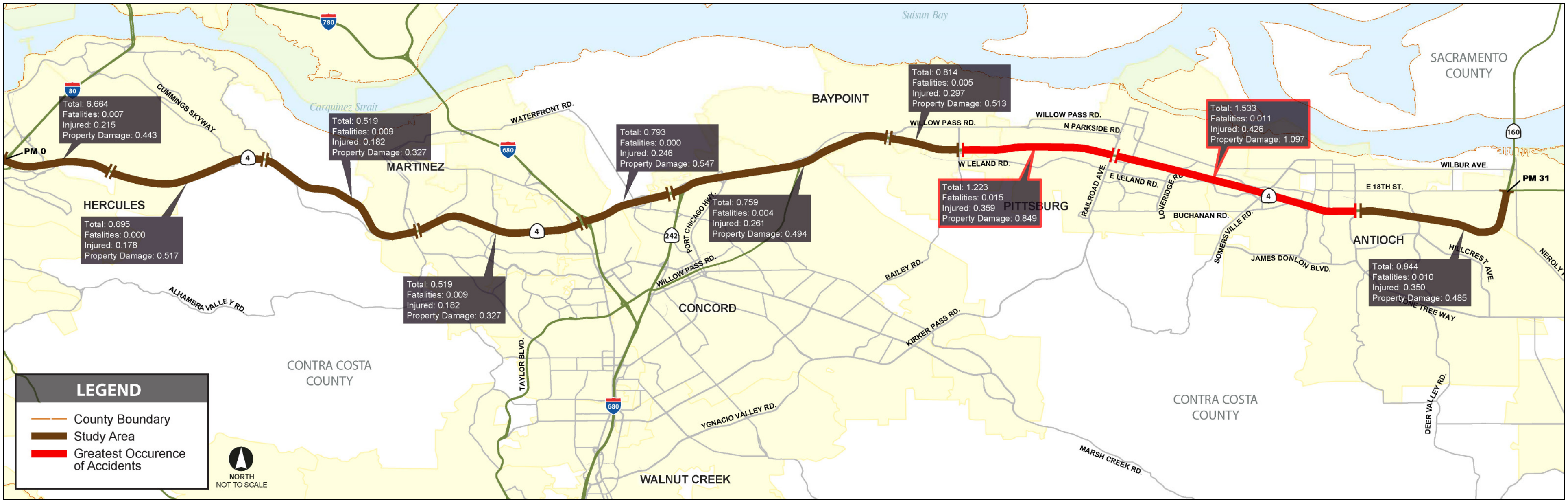
Exhibits 3.10 and 3.11 display accident rates for the ten segments analyzed. Of all the segments analyzed, the 2.93-mile segment between Bailey Road and Railroad Avenue and the 4.74-mile segment between Railroad Avenue and Lone Tree Way have significantly higher overall accident rates than the other SR 4 segments. The accidents within these segments are primarily in the eastbound direction occurring in daylight, clear, and dry conditions. Within these segments in the eastbound direction there are subsequent lane drops from three mixed-flow lanes and one HOV lane to three mixed-flow lanes, and then from three mixed-flow lanes to two mixed-flow lanes. These lane drops could contribute to higher accident rates for these two segments. Also, within these segments, a higher percentage of accidents occurred within roadway construction or maintenance zones, which is not surprising considering that the analysis period overlaps with the construction of the SR 4 East Widening Project. Additionally, these segments had the highest percentage of rear-end collisions.[26]

Exhibit 3.10: Accident Rates – September 2004 through August 2007

SR 4 Segments			Direction	Segment Length (miles)	Accident Rates[1]				Million Vehicle-Miles Traveled (MVM)
					Severity			Total	
					Fatality	Injury	Property Damage Only (PDO)		
I-80	to	Christie Rd	EB & WB	3.45	0.007	0.215	0.443	0.664	149.09
Christie Rd	to	Cummings Skyway	EB & WB	1.24	0.000	0.178	0.517	0.695	56.14
Cummings Skyway	to	Alhambra Ave	EB & WB	4.08	0.009	0.182	0.327	0.519	213.8
Alhambra Ave	to	I-680	EB & WB	3.53	0.007	0.261	0.559	0.826	298.92
I-680	to	SR 242	EB & WB	1.74	0.000	0.246	0.547	0.793	162.68
SR 242	to	Willow Pass Rd	EB & WB	4.38	0.004	0.261	0.494	0.759	686.65
Willow Pass Rd	to	Bailey Rd	EB & WB	1.35	0.005	0.297	0.513	0.814	212.42
Bailey Rd	to	Railroad Ave	EB & WB	2.93	0.015	0.359	0.849	1.223	400.63
Railroad Ave	to	Lone Tree Way	EB & WB	4.74	0.011	0.426	1.097	1.533	566.15
Lone Tree Way	to	SR 160	EB & WB	3.35	0.010	0.350	0.485	0.844	200.18
Estimated Total on SR 4 Corridor					**0.008**	**0.304**	**0.654**	**0.966**	**2,946.66**
[1] Accident Rates are expressed as the number of accidents per million vehicle miles traveled.									

25 Based on TASAS data provided by Caltrans.
26 SR 4 TSAR Report, 9/1/04 – 8/31/07, Caltrans.

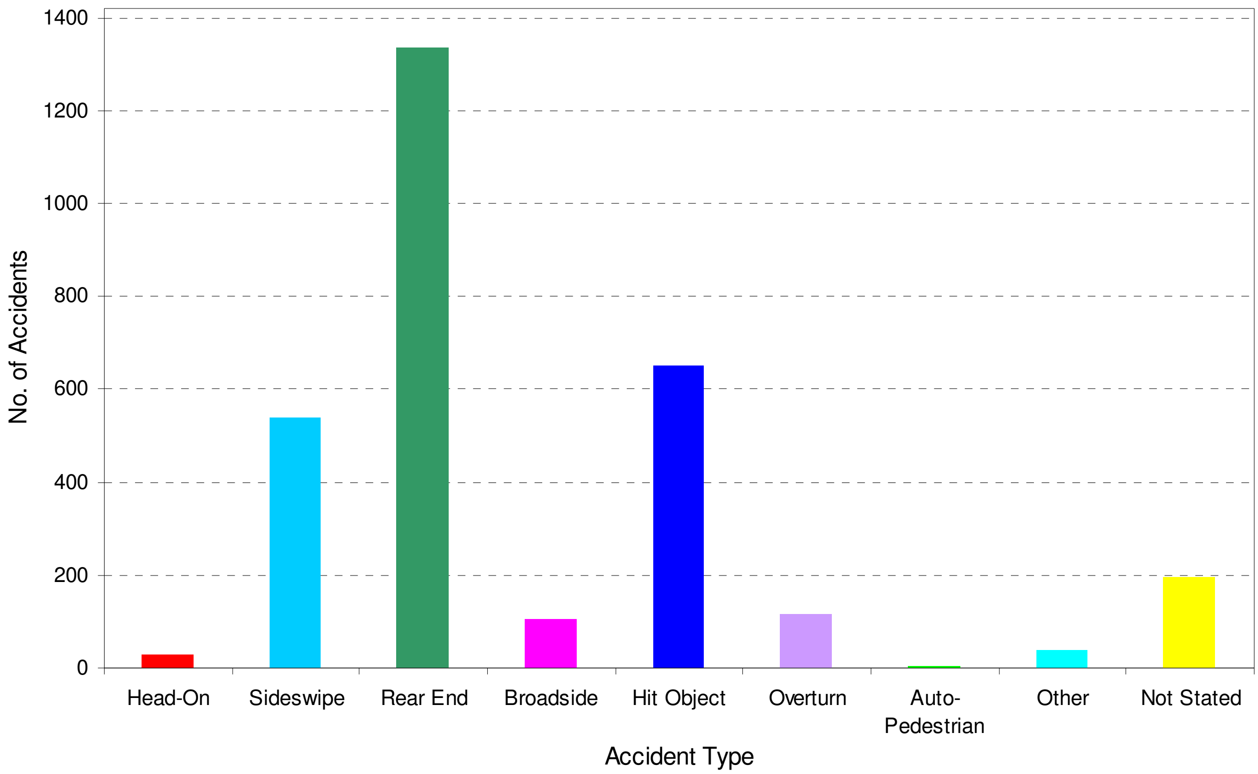
Exhibit 3.11: Accident Rates – September 2004 through August 2007



Note: Accident Rates are expressed as the number of accidents per million vehicle miles traveled.

Accidents on SR 4 by accident type are depicted in Exhibit 3.12. Rear-end collisions account for 44 percent of all accidents in the SR 4 Corridor over the three-year evaluation period. Other typical accident types include collisions with objects on or alongside the roadway, at 22 percent, and sideswipe collisions, at 18 percent.

Exhibit 3.12: Type of Accidents – September 2004 through August 2007



Accidents on SR 4 in Contra Costa County by seasonal variation (month of year), daily variation (day of week), and hourly variation (time of day) are shown in Exhibits 3.13, 3.14, and 3.15 respectively, where it can be seen that the pattern of accidents closely correlates to the pattern of traffic volumes along the corridor (see Exhibits 2.2, 2.3, and 2.4). In other words, more accidents occur during the time periods when the traffic flows are peaking. Overall, approximately 46 percent of accidents in the SR 4 Corridor over the three-year evaluation period occurred during the morning peak period (6:00 AM to 9:00 AM) and the afternoon peak period (3:00 PM to 6:00 PM), which suggests that high traffic volumes are a major contributing factor to accidents.

Exhibit 3.13: Seasonal Variation of Accidents – September 2004 through August 2007

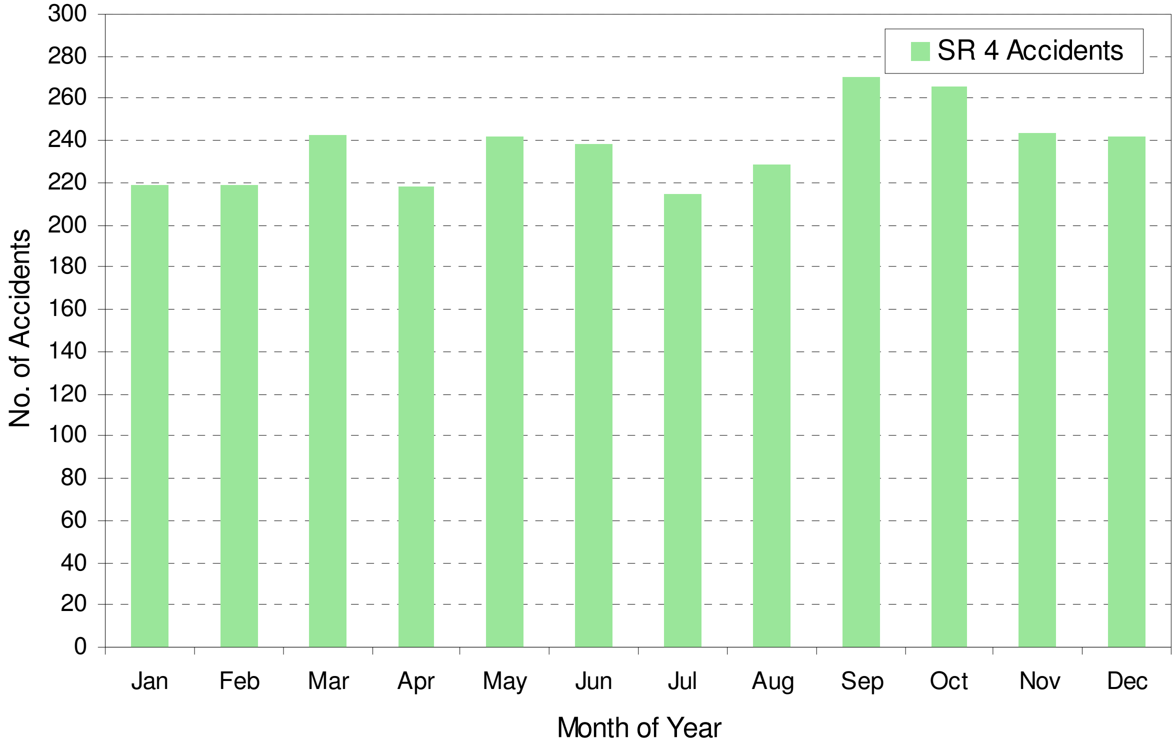


Exhibit 3.14: Daily Variation of Accidents – September 2004 through August 2007

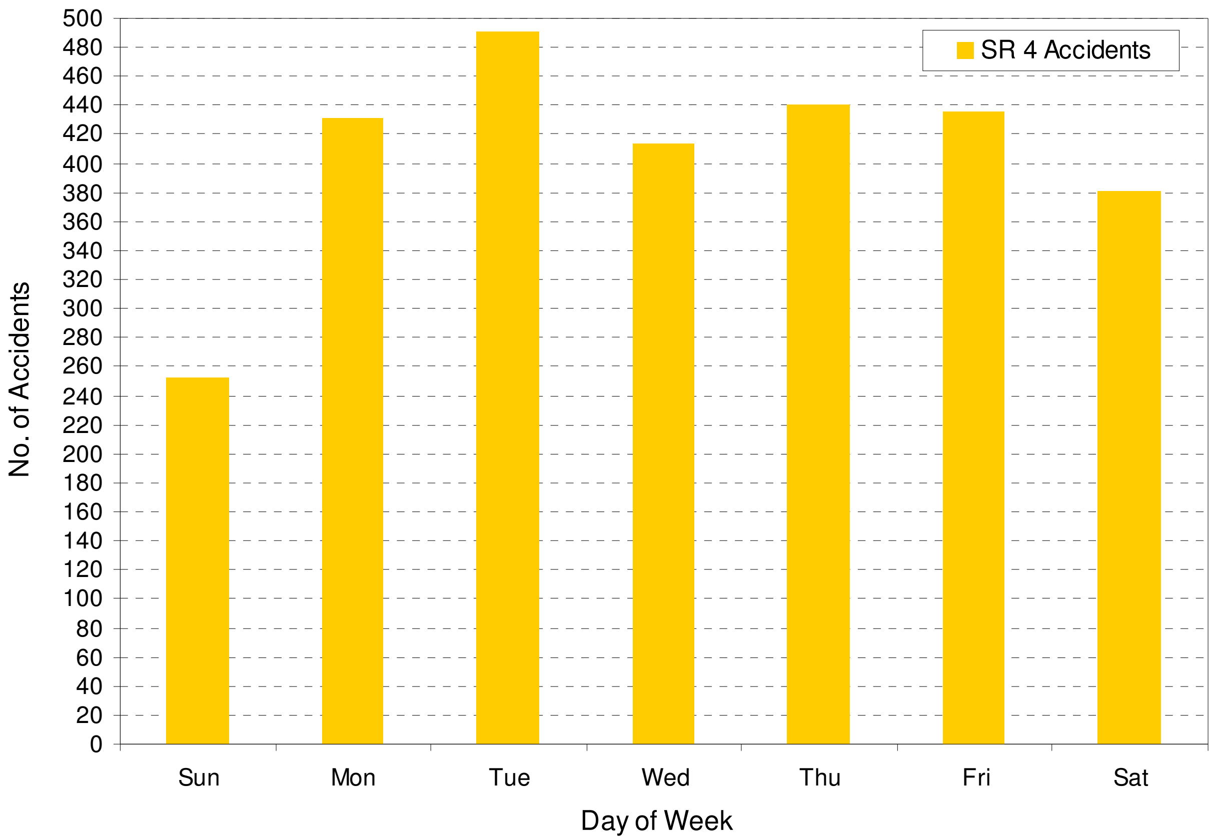
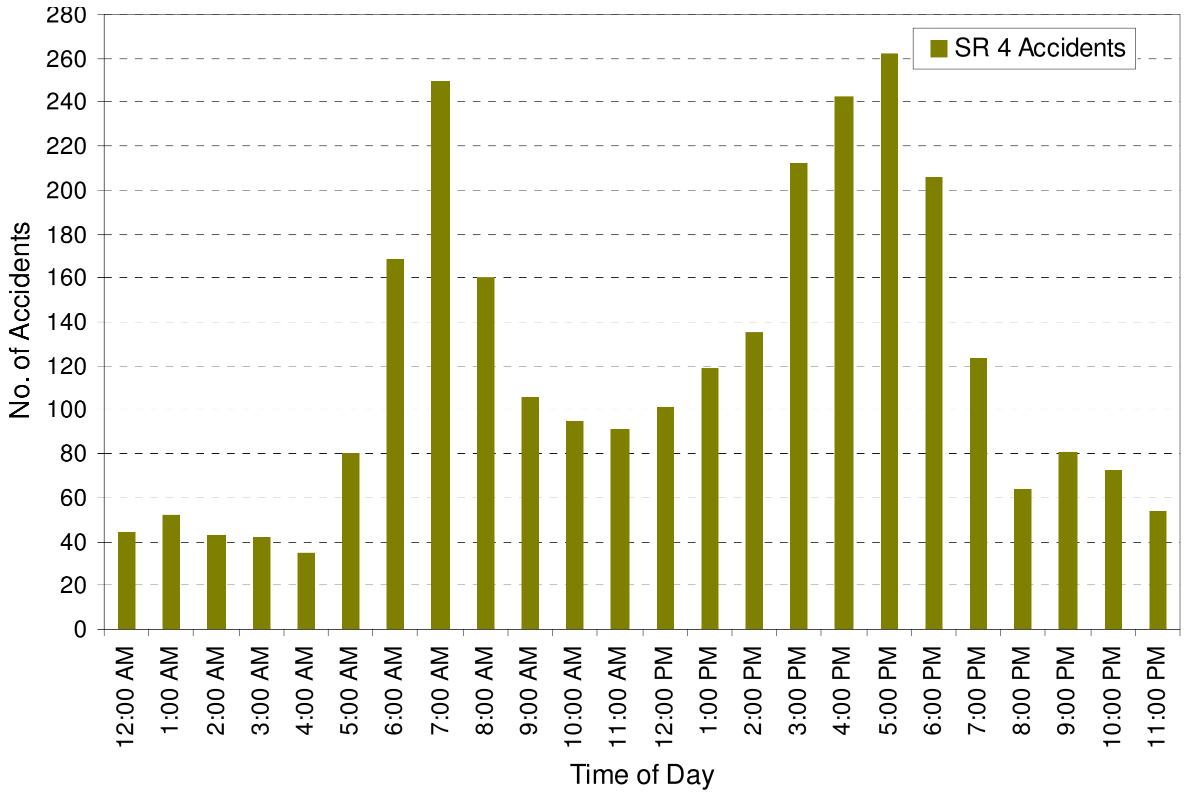


Exhibit 3.15: Hourly Variation of Accidents – September 2004 through August 2007



In summary, accidents along the SR 4 Corridor:

- occur most frequently during peak commute periods, which are periods of higher congestion;
- are primarily rear-end collisions, which typically correlates with higher congestion; and
- are most frequent in the segment between Bailey Road and Lone Tree Way, which is also the segment with the greatest percentage of accidents occurring in construction and maintenance zones.

Appendices

Appendix A: ITS Network Description

ITS Deployment along SR 4					
County	Rte.	PM_{ACT}	Dir.	Approximate Location	Operational Status as of October 2008
Closed Circuit Television Cameras					
CC	4	8.55	E	Alhambra Ave	Incomplete
CC	4	10.8	E	Glacier Ave	Incomplete
CC	4	12	E	Just W of Pacheco Blvd	Incomplete
CC	4	16.9	E	Just E of Willow Pass Rd	Incomplete
CC	4	24.32	E	Loveridge Rd	Incomplete
CC	4	25.32	E	Just E of Loveridge Rd	Incomplete
CC	4	31.1	E	SR 160 N Junction	Incomplete
CC	4	31.78	E	Laurel Rd	Incomplete
CC	4	32.76	E	Oakley Rd	Incomplete
CC	4	13.78	W	Solano Way	Fully Operational
CC	4	14.4	W	SR 242 S	Fully Operational
CC	4	14.9	W	SR 242 Junction	Fully Operational
CC	4	23	W	Just W of Railroad Ave	Incomplete
CC	4	28.6	W	West of Hillcrest Ave	Incomplete
CC	4	31.2	W	E of SR 160 N Junction	Incomplete
CC	4	32.5	W	W of Lone Tree Way	Incomplete
CC	4	33.06	W	Lone Tree Way	Incomplete
Changeable Message Signs					
CC	4	10.8	E	Glacier Ave	Incomplete
CC	4	25.32	E	E of Loveridge Rd.	Fully Operational
CC	4	25.3	W	1 mi. E of Loveridge Rd	Fully Operational
Highway Advisory Radios					
CC	4	12.67	E	I-680 interchange	Incomplete
CC	4	24.32	E	Loveridge Rd.	Incomplete
CC	4	31.11	E	SR 160 I/C	Incomplete
Extinguishable Message Signs					
CC	4	1.1	E	Bayberry Ave	Incomplete
CC	4	8.4	E	W of Alhambra Ave	Incomplete
CC	4	17.7	E	E of Willow Pass Rd	Incomplete
CC	4	22.44	E	E of Mariner Ct	Incomplete
CC	4	28.6	E	W of Hillcrest Ave	Incomplete
CC	4	31.4	E	E of SR 160 N Junction	Incomplete
CC	4	10.81	W	Glacier Ave	Incomplete
CC	4	16.77	W	Willow Pass Rd	Incomplete
CC	4	23	W	W of Railroad Ave	Incomplete
CC	4	32.5	W	Oakley Rd	Incomplete
CC	4	32.76	W	Oakley Rd	Incomplete
Traffic Monitoring Stations					
CC	4	0.35	E	EB80 & Hercules to EB4, MVDS (2)	Fully Operational
CC	4	8.5	E	W. of Alhambra ave	Incomplete
CC	4	11.12	E	W of Melano Way	Incomplete
CC	4	12.74	E	Pacheco Blvd.off ramp	Fully Operational
CC	4	12.77	E	NB 680 to EB 4 (diag)	Incomplete
CC	4	15.75	E	N of port Chicago Hwy. Beside call box 156. Rm-EB-collector	Incomplete
CC	4	17.12	E	Willow Pass Road rm-e-diag (inactive)	Incomplete

ITS Deployment along SR 4					
CC	4	17.49	E	3500'E of Willow pass rd(CB176)	Fully Operational
CC	4	17.85	E	5400' EAST OF WILLOW PASS RD near CB 18.2	Fully Operational
CC	4	18.73	E	Willow Pass Rd rm-e-loop (Bay Point)	Incomplete
CC	4	18.96	E	Willow Pass Rd rm-e-dia (Bay Point)	Incomplete
CC	4	19.39	E	1/2 mile west of Bailey Rd Exit	Fully Operational
CC	4	19.7	E	Before Bailey Rd. exit	Fully Operational
CC	4	20.06	E	Bailey Rd. rm-e-diag	Incomplete
CC	4	22.33	E	West of Railroad Ave	Fully Operational
CC	4	22.74	E	Railroad Ave: rm-e-diag	Incomplete
CC	4	24.32	E	Loveridge Rd on ramp	Fully Operational
CC	4	25.1	E	E of Century Blvd.	Fully Operational
CC	4	26	E	SB side CC 4 at Somersville Rd MVDS pole (1)	Fully Operational
CC	4	30.51	E	Hwy 160 & EB 4 Divide	Fully Operational
CC	4	31.11	E	E of Hwy160 overpass	Fully Operational
CC	4	31.54	E	1/4 miles W of Laurel Rd.	Fully Operational
CC	4	32.03	E	Laurel Rd. rm-e-lp	Fully Operational
CC	4	32.27	E	Laurel Rd. rm-e-diag	Fully Operational
CC	4	32.73	E	W of Lone Tree Way	Fully Operational
CC	4	0.7	W	Willow Ave on ramp rm-w-diag (MVDS 2)	Incomplete
CC	4	12.57	W	SB 680 to WB 4 (Diag)	Incomplete
CC	4	12.76	W	NB 680 to WB 4 (lp)	Fully Operational
CC	4	13.78	W	Arnold Industrial Pl rm-e-diag	Incomplete
CC	4	14.49	W	In front of Memory Lane Cem	Fully Operational
CC	4	14.49	W	In front of Memory Lane Cem	Fully Operational
CC	4	14.9	W	Between WB 4 & SB 242 split	Incomplete
CC	4	15.47	W	On ramp @ Port Chicago	Fully Operational
CC	4	16.77	W	Willow Pass Road / Evora rm-w-diagonal (inactive)	Incomplete
CC	4	18.81	W	Willow Pass Rd rm-w-loop (Bay Point) (inactive)	Incomplete
CC	4	18.85	W	Willow Pass Rd rm-w-dia (Bay Point) (inactive)	Incomplete
CC	4	23.02	W	1500' East of Railroad Ave	Fully Operational
CC	4	26.94	W	A Street / Lonetree Way MVDS pole (1)	Fully Operational
CC	4	28.4	W	W of Winsor Dr.	Incomplete
CC	4	30.77	W	Hwy 160 & WB 4 (main line)	Fully Operational
CC	4	30.93	W	Hwy 160 to WB 4 rm-w-diag	Fully Operational
CC	4	31.1	W	E of Oakley Rd.	Fully Operational
CC	4	32.04	W	Laurel Rd. rm-w-diag	Fully Operational
CC	4	33.32	W	Lone tree way rm-w-diag	Fully Operational
CC	4	33.68	W	Jeffery way rm-w-diag	Fully Operational

Existing ITS Deployment in the SR 4 Corridor – Not Fully Operational as of October 2008

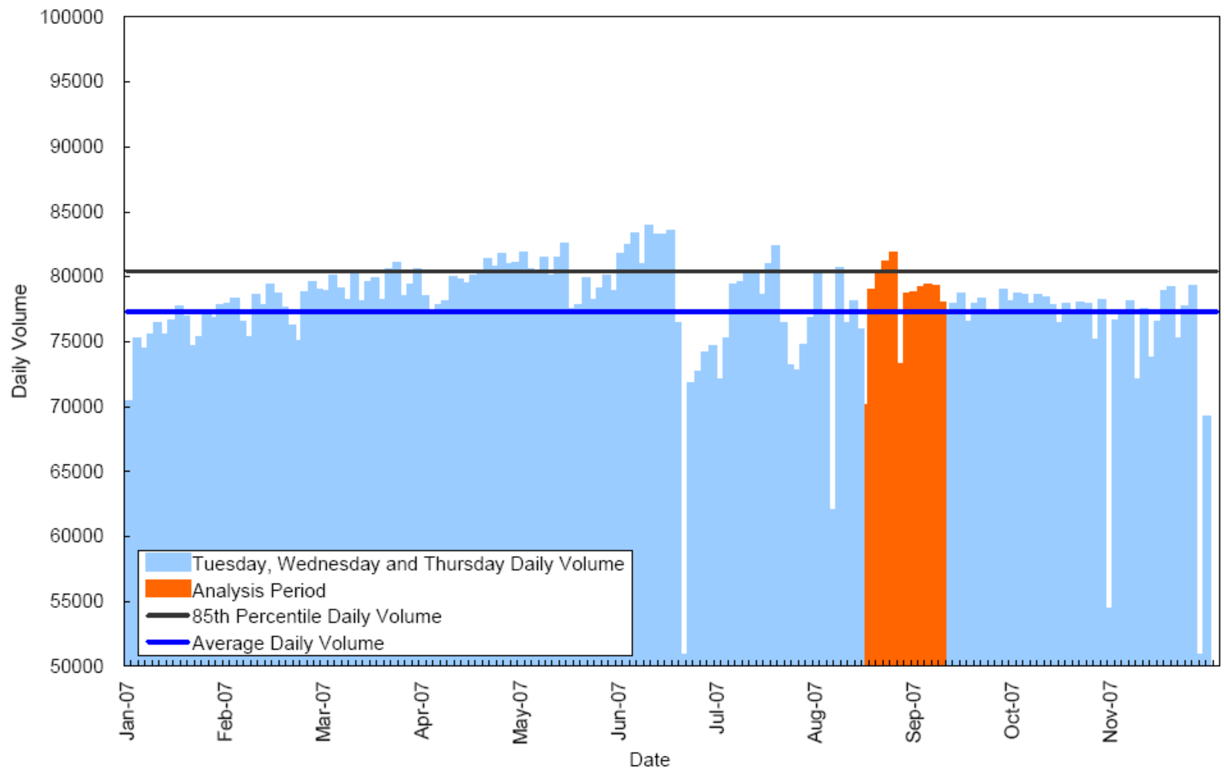
ITS Component Summary

ITS Component	# Not Fully Operational[1]
Changeable Message Signs	0
Closed Circuit TV Cameras	3
Extinguishable Message Signs	1
Highway Advisory Radio	1
Traffic Monitoring Stations	11

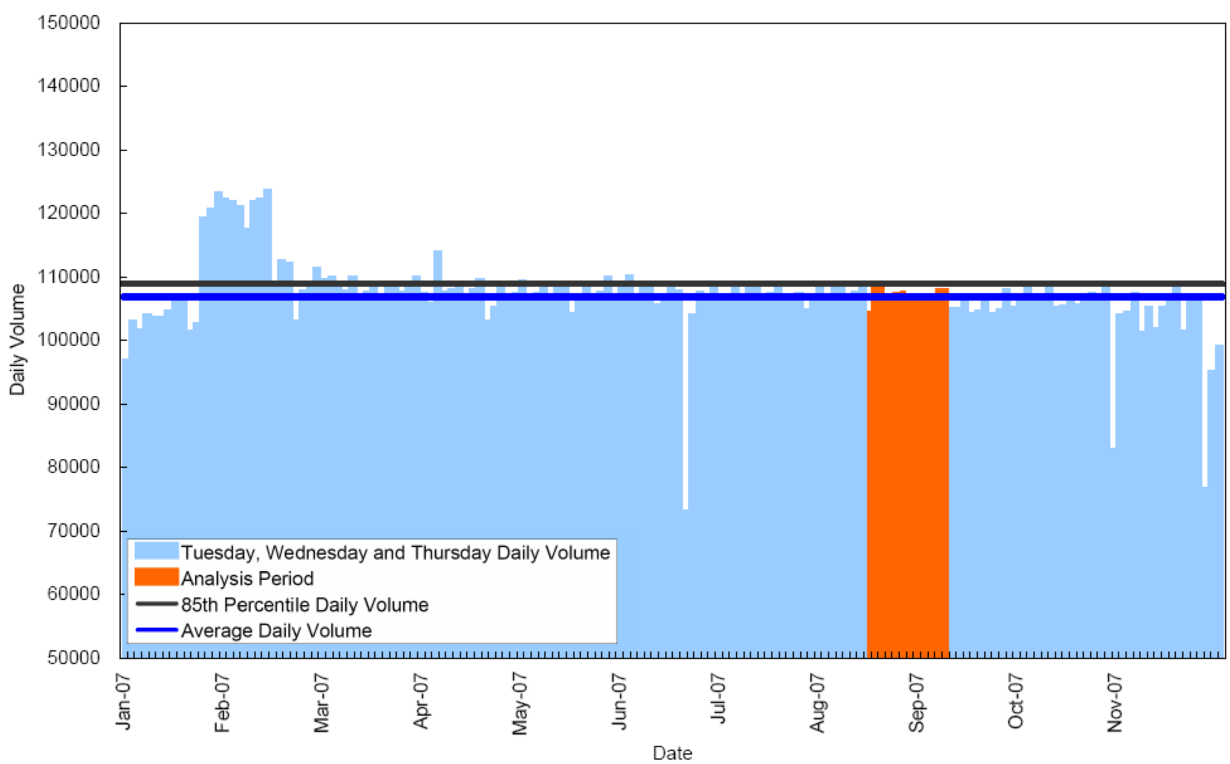
[1] ITS Components that are not fully operable include components under construction, without power, damaged, or without communication to the Traffic Monitoring Center (TMC).

Appendix B: Seasonal Variations of Weekday Daily Two-Way Traffic Volumes on SR 4

Seasonal Variations in Weekday Traffic Volumes (Solano Way)

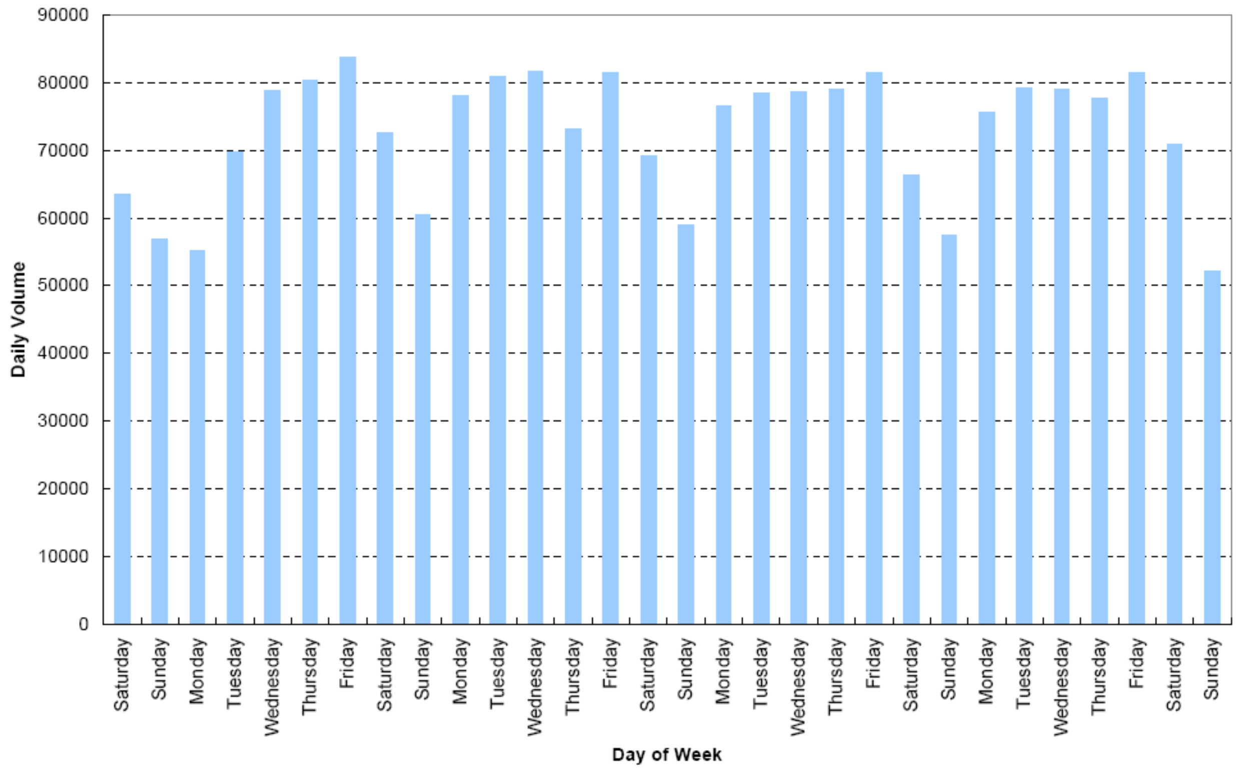


Seasonal Variations in Weekday Traffic Volumes (Bailey Road)

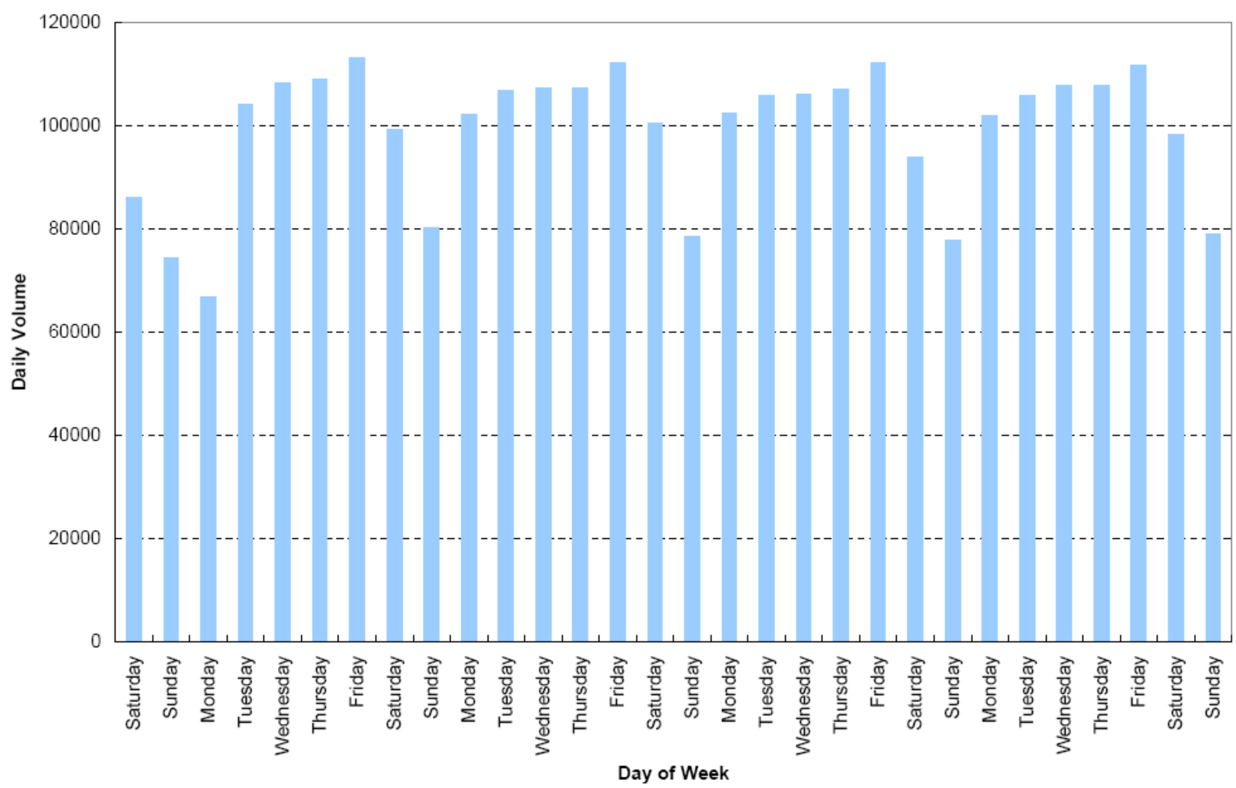


Appendix C: Daily Traffic Variations

Daily Variations in Traffic Volumes (Solano Way) September 1, 2007 – September 30, 2007

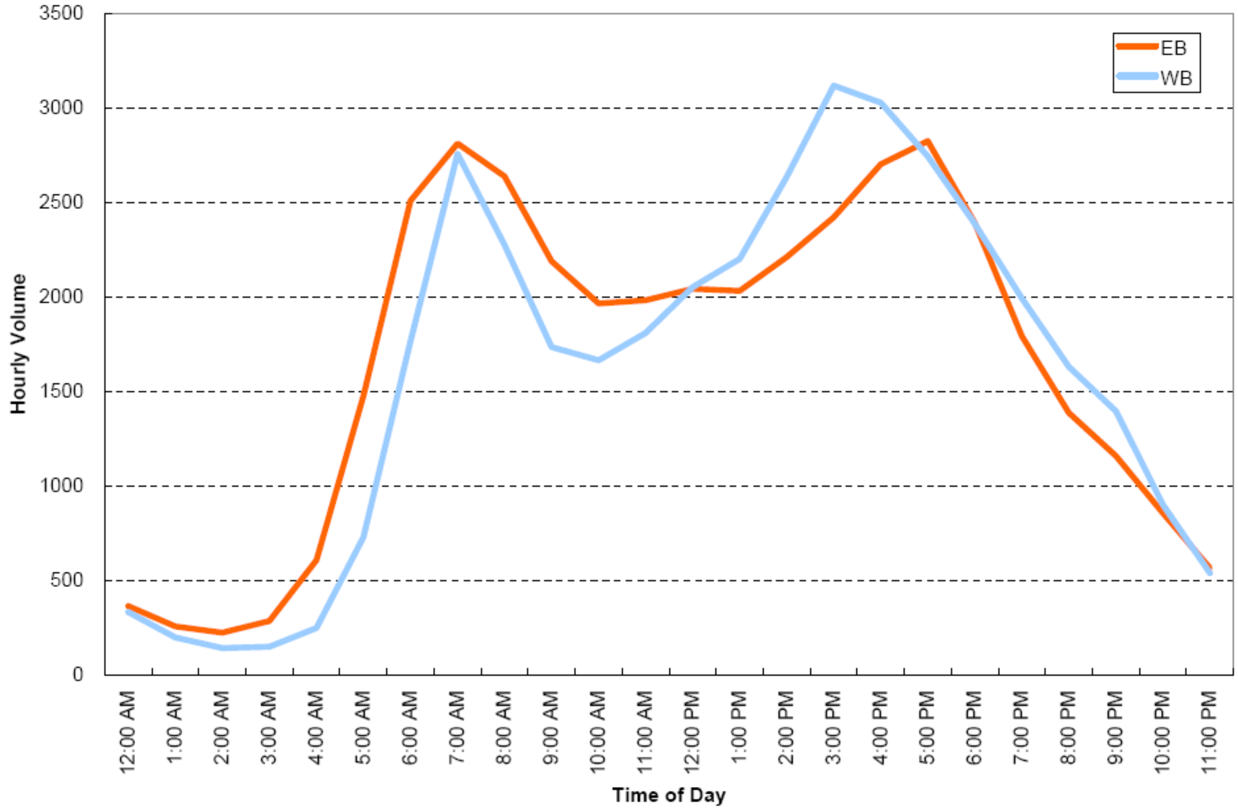


Daily Variations in Traffic Volumes (Bailey Road) September 1, 2007 – September 30, 2007

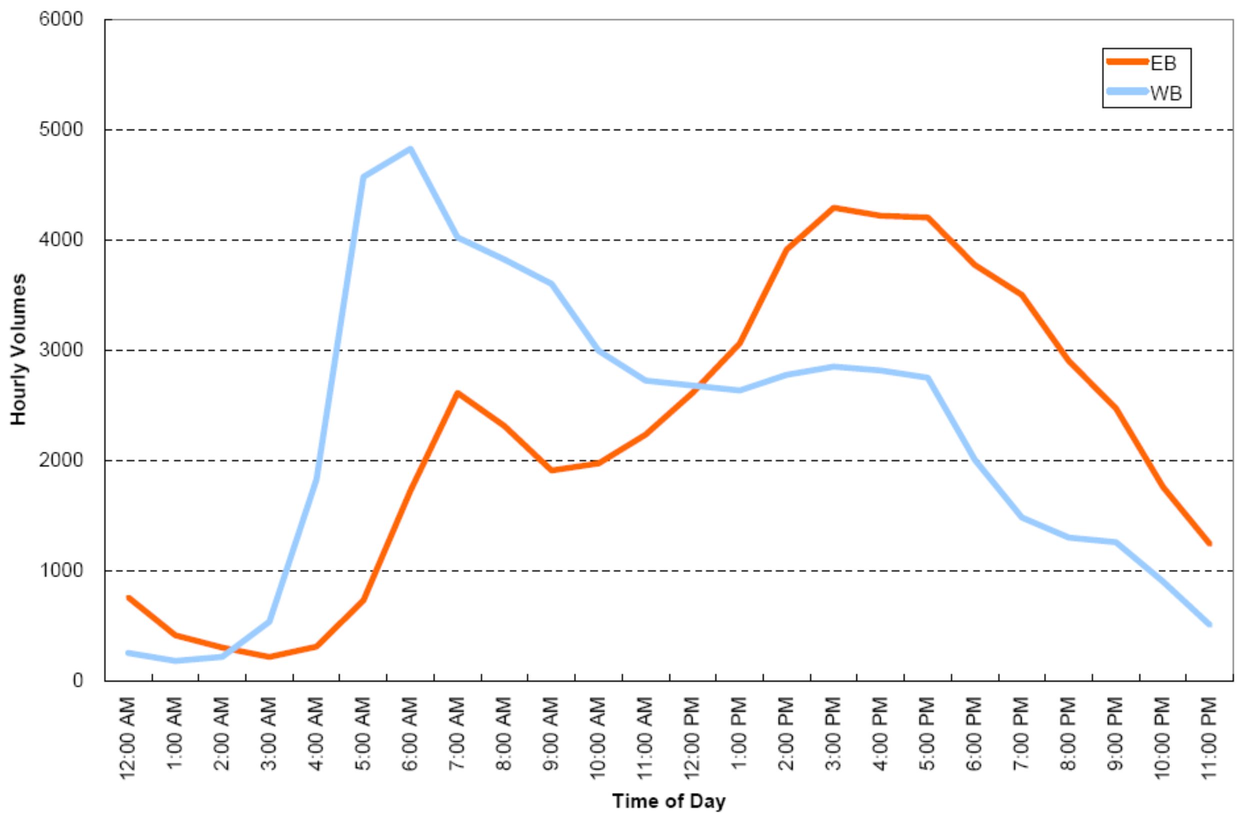


Appendix D: Hourly Variations in Traffic Volumes

Weekday Hourly Traffic Volumes (Solano Way) September 1, 2007 – September 30, 2007

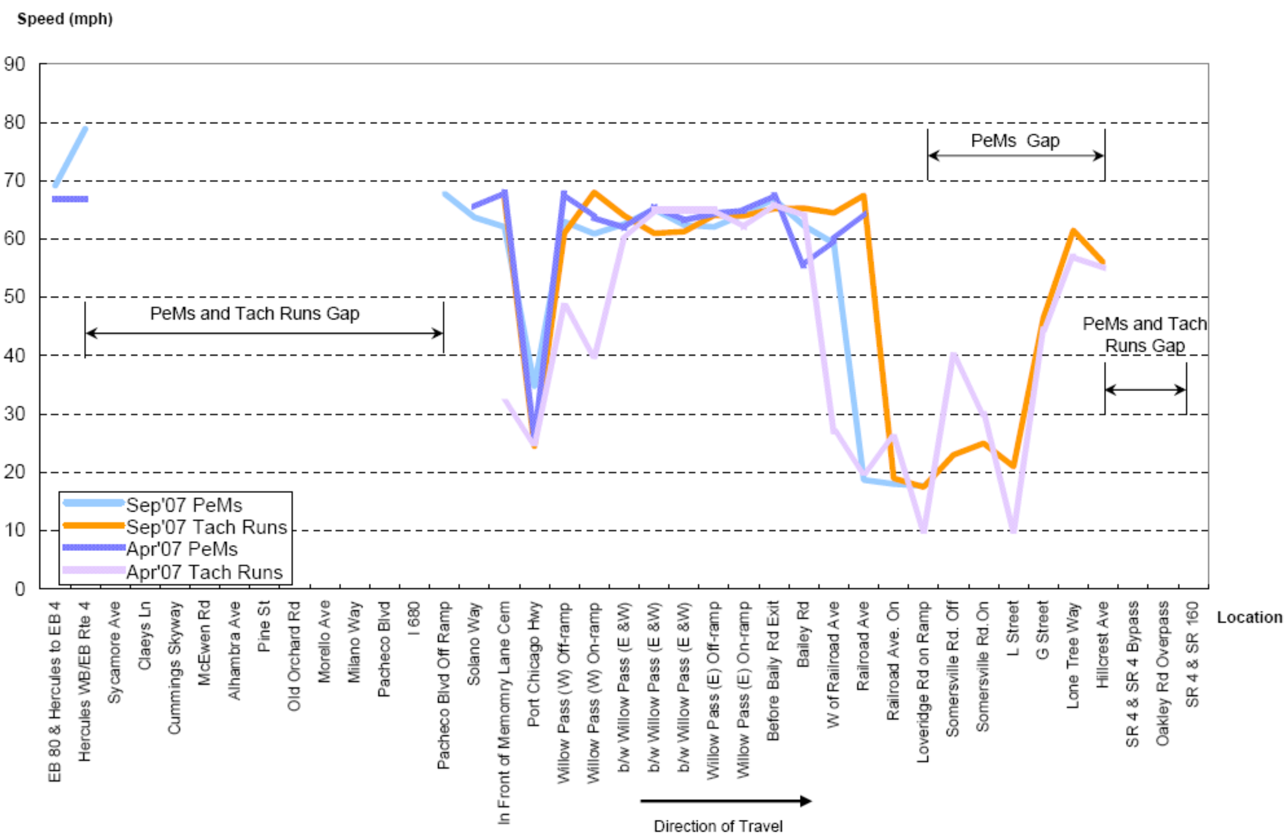


Weekday Hourly Traffic Volumes (Bailey Road) September 1, 2007 – September 30, 2007



Appendix E: SR 4 Comparative Travel Speeds from Various Data Sources

Comparative Travel Speeds from Various Data Sources – SR 4 Eastbound – PM Peak Hour (5:30 PM – 6:30 PM)



State Route 4

Section 4: Future Performance Assessment

The following technical memorandum presents the future conditions analysis for the State Route 4 (SR-4) Corridor in Contra Costa County from the I-80 Interchange to the SR-160 Interchange. The primary objectives of the future conditions analysis are to provide a forecast of future conditions in the SR-4 Corridor and to identify the locations and causes of future congestion.

Attached Document

- **SR-4 Corridor in Contra Costa County**
  Future Conditions Technical Memorandum (FCT)
  Final Draft - July 17, 2009
  Prepared by PBS&J under FPI contract with Metropolitan Transportation Commission

Metropolitan Transportation Commission

SR 4 Corridor in Contra Costa County

Future Conditions Technical Memorandum (FCT)

Prepared by: PBS&J
For: Metropolitan Transportation Commission
Final Draft
July 17, 2009

Table of Contents

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Introduction

The following technical memorandum presents the future conditions analysis for the State Route 4 (SR 4) Corridor in Contra Costa County from the I-80 Interchange to the SR 160 Interchange. The methods and performance measures used for the future conditions analysis are based on those set forth in the *Metropolitan Transportation Commission (MTC) Freeway Performance Initiative (FPI)/Corridor System Management Plan (CSMP) Contra Costa SR 4 Corridor and Alameda/Contra Costa 24 Draft Workplan, Schedule and Budget (September 2008)* and the *Freeway Performance Initiative Traffic Analysis: Performance and Analysis Framework* (April 2007). Consistent with the guidance provided by these documents, the primary objectives of the future conditions analysis are to provide a forecast of future conditions in the SR 4 Corridor and to identify the locations and causes of future congestion. Corresponding to these objectives, the future conditions technical memorandum is presented in three sections:

- **Section 1: Key Findings:** An executive summary of the findings in this analysis.
- **Section 2: Description of Future Conditions in the SR 4 Corridor:** A description of the physical improvements to the SR 4 Corridor that were assumed in this analysis, the selection and calibration of the analysis tools used to conduct the performance analysis and the development of future year traffic forecasts for the 2015 and 2030 study years.
- **Section 3: Future Conditions Performance Analysis:** A projection and evaluation of future conditions along the SR 4 Corridor including discussions of the methodology used, the analysis results, identification of the congested locations and causes of congestion along the corridor.

Section 1: Key Findings

The findings in this report are based on forecasts of travel demand in the SR 4 Corridor and committed improvements that are assumed to be in-place, including (1) the SR 4 East Widening Project (Loveridge Road to SR 160) and (2) the SR 4 Bypass Project. In the near term, this substantial package of corridor improvements will contribute significantly towards improved mobility and congestion mitigation in the corridor.

In the future, population and employment both in Contra Costa County and throughout the Bay Area, is expected to grow significantly and will contribute to increased travel demand on the corridor. In Contra Costa County alone, the population is expected to increase by 23% from about 1 million today to nearly 1.3 million in 2030. Projected employment in the County is expected to grow at an even more robust rate, increasing from nearly 380,000 jobs today to over 550,000 jobs in 2030 – a change of 46%. Accompanying this growth, there will be corresponding increases in traffic demand along the SR 4 Corridor. During the morning peak (westbound), the highest peak travel demands are expected between Port Chicago Highway and Willow Pass Road. At this location, peak traffic demand is projected to increase from 8,000 vph to 10,500 vph by 2030 – an increase of 31%, or the equivalent of more than 1 additional lane of traffic demand.

This increased demand will have a significant impact on travel and mobility in the corridor and, while both the morning and afternoon peak periods will be effected, congestion will be most prominent during the morning peak period in the westbound direction of travel on SR 4 east of I-680. Some of the metrics that characterize future travel on SR 4 are travel speeds, travel time, and cost incurred to motorists due to delay. Travel speeds are projected to decrease significantly from 28 mph in the morning peak today to 14 mph in 2030. Correspondingly, the time it takes to travel the 33-mile corridor from end to end is projected to increase from 1 hour and 7 minutes in 2007 to just over 2 hours in 2030. Total delay along SR 4 is estimated to cost motorists $165 million per year on SR 4.

While short-term and long-term conditions are discussed in detail in the sections that follow, there are several key findings and conclusions that can be drawn from the analysis of future conditions on SR 4. These are:

- Consistent with the existing conditions analysis presented previously, this future conditions analysis does not reveal any controlling bottlenecks on SR 4 between I-80 and I-680. For this reason mitigation strategies need not be considered for this west-most segment of SR 4. It should be noted that during the morning peak period, the ramp from eastbound SR 4 to southbound I-680 is often congested due to back-ups on southbound I-680. Likewise, congestion is also present on the ramp from westbound SR 4 to westbound I-80 due to back-ups on westbound I-80. While the congestion on these ramps does have an affect on SR 4 operations and will likely worsen in the future, addressing the congestion would involve addressing operations on I-680 and I-80, which is beyond the scope of this study.
- Two bottlenecks present in the existing conditions analysis (ECT), both westbound and eastbound between the Somersville Road and Loveridge Road interchanges (AM peak hour and PM peak hour, respectively) will be completely mitigated in 2015 and 2030 with completion of the SR 4 East Widening Project.
- In 2015, bottlenecks and congestion are projected east of the I-680 Interchange between I-680 and Willow Pass Road. Along this segment, demand exceeds capacity by about 1,000 vph. For this reason targeted HOV lane extensions west of the current limits to encourage HOV travel, and system management (including targeted ramp metering) could extend the operational capabilities of SR 4 in this area, effectively delaying the need for more significant investment in the corridor.
- By 2030, bottlenecks and congestion are still projected to be largely focused on the section of SR 4 between I-680 and Willow Pass Road, although unlike 2015, the demands are significantly higher than the capacity along this section of the freeway. In the long term, the HOV lanes along SR 4 begin to function primarily as a "queue jump" to bypass severe congestion in the mixed-flow lanes. Connecting the SR 4 HOV lanes directly to those on I-680 via dedicated ramp connections will provide for a continuous HOV alternative along the most heavily traveled sections of SR 4.

- An eastbound bottleneck consistently shows in the existing and future conditions between Route 242 and Port Chicago Highway, which results from the complicated weaving, lane drops, and HOV lane additions that occur on this section of SR 4. In the short term, geometric modifications that can mitigate this bottleneck location should be examined.
- Given the high levels of demand in 2030, strategies that enhance the efficiency of the system and provide alternatives to personal vehicle traffic on SR 4 will need to be explored and incorporated into the management plan for the corridor. The segment of the corridor east of I-680 simply does not have the available space to be expanded for the traffic demands that are forecasted in the long term.

Short Term Conditions in 2015

In 2015 for the westbound direction of travel in the morning peak period, the duration of the bottleneck and associated queuing that is present today between the Willow Pass Road and Port Chicago Highway interchanges in the vicinity of the westbound HOV lane drop (Location 2) is projected to continue and worsen. This location is a four-lane section (three mixed-flow lanes plus one HOV lane), which is projected to provide inadequate capacity to accommodate the demand. Additionally, HOVs exiting at SR 242 or entering at Willow Pass Road must cross the mixed-flow lanes, which will contribute to the congested conditions. The westbound bottleneck between the Willow Pass Road and Port Chicago Highway interchanges is projected to develop between 6 and 7 am and would last for about 5 hours, one hour more than existing conditions. The other westbound bottleneck that is present today between Somersville Road and Loveridge Road is not projected to be present in 2015 because of programmed freeway widening. A new westbound bottleneck is projected to develop by 2015 between the Solano Way and I-680 interchanges (Location 1) as a result of capacity issues on the two-lane segment approaching the I-680 Interchange. The bottleneck between the Solano Way and I-680 interchanges is projected to develop between 6 and 7 am and would last for about two hours.

For the eastbound direction in the afternoon peak period, the controlling bottleneck is projected to occur between Port Chicago Highway and Willow Pass Road (Location 3) and will worsen compared to current conditions. This segment is projected to provide inadequate capacity to accommodate the demand. The bottleneck that exists today and lasts for about two hours in that vicinity is projected to be embedded in the queue. This bottleneck is projected to begin at 3 pm and last for about 4.75 hours, which represents a significant increase in the duration of peak period congestion as compared with existing conditions. Between 3 and 5 pm, a separate bottleneck is projected to occur between I-680 and Solano Way, but it would be embedded in the queues that are projected to extend from Location 3 between 5 and 7 pm. The resulting peak-hour queue is projected to extend six miles west from Location 3 to Morello Avenue. The existing bottleneck between Loveridge Road and Somersville Road is projected to disappear by 2015 as a result of programmed freeway widening.

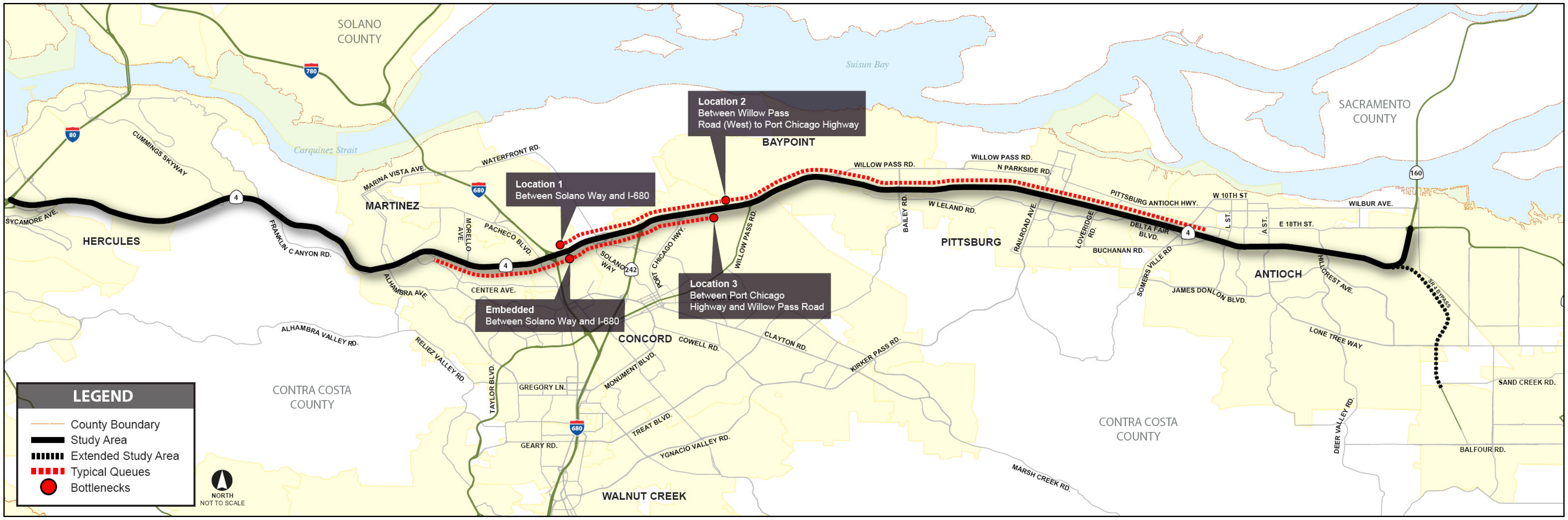
Additional information on the peak-hour condition of these bottlenecks is presented in Exhibit 1.1 and depicted graphically in Exhibit 1.2.

Exhibit 1.1: Locations and Causes of Congestion on SR 4 in 2015

Location	Bottleneck Description	Cause	Max. Queue Length (mi./Peak Period)	Avg. Speed (mph/Peak Period)	Total Delay (Veh·Hrs/ Peak Period)	Congestion Delay (Veh·Hrs/ Peak Period)
1	2015 Westbound, AM Peak Between Solano Way and Interstate 680	This bottleneck is projected to develop between the interchanges of Solano Way and I-680. The bottleneck is the two-lane mixed-flow section that is projected to provide inadequate capacity to accommodate the demand. Congestion is projected to extend about two miles and is projected to dissipate in the vicinity of Port Chicago Highway.	2.0	36	1,200	720
2	2015 Westbound, AM Peak Between Willow Pass Road and Port Chicago Hwy	This bottleneck is projected to develop at the same location as in the existing condition, between the Willow Pass Road and Port Chicago Highway interchanges. This location is a four-lane section (three mixed-flow lanes plus one HOV lane), which is projected to provide inadequate capacity to accommodate the demand. HOVs exiting at SR 242 or entering at Willow Pass Road must cross the mixed-flow lanes, which will contribute to the congested conditions. The existing queue in 2007 that extends approximately six miles east to between Loveridge Road and Railroad Avenue is projected to lengthen in 2015 to extend 10 miles to between L Street and Somersville Road.	10.0	23	7,900	6,300
3	2015 Eastbound, PM Peak Between Port Chicago Highway and Willow Pass Road	This controlling bottleneck is projected to develop between the Port Chicago Highway and Willow Pass Road interchanges at a four-lane roadway section consisting of three-mixed flow lanes and one HOV lane. This segment is projected to provide inadequate capacity to accommodate the demand. Queues caused by this bottleneck are projected to extend six miles west to Morello Avenue.	6.5	27	3,300	2,400

Note: For the purposes of this study, total delay is defined as the recurrent delay due to congestion for vehicles traveling at speeds of 60 mph or less. Congestion delay is defined as the recurrent delay due to congestion for vehicles traveling at speeds of 35 mph or less.

Exhibit 1.2: Locations of Recurrent Congestion on SR 4 in 2015



Long Term Conditions in 2030

For the westbound direction of travel in the morning peak period, the bottlenecks that are projected to occur in the 2015 analysis will continue to worsen. The controlling bottleneck in 2030 is projected at previously identified Location 1 – between Solano Way and Interstate 680. The Location 1 bottleneck is projected to develop in the two-lane, mixed-flow section that would not provide adequate capacity to accommodate the demand and would last for more than 5 hours. The Location 2 bottleneck, between Willow Pass Road and Port Chicago Highway, is previously identified in 2015 conditions and is projected to develop along a four-lane section (three mixed-flow lanes plus one HOV lane), that would not provide adequate capacity to accommodate the demand and would last for more than 5 hours in 2030. HOVs exiting at SR 242 or entering at Willow Pass Road must cross the mixed-flow lanes, which will contribute to the congested conditions.

While these two bottlenecks are projected to produce distinct queues between 6 and 7 am, beginning at 7 am the Location 2 bottleneck is projected to become embedded in the queues that originate from the Location 1 bottleneck. Queues from the controlling bottleneck at Location 1 are projected to extend 16 miles east to Hillcrest Avenue Interchange.

In 2030 the eastbound bottleneck at Location 3, which is located between Port Chicago Highway and Willow Pass Road, will continue to cause worsening congestion in the SR 4 Corridor. This segment is projected to provide inadequate capacity to accommodate the demand and would last for more than 5 hours. Between 3 and 4 pm, a separate bottleneck is projected to occur between I-680 and Solano Way, but this bottleneck would be embedded in the queues extending from Location 3 between 4 and 7 pm. The resulting peak-hour queue is projected to extend almost 16 miles west from Location 3 to I-80.

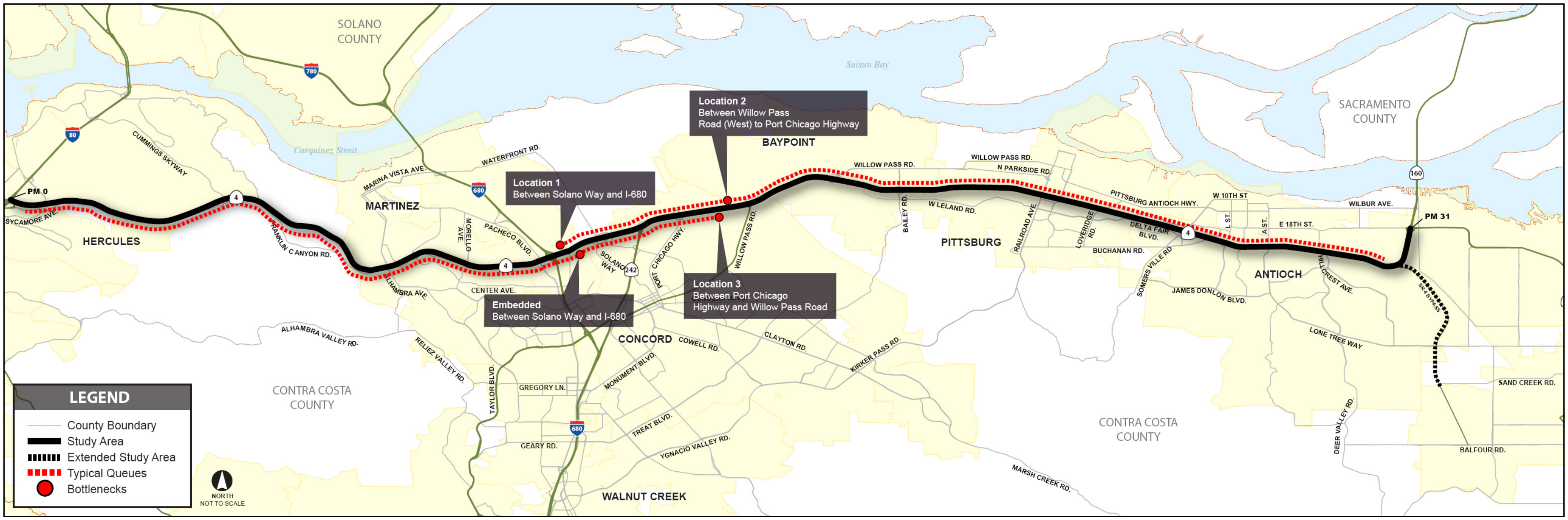
Additional information on the peak-hour condition of these bottlenecks is presented in Exhibit 1.3, below, and depicted graphically in Exhibit 1.4.

Exhibit 1.3: Locations and Causes of Congestion on SR 4 in 2030

Location	Bottleneck Description	Cause	Max. Queue Length (mi./Peak Period)	Avg. Speed (mph/Pea Period)	Total Delay (Veh·Hrs/ Peak Period)	Congestion Delay (Veh·Hrs/ Peak Period)
1	2030 Westbound AM Peak Between Solano Way and Interstate 680	Similar to 2015, this bottleneck is projected to develop in the two-lane mixed-flow section that would not provide adequate capacity to accommodate the demand. The queue approaching this bottleneck is projected to extend two miles east to Willow Pass Road. Beginning at 7 am queues from this bottleneck are projected to extend through Location 2 (see below).	2.5	19	2,600	2110
2	2030 Westbound AM Peak Between Willow Pass Road and Port Chicago Hwy	Similar to 2015, this bottleneck is projected to develop in a four-lane section (three mixed-flow lanes plus one HOV lane), which would not provide adequate capacity to accommodate the demand. HOVs exiting at SR 242 or entering at Willow Pass Road must cross the mixed-flow lanes, which would contribute to the congested conditions. After 7 am this bottleneck is projected to become embedded in the downstream bottleneck at Location 1. Queues extending through this bottleneck from Location 1 are projected to extend 16 miles east to Hillcrest Avenue Interchange.	13.5	16	12,100	10,100
3	2030 Eastbound PM Peak Between Port Chicago and Willow Pass Road	Similar to 2015, this segment is projected to provide inadequate capacity to accommodate the demand. Queues approaching the bottleneck are projected to extend almost 16 miles to I-80.	16.0	14	9,500	8,100

Note: For the purposes of this study, total delay is defined as the recurrent delay due to congestion for vehicles traveling at speeds of 60 mph or less. Congestion delay is defined as the recurrent delay due to congestion for vehicles traveling at speeds of 35 mph or less.

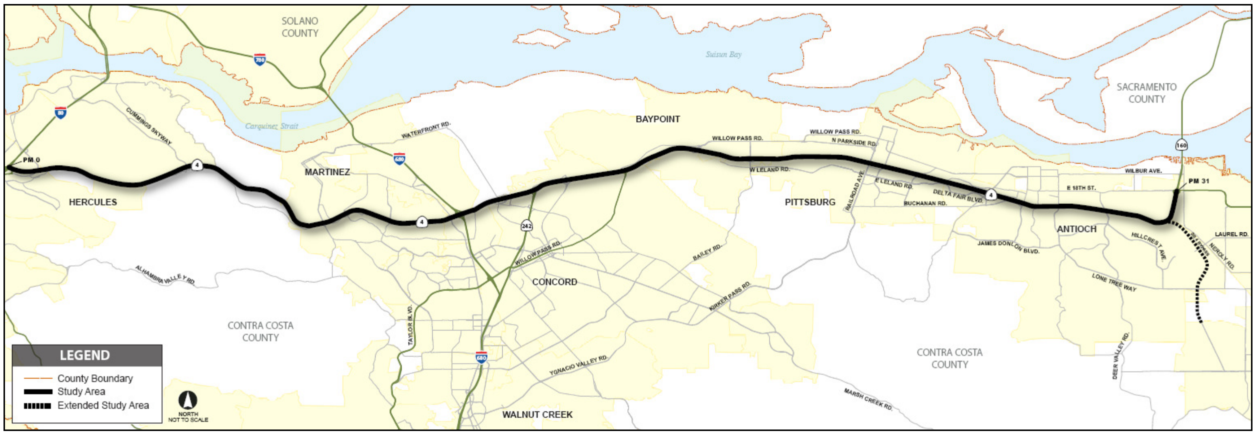
Exhibit 1.4: Locations of Recurrent Congestion on SR 4 in 2030



Section 2: Description of Future Conditions in the SR 4 Corridor

This section provides a description of future roadway conditions for the 33-mile SR 4 Corridor in Contra Costa County extending from the I-80 Interchange to Lone Tree Way, including the SR 4 Bypass. Exhibit 2.1 illustrates the SR 4 Corridor analysis limits.[1]

Exhibit 2.1: Study Corridor and Analysis Limits



Today and in the future, SR 4 serves as the only major east-west transportation link joining the communities of Antioch, Pittsburg, Oakley and Brentwood with Central Contra Costa County and the Bay Area. In addition to serving local and intercity travel needs, this corridor provides access to major industrial facilities (e.g., oil refineries) in both northern and western Contra Costa County. As such, the Contra Costa Transportation Authority (CCTA) identifies SR 4 as a Route of Regional Significance (*West County Action Plan, Central County Action Plan, and East County Action Plan for Routes of Regional Significance, August - December 2008)*.[2]

According to the Association of Bay Area Governments (ABAG), population in Contra Costa County is expected to increase by approximately 23 percent by 2030. The 2007 employment level is projected to increase by about 46 percent by 2030. With severe congestion already occurring today along some sections of SR 4, conditions can be expected to worsen significantly in the future due to regional growth and increases in intercity/interstate personal travel and goods movement through Contra Costa County. Exhibit 2.2 presents existing and future demographic statistics for Contra Costa County.

Exhibit 2.2: Existing and Projected Population and Employment in Contra Costa County

Contra Costa County	2007	2030	Percent Change
Population	1,023,400	1,255,300	23%
Employment	379,000	551,500	46%
Source: Projections 2007 – Forecasts for the San Francisco Bay Area to the year 2035, Association of Bay Area Governments, December 2006.			

1 The Extended Study Area includes the SR 4 Bypass from SR 160 to Sand Creek Road. Sand Creek Road was selected as the terminus because freeway construction of the SR 4 Bypass is planned to Sand Creek Road by the first future analysis year of 2015.

2 Routes of Regional Significance are roadways that meet one or more of the following criteria: connect two or more "regions" of Contra Costa County across County boundaries; carry a significant amount of through-traffic; or provide access to a regional highway or transit facility (e.g., a BART station or freeway interchange).

Committed Improvements in the SR 4 Corridor

The Contra Costa Transportation Authority, in cooperation with the Federal Highway Administration and the California Department of Transportation, proposes several improvements throughout the SR 4 Corridor that are system related transportation improvements (e.g., provision of HOV lanes), transit and public transportation investments (e.g., park & ride centers), interchange improvements and other infrastructure investments (e.g., auxiliary lane expansions). For the purposes of this study, fully funded improvement projects that would significantly affect 2015 and 2030 traffic operations on SR 4 were incorporated into the future conditions analysis.[3] According to the *Contra Costa Countywide Comprehensive Transportation Plan* (Adopted May 2004), the following major projects are committed improvements for the SR 4 Corridor:

SR 4 East Widening Project (Loveridge Road to SR 160) – is a proposed freeway widening project that will widen SR 4 from the existing four lanes to eight lanes. The widened freeway would generally consist of one HOV lane and three mixed-flow lanes in each direction. However, the HOV lanes would not extend for the entire length of the project; the westbound HOV lane would begin and the eastbound HOV lane would terminate in the vicinity of Hillcrest Avenue. This project will reserve sufficient width in the SR 4 median to accommodate future public transportation investments (i.e., eBART) and will reconstruct and/or partially reconstruct interchanges at Loveridge Road, Somersville Road, Contra Loma Boulevard/L Street, Lone Tree Way/A Street, and Hillcrest Avenue.

SR 4 Bypass – The SR 4 Bypass connects the communities of Oakley and Brentwood to SR 4 and includes three segments described below. Although these improvements are included in the CCTA regional demand model for the purpose of forecasting future travel demands for the project, only the freeway portion of the SR 4 Bypass that is already complete or planned for completion by the year 2015 (Segment 1 and the portion of Segment 2 from Lone Tree Way to Sand Creek Road) is represented in the FREQ12 model network for years 2015 and 2030.

a. Segment 1 of this facility was completed in 2008; it is a four- to six-lane freeway located between the SR 4/SR 160 Interchange and Lone Tree Way. Apart from the two interchanges at the segment's termini, there is one interchange located at Laurel Road.

b. Segment 2 of the SR 4 Bypass, completed in 2002, is a two-lane expressway located between Lone Tree Way and Balfour Road. There are plans to upgrade the segment from Lone Tree Way to Sand Creek Road to a four-lane freeway with an interchange at Sand Creek Road by 2012. This entire segment is planned to eventually be upgraded to a four-lane freeway facility all the way to Balfour Road, with an interchange at Balfour Road.

Selection and Calibration of the Future Conditions Analysis Tool

In consultation with MTC, the macroscopic simulation model FREQ12 was chosen as the most appropriate analysis tool to be applied to the future conditions analysis of the SR 4 Corridor. Originally developed by the Institute of Transportation Studies at the University of California at Berkeley, FREQ12 is the latest version of this freeway simulation tool with over thirty years of continuous software improvement and development. The choice of FREQ12 for use in this study was primarily determined based on the data inputs available from existing sources; the ability of the model to produce the desired measures of freeway performance efficiently and reliably; and the ease of use for comparing existing and future improvement scenarios.

The first steps in applying FREQ12 to the SR 4 Corridor were to input existing (2007) configurations and geometry and then to develop average weekday AM and PM peak hour volume inputs. The existing configurations and volumes are documented in Appendix A and were coded into FREQ12 using standard methods.[4]

[3] Projects that meet the definition of committed as described in this section are included in the future conditions analysis. It is worth noting that the models used to prepare the underlying forecasts include other improvements that do not meet this definition of committed. Additional discussion on this topic may be found in the subsequent discussion of future volume forecasts.

[4] Standard FREQ12 methods are documented in the *Freeway Analysis Manual* by Dolf May and Lannon Leiman, March 10, 2005.

The AM and PM peak hour were determined by using the hour with the highest demand volumes as determined in the *SR 4 Existing Conditions Technical Memorandum* (Final Draft, PBS&J, January 23, 2008). These hours are from 8 to 9 AM and from 5 to 6 PM.

The average weekday AM and PM peak hour volume inputs were developed by using mainline and ramp traffic counts provided by MTC. Since these volume counts were conducted over various years (2002-2006), an adjustment factor of 1.5 percent growth per year was applied to all of the available traffic volume data to match 2007 traffic volumes. The 2007 traffic volumes were then adjusted across the length of the corridor so that volumes on the mainline off-ramps and on-ramps were balanced. As such, the mainline volumes reflect the amount of traffic entering and exiting at each ramp.

The existing HOV lane on SR 4 was coded from Port Chicago Highway to Railroad Avenue; vehicles with two or more occupants were assigned to the HOV lanes and represent approximately 15 percent of total traffic in the eastbound direction and approximately 19 percent in the westbound direction. The HOV assignments were estimated based on existing HOV lane data published in the 2007 Caltrans report on HOV lanes in the Bay Area.

Once the existing 2007 geometric and volume inputs were developed, adjustments were made to the volume inputs to account for demand volumes. The ECT revealed several sections of the SR 4 Corridor that operate at speeds of 35 mph or less for extended periods during the AM and PM peak periods – a condition that indicates constrained flows due to congestion. Using the amount of delay estimated in the ECT, and the length and duration of the queues, the amount of unserved demand was estimated. This unserved demand was distributed upstream of the bottleneck at on- and off-ramps within the queue. This process was necessary to convert available 2007 traffic volumes to 2007 traffic demand volumes. Once the 2007 traffic volumes were adjusted to account for demand, FREQ12 runs were conducted. The resulting FREQ12 simulation conditions were then compared to existing speeds and queues documented in the ECT. From this comparison, necessary adjustments were made to match congestion patterns at the existing bottleneck conditions. This comparison process between the FREQ12 runs and the data documented in the ECT is known as the FREQ12 calibration and validation.

Exhibits 2.3 and 2.4 present a comparison of 2007 speeds and queue lengths along SR 4 based on the data reported in the ECT and the estimates produced by FREQ12. The existing conditions analysis indicated that the westbound AM peak hour was the most heavily congested direction of travel and time period for the SR 4 Corridor. As such, the speeds presented below illustrate that with the calibration process, the estimated speeds and queue lengths from the FREQ12 model compare closely with the measured data from PeMS. More detail on the mainline and ramp volumes used for this analysis can be found in Appendix A.

Exhibit 2.3: FREQ Model Validation - Comparison of Speeds and Queues on SR 4 (2007 Westbound, AM Peak Hour)

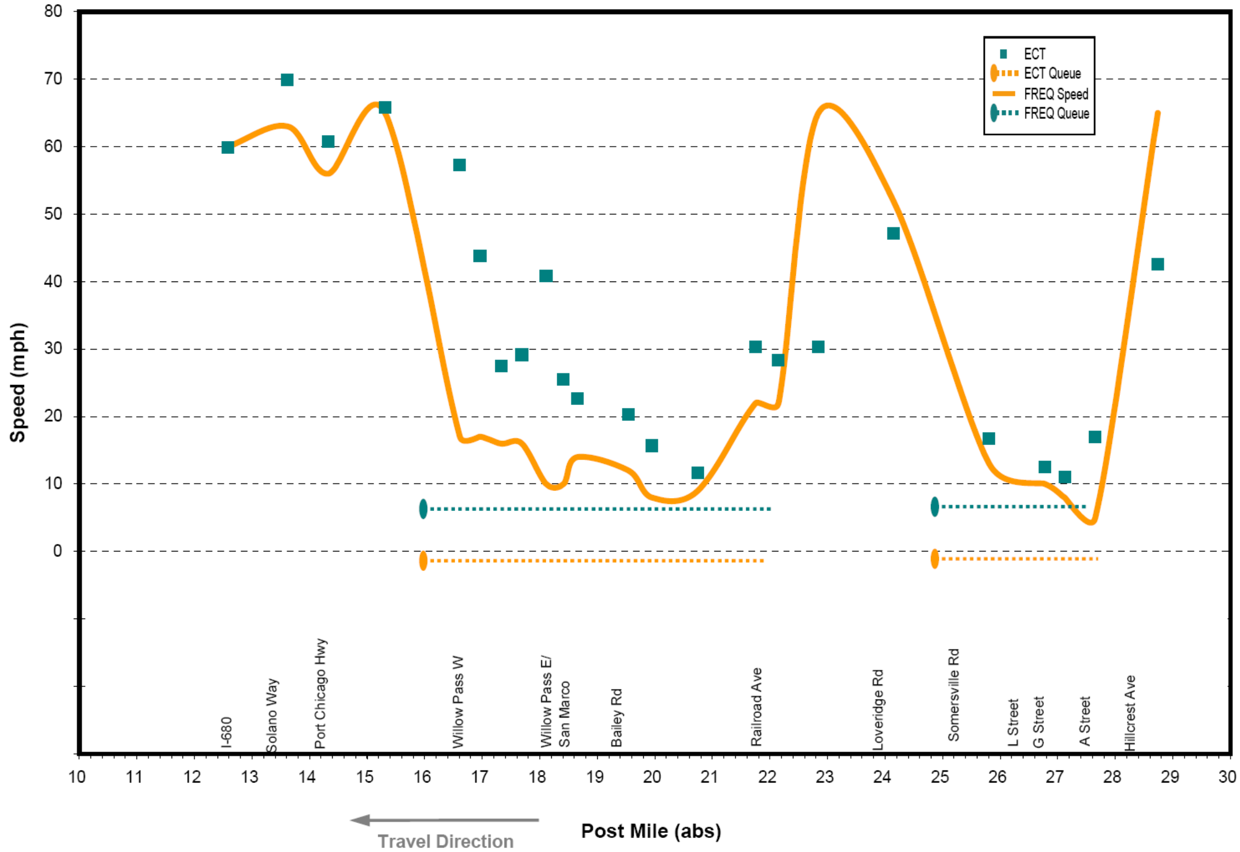
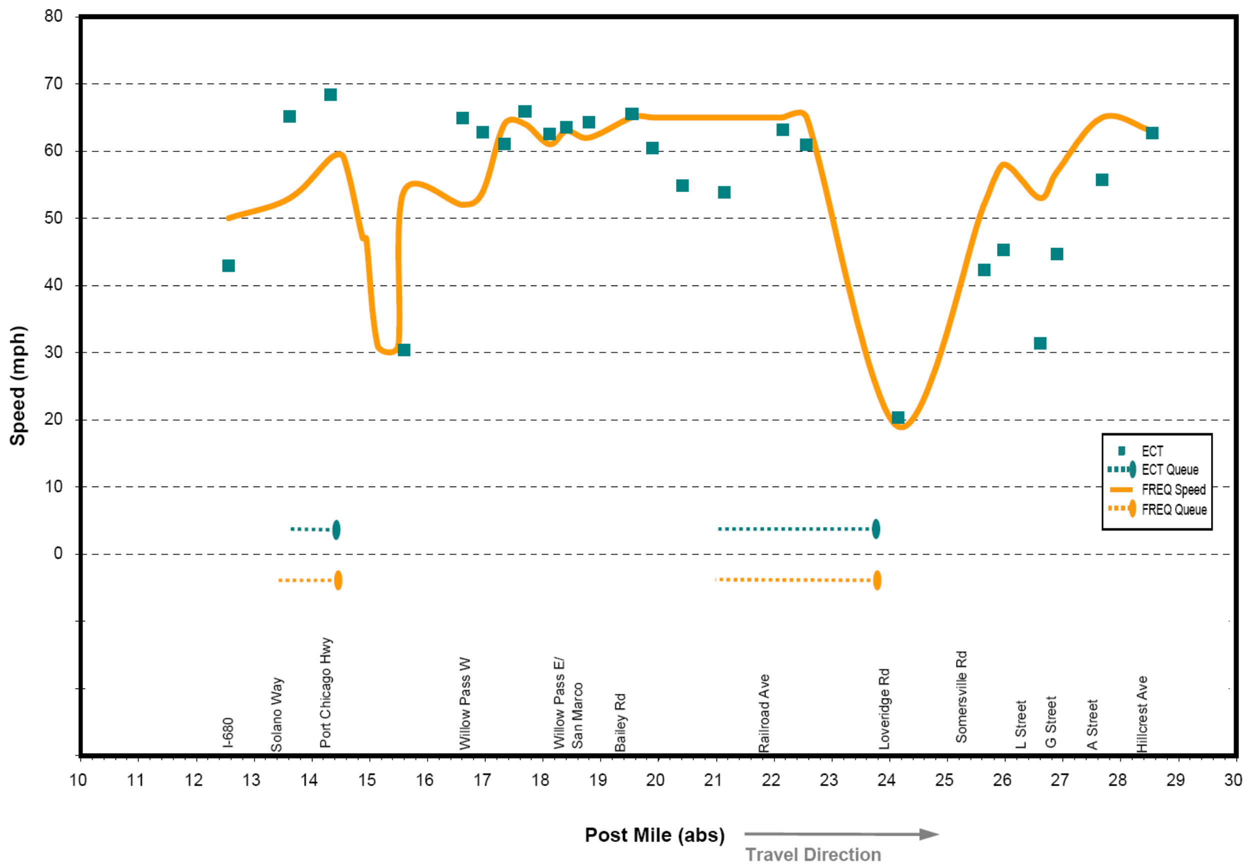


Exhibit 2.4: FREQ Model Validation - Comparison of Speeds and Queues on SR 4 (2007 Eastbound, PM Peak Hour)



Future Volume Forecasts for the SR 4 Corridor

As noted previously, the CCTA travel demand model was used to develop future traffic volumes for the SR 4 Corridor. Other travel demand models that include the Contra Costa County transportation network are the MTC Regional Model, the Alameda County Congestion Management Authority (ACCMA) Model, the San Francisco County Transportation Authority (SFCTA) Model, and the Solano Transportation Authority (STA) Napa/Solano County Model. However, these models are not focused on the SR 4 project area of influence. Therefore, in consultation with MTC, it was determined that the CCTA model was the most appropriate for use in forecasting future traffic volumes in the SR 4 Corridor.

The CCTA model provides a 2000 base year, two interim years, 2010 and 2020; and a year 2030 forecast of travel demand based on future population, employment and regional traffic growth. To project future volumes on SR 4, the study team began with interpolating 2000, 2010, 2020 and 2030 volumes from the model on each mainline segment and ramp for the analysis years of 2007 (used for validation of the FREQ12 model), 2015 and 2030. After interpolation, the volume differences between each of these years (2007 to 2015 and 2007 to 2030) were calculated and these volume differences were in turn added to each of the mainline segments and ramps in the calibrated 2007 FREQ12 volume data sets. The future traffic volumes were then compared once again to the projected volumes from the CCTA model and where necessary, adjustments were made to reconcile any significant differences in the relationships between peak morning and peak afternoon traffic volumes. The HOV assignments for vehicles with two or more occupants were assumed to be the same as the existing condition (approximately 19 percent of the total westbound traffic volume and 15 percent of the total eastbound traffic volume).

In addition to the committed improvements mentioned earlier in this report, the CCTA model includes other improvements – most notably eBART – that do not meet the definition of committed improvements for the purposes of this analysis. While projects such as eBART are included in the underlying forecast models, the methodology of incorporating these forecasts as incremental traffic growth over the validated existing volumes does not result in a significant or meaningful understatement of demands along the SR 4 Corridor. The issue of eBART as a mitigation strategy on SR 4 will be addressed in the next phase of this SR 4 study, which focuses on the prioritization of a range of candidate mitigation strategies.

Exhibits 2.5 and 2.6 show comparisons of the westbound and eastbound peak hour volumes, respectively, on SR 4 under 2007 (from the validated FREQ12 runs), 2015 and 2030 conditions. As illustrated in the exhibits, the highest peak traffic volume flows in the currently congested area between the Willow Pass Road and Port Chicago Highway Interchanges and is projected to be significantly higher than existing conditions based on the traffic growth developed using the CCTA travel demand model. At this location, the westbound AM peak hour demand is expected to increase from 8,500 vehicles per hour (vph) in 2007 to 11,000 vph in 2015, or an increase of 29 percent. By 2030, the westbound peak hour demand at this location is projected to increase to 12,000 vph, or an increase of 42 percent compared to the existing 2007 conditions.

Exhibit 2.7 shows a comparison of average weekday traffic volumes on SR 4 under 2007 (from the validated FREQ12 runs), 2015 and 2030 conditions at three representative locations along the corridor: Solano Way, Willow Pass Road, and Bailey Road. The projected traffic volume increases between 2007 and 2015 are between 6% and 39%, with the highest increases projected in the eastern portion of the corridor. Between 2015 and 2030, traffic volumes are projected to increase by 32% at Solano Way (west of the SR 242 Interchange, and by 23% at Willow Pass Road and Bailey Road (east of the SR 242 Interchange).

The traffic volumes for the mainline segments and ramps for each of the analysis years and directions of travel are presented in detail in Appendix A.

Exhibit 2.5: Comparison of Existing and Projected Traffic Volumes on SR 4 (Westbound, AM Peak Hour)

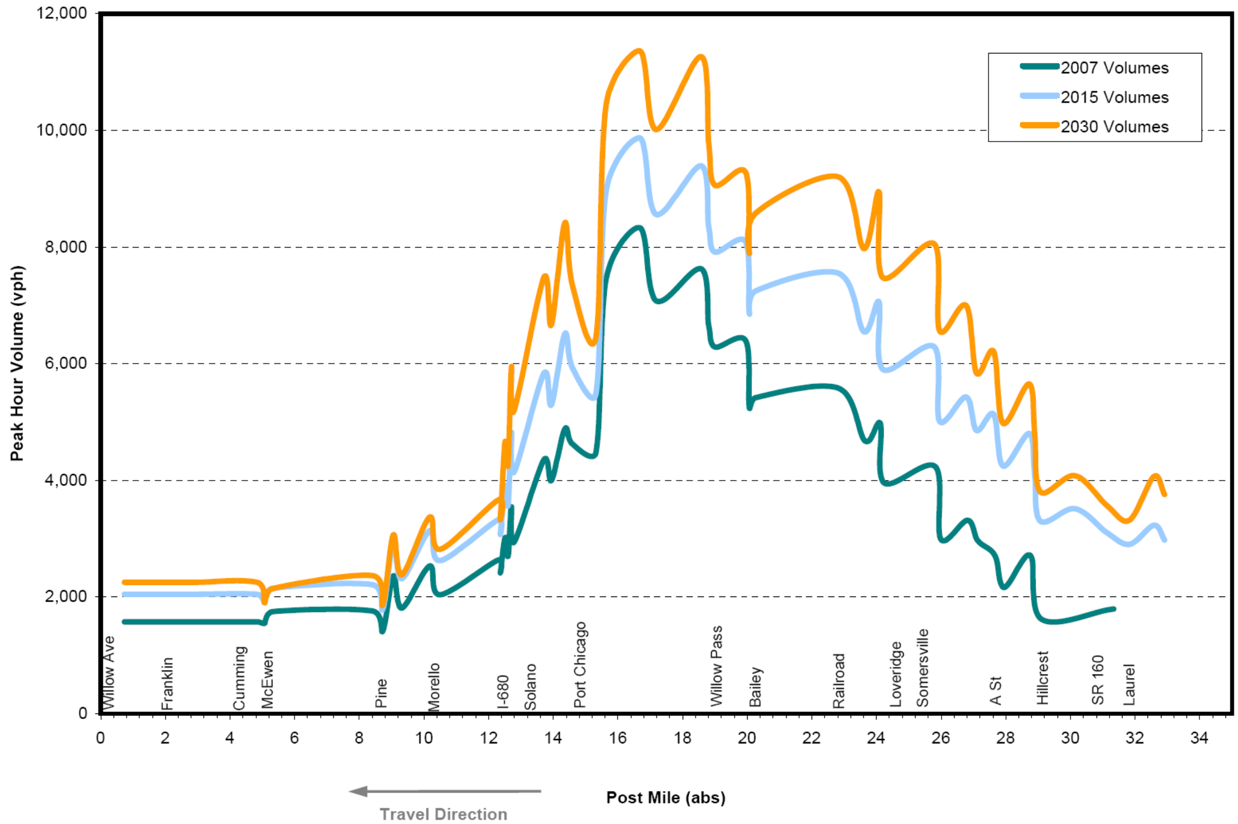


Exhibit 2.6: Comparison of Existing and Projected Traffic Volumes on SR 4 (Eastbound, PM Peak Hour)

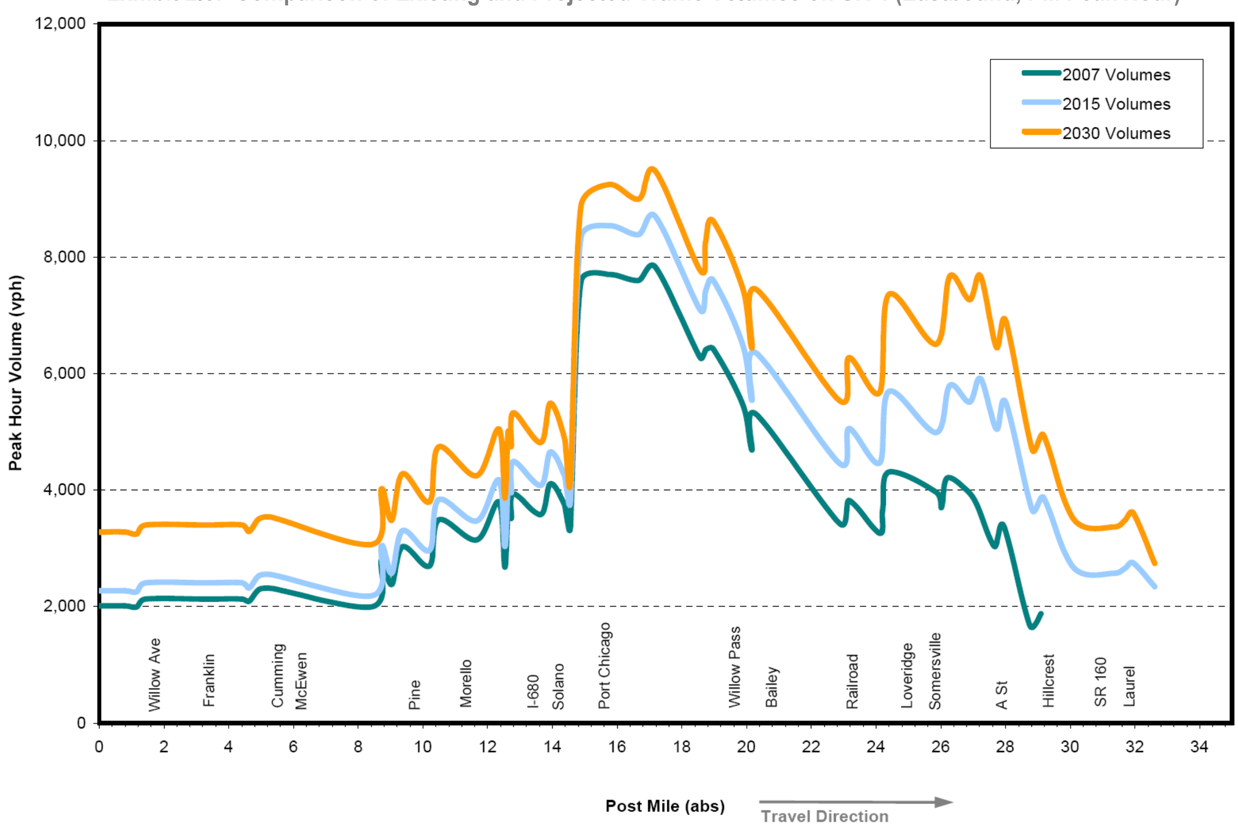
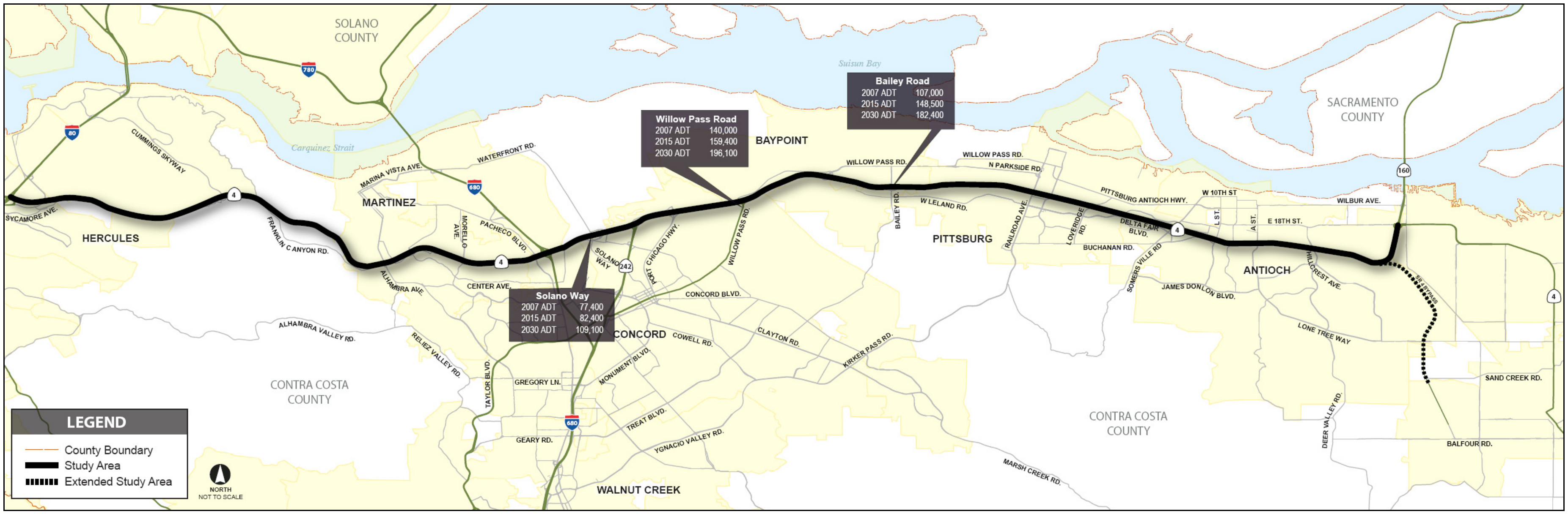


Exhibit 2.7: Comparison of Existing and Projected Average Weekday Traffic Volumes on SR 4



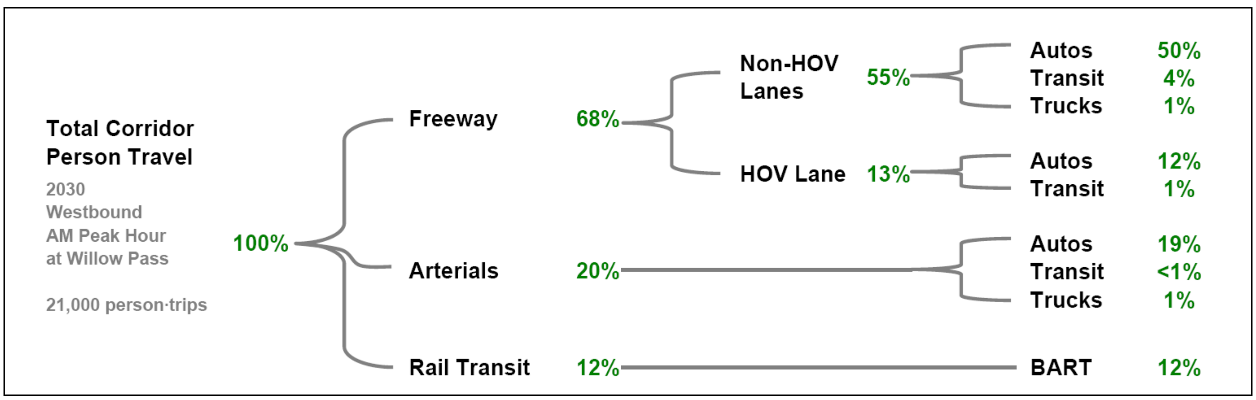
Travel by Mode in the SR 4 Corridor

Exhibit 2.8 summarizes modes of travel in terms of person trips on SR 4 in 2030 for a screenline in the vicinity of Willow Pass Road.[5] This summary represents conditions during the morning peak hour in the westbound direction of travel. The intent of this summary is to show relative market shares of the various modes of travel on SR 4.

Freeway travel via either mixed-flow lanes or the HOV lane will be the dominant mode of travel in 2030, with 62% of the person trips made via personal automobiles, of which 12% will be HOV. On the freeway, public transit (excluding BART) will account for 5% of the person trips. The mode share of truck person trips will account for a relatively small percentage of traffic on SR 4, approximately 1%.

Across this screenline, the second highest travel mode will be arterial travel in personal automobiles, which will account for 19% of the 2030 person trips made during the morning peak hour in the westbound direction. BART will carry 12% of the person trips in the corridor in 2030 which, while a significant mode share, is less than routes such as SR 24 where BART ridership, as a percentage of person trip making, is 3 times higher.

Exhibit 2.8: Mode Share on SR 4 (Westbound, AM Peak Hour)



Source: CCTA Travel Demand Model.

[5] A screenline is a hypothetical line that would be crossed by persons traveling to or from specific areas and is used to describe the magnitude of travel to or from specific areas.

Travel Patterns in the SR 4 Corridor

Exhibit 2.9 summarizes projected travel patterns in terms of vehicle trip origins and vehicle trip destinations for travel on SR 4 in 2000. This summary represents 2000 conditions during the morning peak hour in the westbound direction of travel on SR 4 between Willow Pass Road (East) and Willow Pass Road (West). The AM peak hour travel patterns presented here are assumed to be largely consistent with future 2030 travel patterns.

The majority (94.8%) of personal vehicle trips in the SR 4 Corridor will originate within or nearby the corridor from cities within East Contra Costa County. Only a small percentage of vehicle trips in the SR 4 Corridor will originate from San Joaquin County (4.2%) or Sacramento County (1.0%).

Nearly half (44.2%) of vehicle trips in the SR 4 Corridor will have destinations in Central Contra Costa County in cities such as Concord, Martinez and Walnut Creek. Over a quarter of vehicle trips will have destinations in Oakland/West Alameda County (18.5%) and San Francisco/San Mateo Counties (10.3%). The remaining quarter of vehicle trips will have destinations in the Tri-Valley (14.1%), West Contra Costa and Marin Counties (6.6%), Santa Clara County (4.8%), and Solano/Napa/Sonoma Counties (1.5%).

Exhibit 2.9: Travel Patterns on SR 4 (Westbound, AM Peak Hour)

Origin		Destination	
East Contra Costa County	94.8%	Central Contra Costa County	44.2%
San Joaquin County	4.2%	Oakland/West Alameda County	18.5%
Sacramento County	1.0%	San Ramon Valley/Tri-Valley	14.1%
		San Francisco/San Mateo Counties	10.3%
		West Contra Costa/Marin Counties	6.6%
		Santa Clara County	4.8%
		Solano/Napa/Sonoma Counties	1.5%

Source: CCTA Travel Demand Model

Section 3: Future Conditions Performance Analysis

The primary focus of the future conditions performance analysis is to identify locations and causes of recurrent congestion along the SR 4 Corridor in Contra Costa County. To achieve this goal, the validated FREQ12 model described in the previous section was applied to the projected volumes for 2015 and 2030 conditions. This section of the future condition technical memorandum summarizes the application of the FREQ12 model; the performance measures used in the future analysis and the future congestion locations; and bottlenecks and causes along the corridor.

Application of the FREQ12 Model

The SR 4 Corridor ECT indicated that congestion today is a multiple-hour event. In order to accurately calibrate the FREQ12 model to best simulate existing conditions, FREQ12 was modeled for several time increments, known as time slices. These time slices were modeled at increments of one hour for a total duration of four hours during the morning and afternoon peak periods. A FREQ12 analysis with multiple time slices is more accurate than a single time slice because it shows the effects of congestion and queues building over time. The third time slice for each peak period represents the peak hour volumes and the three shoulder hours (two hours before and one hour after the peak) are used for the first, second, and fourth time slices. Shoulder factors are based on relative proportions of traffic demand.

To build the four-hour application of FREQ12, the existing traffic counts were reviewed in order to develop shoulder factors that could be used to adjust the 2015 and 2030 peak hour volumes. This adjustment factor was based on the existing distribution of traffic during the peak periods. The adjustment factors used for the four time slices by peak period and direction of travel are summarized in Appendix B.

Future Performance Measures

Detailed summaries for various performance metrics may be found in Appendix C of this report.[6] In general, this analysis finds that even with the committed improvements that were included in this analysis, congestion along SR 4 is expected to significantly worsen between 2007 and 2030.

- **Peak Hour Vehicle Demand**: While not a strict performance measure, estimates of vehicle demand drive the remainder of the measures summarized in the following discussion for the SR 4 Corridor. Today, peak hour demand on SR 4 is 7,600 vph in the morning, westbound direction of travel and 7,800 vph in the afternoon, eastbound direction of travel. By 2030, these demands are estimated to be 11,300 vph and 9,500 vph, respectively – an increase of between 20% and 50% in peak hour travel demand in the SR 4 Corridor.[7]

- **Peak Hour Travel Speed**: Peak hour travel speeds through out the corridor are projected to deteriorate even with the committed improvement identified. Today the average peak hour speed in the morning, westbound direction of travel is 28 mph. By 2030, the peak hour speed is projected to be 14 mph due to increased demands and the resulting congestion on SR 4.

- **Peak Hour Travel Time**: Today it is estimated to take 1 hour and 7 minutes to travel the 33-mile SR 4 Corridor end to end in westbound direction during the morning peak hour. With the increased travel demands and projected decreases in travel speeds, this same 33-mile trip is projected to take over 2 hours by 2030.

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6 In comparing this data to that previously presented in the SR 4 Existing Conditions Analysis, there are differences in the estimates of delay for 2007 presented in this report. This is because two different computational methodologies were used. The existing conditions analysis relied upon travel time runs and measurements of corridor performance taken from the PeMS database. The future conditions analysis is based on validated models for the corridor and produces results that, while in the same order of magnitude, do show differences when compared to the measured data used in the existing conditions evaluation.

7 Traffic demands are between Willow Pass (East) and Willow Pass (West) Interchanges for both peak hours reported.

- **Total Delay:** This measure is based on the difference between projected travel speeds along the corridor and free-flow speeds (60 mph). Delay in the SR 4 corridor is projected to more than five times from 8,100 hours per day in 2007 to 41,500 hours in 2030. In 2030, this translates to a delay cost of $165 million per year on SR 4.

- **Miles of Congestion:** Today, between 3.5 miles (PM eastbound) and 8 miles (AM westbound) of the 33-mile corridor are congested during peak travel periods. With the projected demand in 2030, the congested segments are expected to range from between 16 and 16.5 miles of the corridor. In other words, during the peak periods, 50% of the corridor will be congested in the peak direction of travel.

In addition to the performance measures described above, the duration of congestion, known as the peak spread, was also evaluated. In order to estimate the duration of congestion in the 2015 and 2030 analysis years, the 24-hour demand profile from the existing conditions analysis was applied to 2015 average daily traffic volumes from the CCTA travel demand model. This analysis quantifies the extent to which the duration of the congested period in the SR 4 Corridor is projected to increase.

As shown in Exhibit 3.1, the duration of congestion is expected to increase from 4 hours in existing conditions to 5 hours by 2015 in the westbound direction, and from 4 hours to 4.75 hours in the eastbound direction. Estimations of the duration of congestion in 2030 indicate that future levels could exceed the 2015 levels; however, other considerations such as modal shifts, use of alternative routes, and the effects of transportation demand management (TDM) measures could result in the stabilization of the duration of congestion around the 4- to 5-hour range beyond 2015.

Exhibit 3.1: Duration of Congestion on SR 4

Direction	Existing	2015	2030
Westbound (AM Peak)	4 hrs	5 hrs	> 5 hrs
Eastbound (PM Peak)	4 hrs	4.75 hrs	> 4.75 hrs

Source: PBS&J.

Appendices

Appendix A: Existing (2007) and Projected Future (2015 & 2030) Traffic Demands

Appendix B: Peak and Shoulder Factors Used to Create Multiple Analysis Hours in FREQ12

Appendix C: Existing (2007) and Projected Future (2015 & 2030) Performance Measures

Appendix A: Existing (2007) and Projected Future (2015 & 2030) Traffic Demands

SR 4 Westbound AM - Freeway and Ramp Traffic Demands

Existing (2007)

Location			Abs PM		Section Length (ft)	Configuration			2007			
			From	To		Mainline Lanes	Off-Ramp Lanes	On-Ramp Lanes	Capacity	Peak Hour Demands (7-8 AM) Off-Ramp	On-Ramp	Mainline
-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-
160 Merge	to	Hillcrest Off	31.33	29.10	11,764	2			4,000			1,795
Hillcrest Off	to	Hillcrest On	29.10	28.76	1,822	2	1		4,000	180		1,615
-	-	-	-	-	-	-	-	-	-	-	-	-
Hillcrest On	to	A St Off	28.76	27.95	4,277	2		1	4,000		1,100	2,715
A St Off	to	A St On	27.95	27.66	1,515	2	1		4,000	550		2,165
A St On	to	G St On	27.66	27.13	2,798	2		1	4,000		550	2,715
G St On	to	L St On	27.13	26.81	1,700	2		1	4,000		250	2,965
L St On	to	Somersville Off	26.81	25.99	4,345	2		1	4,000		350	3,315
Somersville Off	to	Somersville On	25.99	25.82	892	2	1		4,000	320		2,995
Somersville On	to	Loveridge Off	25.82	24.23	8,364	2		1	4,000		1,238	4,233
Loveridge Off	to	Loveridge On	24.23	24.11	634	2	1		4,000	279		3,954
Loveridge On	to	Railroad Off	24.11	23.64	2,482	3		1	6,000		1,022	4,976
Railroad Off	to	Railroad On	23.64	22.82	4,330	3	1		6,000	298		4,678
Railroad On	to	Bailey NB Off	22.82	20.28	13,443	3+1H		1	7,650		900	5,578
Bailey NB Off	to	Bailey SB Off	20.28	20.07	1,119	3+1A+1H	1		7,830	156		5,422
Bailey SB Off	to	Bailey SB On	20.07	19.95	612	3+1H	1		7,650	180		5,242
Bailey SB On	to	Willow Pass NB Off	19.95	19.00	5,011	3+1A+1H		1	8,800		1,150	6,392
Willow Pass NB Off	to	Willow Pass NB On	19.00	18.81	1,008	3+1H	1		7,650	105		6,287
Willow Pass NB On	to	Willow Pass SB On	18.81	18.57	1,262	3+1H		1	7,650		350	6,637
Willow Pass SB On	to	Willow Pass W Off	18.57	17.18	7,329	4+1H		2	9,650		990	7,627
Willow Pass W Off	to	Willow Pass W On	17.18	16.69	2,614	3+1H	1		7,650	550		7,077
Willow Pass W On	to	Port Chicago Off	16.69	15.64	5,512	3+1H		1	7,650		1,250	8,327
Port Chicago Off	to	SR-242 Off	15.64	15.32	1,695	5	1		10,000	850		7,477
SR-242 Off	to	Port Chicago On	15.32	14.59	3,881	2	3		4,000	3,000		4,477
Port Chicago On	to	SR-242 On	14.59	14.36	1,225	2		1	4,000		150	4,627
SR-242 On	to	Solano Off	14.36	13.94	2,196	2+1A		1	4,250		250	4,877
Solano Off	to	Solano On	13.94	13.71	1,236	2	1		4,000	880		3,997
Solano On	to	I-680 NB Off	13.71	12.79	4,836	2		1	4,000		350	4,347
I-680 NB Off	to	I-680 NB On	12.79	12.70	449	2	1		4,000	1,400		2,947
I-680 NB On	to	I-680 SB Off	12.70	12.60	544	2+1A		1	4,600		600	3,547
I-680 SB Off	to	I-680 SB On	12.60	12.50	512	2	1		4,000	840		2,707
I-680 SB On	to	Pacheco Off	12.50	12.36	760	2+1A		1	4,310		310	3,017
Pacheco Off	to	Pacheco On	12.36	12.31	248	2	1		4,000	600		2,417
Pacheco On	to	Morello Off	12.31	10.51	9,536	3		1	6,000		220	2,637
Morello Off	to	Morello On	10.51	10.18	1,758	3	1		6,000	598		2,039
Morello On	to	Pine St Off	10.18	9.31	4,551	3		1	6,000		495	2,534
Pine St Off	to	Pine St On	9.31	9.05	1,399	3	1		6,000	723		1,811
Pine St On	to	Alhambra Off	9.05	8.72	1,742	3+1A		1	6,550		550	2,361
Alhambra Off	to	Alhambra On	8.72	8.41	1,632	3	1		6,000	950		1,411
Alhambra On	to	McEwen Off	8.41	5.32	16,331	3		1	6,000		350	1,761
McEwen Off	to	Cumming Off	5.32	5.07	1,304	2	1		4,000	14		1,747
Cumming Off	to	Cumming On	5.07	4.84	1,236	2	1		4,000	198		1,549
Cumming On	to	Franklin Off	4.84	2.93	10,059	2		1	4,000		25	1,574
Franklin Off	to	Franklin On	2.93	2.30	3,351	2			4,000			1,574
Franklin On	to	Willow Ave	2.30	1.15	6,070	2			4,000			1,574
Willow Ave	to	I-80 Off	1.15	0.73	2,180	2	1		4,000	0		1,574
I-80 Off	to	San Pablo	0.73	0.00	3,869	2			4,000			1,574

Future (2015 & 2030)

Location			Abs PM		Section Length (ft)	Configuration			2015				2030			
			From	To		Mainline Lanes	Off-Ramp Lanes	On-Ramp Lanes	Capacity	Peak Hour Demands (7-8 AM) Off-Ramp	On-Ramp	Mainline	Capacity	Peak Hour Demands (7-8 AM) Off-Ramp	On-Ramp	Mainline
Lone Tree Way	to	Lone Tree Way On	32.90	32.58	1,722	2			4,000			2,979	4,000			3,936
Lone Tree Way On	to	Laurel Off	32.58	31.83	3,966	2		1	4,000		250	3,229	4,000		312	4,248
Laurel Off	to	Laurel On	31.83	31.13	3,674	2	1		4,000	326		2,903	4,000	749		3,499
Laurel On	to	160 Merge	31.13	30.15	5,977	3		1	6,000		198	3,101	6,000		123	3,622
160 Merge	to	Hillcrest Off	30.15	29.07	5,700	2		1	4,000		410	3,511	4,000		456	4,078
Hillcrest Off	to	Hillcrest NB On	29.07	28.89	922	3+1H	1		7,650	210		3,301	7,650	277		3801
Hillcrest NB On	to	Hillcrest SB On	28.89	28.72	900	3+1H		1	7,650		806	4,107	7,650		1,005	4,806
Hillcrest SB On	to	A St Off	28.72	27.91	4,277	3+1H		1	7,650		698	4,805	7,650		845	5,651
A St Off	to	A St On	27.91	27.62	1,515	3+1H	1		7,650	561		4,244	7,650	675		4,976
A St On	to	L St Off	27.62	27.09	2,798	3+1H		1	7,650		890	5,134	7,650		1,230	6,206
L St Off	to	L St On	27.09	26.77	1,700	3+1H		1	7,650	280		4,854	7,650	367		5,839
L St On	to	Somersville Off	26.77	25.95	4,345	3+1H		1	7,650		574	5,428	7,650		1,160	6999
Somersville Off	to	Somersville On	25.95	25.78	892	3+1H	1		7,650	413		5,015	7,650	435		6,564
Somersville On	to	Loveridge Off	25.78	24.20	8,364	3+1H		1	7,650		1,275	6,290	7,650		1,488	8,052
Loveridge Off	to	Loveridge On	24.20	24.08	634	3+1H	1		7,650	389		5,901	7,650	579		7,473
Loveridge On	to	Railroad Off	24.08	23.61	2,482	3+1H		1	7,650		1,156	7,057	7,650		1,472	8,945
Railroad Off	to	Railroad On	23.61	22.82	4,130	3+1H	1		7,650	508		6,549	7,650	975		7,970
Railroad On	to	Bailey NB Off	22.82	20.28	13,443	3+1H		1	7,650		1,000	7,549	7,650		1,230	9,200
Bailey NB Off	to	Bailey SB Off	20.28	20.07	1,119	3+1A+1H	1		8,037	298		7,251	8,335	612		8,588
Bailey SB Off	to	Bailey SB On	20.07	19.95	612	3+1H	1		7,650	387		6,864	7,650	685		7,903
Bailey SB On	to	Willow Pass NB Off	19.95	19.00	5,011	3+1A+1H		1	8,873		1,223	8,087	9,024		1,374	9,277
Willow Pass NB Off	to	Willow Pass NB On	19.00	18.81	1,008	3+1H	1		7,650	175		7,912	7,650	218		9,059
Willow Pass NB On	to	Willow Pass SB On	18.81	18.57	1,262	3+1H		1	7,650		421	8,333	7,650		701	9,760
Willow Pass SB On	to	Willow Pass W Off	18.57	17.18	7,329	4+1H		2	9,650		1,057	9,390	9,650		1,504	11,264
Willow Pass W Off	to	Willow Pass W On	17.18	16.69	2,614	3+1H	1		7,650	834		8,556	7,650	1,251		10,013
Willow Pass W On	to	Port Chicago Off	16.69	15.64	5,512	3+1H		1	7,650		1,310	9,866	7,650		1,346	11,359
Port Chicago Off	to	SR-242 Off	15.64	15.32	1,695	5	1		10,000	881		8,985	10,000	899		10,460
SR-242 Off	to	Port Chicago On	15.32	14.59	3,881	2	3		4,000	3,500		5,485	4,000	4,000		6,460
Port Chicago On	to	SR-242 On	14.59	14.36	1,225	2		1	4,000		453	5,938	4,000		900	7,360
SR-242 On	to	Solano Off	14.36	13.94	2,196	2+1A		1	4,571		571	6,509	5,050		1,050	8,410
Solano Off	to	Solano On	13.94	13.71	1,236	2	1		4,000	1,214		5,295	4,000	1,740		6,670
Solano On	to	I-680 NB Off	13.71	12.79	4,836	2		1	4,000		532	5,827	4,000		800	7,470
I-680 NB Off	to	I-680 NB On	12.79	12.70	449	2	1		4,000	1,680		4,147	4,000	2,268		5,202
I-680 NB On	to	I-680 SB Off	12.70	12.60	544	2+1A		1	4,674		674	4,821	4,733		733	5,935
I-680 SB Off	to	I-680 SB On	12.60	12.50	512	2	1		4,000	1,235		3,586	4,000	1,667		4,268
I-680 SB On	to	Pacheco Off	12.50	12.36	760	2+1A		1	4,322		322	3,908	4,380		380	4,648
Pacheco Off	to	Pacheco On	12.36	12.31	248	2	1		4,000	830		3,078	4,000	1,300		3,348
Pacheco On	to	Morello Off	12.31	10.51	9,536	3		1	6,000		249	3,327	6,000		320	3,668
Morello Off	to	Morello On	10.51	10.18	1,758	3	1		6,000	704		2,623	6,000	848		2,820
Morello On	to	Pine St Off	10.18	9.31	4,551	3		1	6,000		514	3,137	6,000		550	3,370
Pine St Off	to	Pine St On	9.31	9.05	1,399	3	1		6,000	824		2,313	6,000	988		2,382
Pine St On	to	Alhambra Off	9.05	8.72	1,742	3+1A		1	6,613		613	2,926	6,682		682	3,064
Alhambra Off	to	Alhambra On	8.72	8.41	1,632	3	1		6,000	1,140		1,786	6,000	1,200		1,864
Alhambra On	to	McEwen Off	8.41	5.32	16,331	3		1	6,000		423	2,209	6,000		500	2,364
McEwen Off	to	Cumming Off	5.32	5.07	1,304	2	1		4,000	62		2,147	4,000	220		2,144
Cumming Off	to	Cumming On	5.07	4.84	1,236	2	1		4,000	213		1,934	4,000	246		1,898
Cumming On	to	Franklin Off	4.84	2.93	10,059	2		1	4,000		112	2,046	4,000		355	2,253
Franklin Off	to	Franklin On	2.93	2.30	3,351	2			4,000			2,046	4,000			2,253
Franklin On	to	Willow Ave	2.30	1.15	6,070	2			4,000			2,046	4,000			2,253
Willow Ave	to	I-80 Off	1.15	0.73	2,180	2	1		4,000	0		2,046	4,000	0		2,253
I-80 Off	to	San Pablo	0.73	0.00	3,869	2			4,000			2,046	4,000			2,253

SR 4 Eastbound PM - Freeway and Ramp Traffic Demands

Existing (2007)

Location			Abs PM		Section Length (ft)	Configuration			2007			
									Capacity	Peak Hour Demands (5-6 PM)		
			From	To		Mainline Lanes	Off-Ramp Lanes	On-Ramp Lanes		Off-Ramp	On-Ramp	Mainline
I-80	to	Willow Avenue On	0.00	0.78	4,108	3			6,000			2,011
Willow Avenue On	to	Sycamore Off	0.78	1.15	1,969	3		1	6,000			2,011
Sycamore Off	to	Sycamore On	1.15	1.43	1,453	2	1		4,000	17		1,994
Sycamore On	to	Franklin Off	1.43	3.20	9,358	2		1	4,000		134	2,128
Franklin Off	to	Franklin On	3.20	3.43	1,211	2			4,000			2,128
Franklin On	to	Barry Hill Off	3.43	4.41	5,175	2			4,000			2,128
Barry Hill Off	to	Cumming Skwy Off	4.41	4.63	1,156	2			4,000			2,128
Cumming Skwy Off	to	Cumming Skwy On	4.63	4.94	1,632	2	1		4,000	40		2,088
Cumming Skwy On	to	McEwen On	4.94	5.33	2,096	2		1	4,000		206	2,294
McEwen On	to	Alhambra Off	5.33	8.45	16,452	2		1	4,000		15	2,309
Alhambra Off	to	Alhambra On	8.45	8.72	1,410	2	1		4,000	310		1,999
Alhambra On	to	Pine St Off	8.72	9.03	1,653	2+1A		1	4,421		800	2,799
Pine St Off	to	Pine St On	9.03	9.37	1,795	3	1		6,000	421		2,378
Pine St On	to	Morello Ave Off	9.37	10.20	4,377	3		1	6,000		652	3,030
Morello Ave Off	to	Morello Ave On	10.20	10.49	1,526	3	1		6,000	335		2,695
Morello Ave On	to	Pacheco Off	10.49	11.66	6,220	3		1	6,000		796	3,491
Pacheco Off	to	Pacheco On	11.66	12.35	3,617	2	1		4,000	347		3,144
Pacheco On	to	I-680 SB Off	12.35	12.53	961	2+1A		1	4,653		653	3,797
I-680 SB Off	to	I-680 SB On	12.53	12.63	502	2	1		4,000	1,120		2,677
I-680 SB On	to	I-680 NB Off	12.63	12.72	512	2+1A		1	4,146		980	3,657
I-680 NB Off	to	I-680 NB On	12.72	12.80	380	2	1		4,000	146		3,511
I-680 NB On	to	Solano Off	12.80	13.64	4,440	2		1	4,000		430	3,941
Solano Off	to	Solano On	13.64	13.94	1,579	2	1		4,000	361		3,580
Solano On	to	SR-242 SB Off	13.94	14.38	2,318	2+1A		1	4,367		530	4,110
SR-242 SB Off	to	SR-242 NB Off	14.38	14.55	919	2	1		4,000	367		3,743
SR-242 NB Off	to	SR-242 NB On	14.55	14.88	1,742	2	1		4,000	398		3,345
SR-242 NB On	to	Port Chicago On	14.88	15.75	4,615	4		3	7,500		4,233	7,578
Port Chicago On	to	Willow Pass W Off	15.75	16.67	4,821	3+1H		1	7,650		121	7,699
Willow Pass W Off	to	Willow Pass W On	16.67	17.18	2,719	3+1H	1		7,650	101		7,598
Willow Pass W On	to	San Macro Off	17.18	18.57	7,308	4+1H		1	9,650		230	7,828
San Macro Off	to	Willow Pass On	18.57	18.73	855	3+1H	1		7,650	1,556		6,272
Willow Pass On	to	San Macro On	18.73	18.96	1,251	3+1H		1	7,650		134	6,406
San Macro On	to	Bailey SB Off	18.96	19.88	4,821	3+1H		1	7,650		18	6,424
Bailey SB Off	to	Bailey NB Off	19.88	20.17	1,521	3+1A+1H	1		8,435	950		5,474
Bailey NB Off	to	Bailey NB On	20.17	20.29	681	3+1H	1		7,650	785		4,689
Bailey NB On	to	Railroad Off	20.29	22.88	13,639	3+1H		1	7,650		605	5,294
Railroad Off	to	Railroad On	22.88	23.16	1,499	3	1		6,000	1,875		3,419
Railroad On	to	Loveridge Off	23.16	24.11	4,995	2		1	4,000		400	3,819
Loveridge Off	to	Loveridge SB On	24.11	24.20	507	2	1		4,000	568		3,251
Loveridge SB On	to	Loveridge NB On	24.20	24.40	1,051	2		1	4,000		425	3,676
Loveridge NB On	to	Somerville SB Off	24.40	25.85	7,630	2		1	4,000		630	4,306
Somerville SB Off	to	Somerville NB Off	25.85	26.02	887	2	1		4,000	346		3,960
Somerville NB Off	to	Somerville NB On	26.02	26.19	919	2	1		4,000	267		3,693
Somerville NB On	to	L St Off	26.19	26.80	3,231	2		1	4,000		510	4,203
L St Off	to	G St Off	26.80	27.11	1,632	2	1		4,000	210		3,993
G St Off	to	A St Off	27.11	27.65	2,856	2	1		4,000	245		3,748
A St Off	to	A St On	27.65	27.94	1,515	2	1		4,000	720		3,028
A St On	to	Hillcrest Off	27.94	28.75	4,293	2		1	4,000		353	3,381
Hillcrest Off	to	Hillcrest On	28.75	29.09	1,811	2	1		4,000	1,850		1,531
Hillcrest On	to	160 Off	29.09	31.34	11,832	2		1	4,000		205	1,736
-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-

Future (2015 & 2030)

Location			Abs PM		Section Length (ft)	Configuration			2015				2030			
									Capacity	Peak Hour Demands (5-6 PM)			Capacity	Peak Hour Demands (5-6 PM)		
			From	To		Mainline Lanes	Off-Ramp Lanes	On-Ramp Lanes		Off-Ramp	On-Ramp	Mainline		Off-Ramp	On-Ramp	Mainline
I-80	to	Willow Avenue On	0.00	0.78	4,108	3			6,000			2,271	6,000			3,279
Willow Avenue On	to	Sycamore Off	0.78	1.15	1,969	3		1	6,000		0	2,271	6,000		0	3,279
Sycamore Off	to	Sycamore On	1.15	1.43	1,453	2	1		4,000	18		2,253	4,000	34		3,245
Sycamore On	to	Franklin Off	1.43	3.20	9,358	2		1	4,000		154	2,407	4,000		157	3,402
Franklin Off	to	Franklin On	3.20	3.43	1,211	2			4,000			2,407	4,000			3,402
Franklin On	to	Barry Hill Off	3.43	4.41	5,175	2			4,000			2,407	4,000			3,402
Barry Hill Off	to	Cumming Skwy Off	4.41	4.63	1,156	2			4,000			2,407	4,000			3,402
Cumming Skwy Off	to	Cumming Skwy On	4.63	4.94	1,632	2	1		4,000	90		2,317	4,000	112		3,290
Cumming Skwy On	to	McEwen On	4.94	5.33	2,096	2		1	4,000		216	2,533	4,000		220	3,510
McEwen On	to	Alhambra Off	5.33	8.45	16,452	2		1	4,000		16	2,549	4,000		21	3,531
Alhambra Off	to	Alhambra On	8.45	8.72	1,410	2	1		4,000	360		2,189	4,000	460		3,071
Alhambra On	to	Pine St Off	8.72	9.03	1,653	2+1A		1	4,471		855	3,044	4,541		950	4,021
Pine St Off	to	Pine St On	9.03	9.37	1,795	3	1		6,000	471		2,573	6,000	541		3,480
Pine St On	to	Morello Ave Off	9.37	10.20	4,377	3		1	6,000		732	3,305	6,000		802	4,282
Morello Ave Off	to	Morello Ave On	10.20	10.49	1,526	3	1		6,000	340		2,965	6,000	485		3,797
Morello Ave On	to	Pacheco Off	10.49	11.66	6,220	3		1	6,000		871	3,836	6,000		946	4,743
Pacheco Off	to	Pacheco On	11.66	12.35	3,617	2	1		4,000	364		3,472	4,000	497		4,246
Pacheco On	to	I-680 SB Off	12.35	12.53	961	2+1A		1	4,703		703	4,175	4,803		803	5,049
I-680 SB Off	to	I-680 SB On	12.53	12.63	502	2	1		4,000	1,142		3,032	4,000	1,187		3,862
I-680 SB On	to	I-680 NB Off	12.63	12.72	512	2+1A		1	4,153		1,080	4,112	4,246		1,130	4,992
I-680 NB Off	to	I-680 NB On	12.72	12.80	380	2	1		4,000	153		3,959	4,000	246		4,746
I-680 NB On	to	Solano Off	12.80	13.64	4,440	2		1	4,000		530	4,489	4,000		580	5,326
Solano Off	to	Solano On	13.64	13.94	1,579	2	1		4,000	411		4,078	4,000	511		4,815
Solano On	to	SR-242 SB Off	13.94	14.38	2,318	2+1A		1	4,417		580	4,658	4,617		680	5,495
SR-242 SB Off	to	SR-242 NB Off	14.38	14.55	919	2	1		4,000	417		4,241	4,000	617		4,878
SR-242 NB Off	to	SR-242 NB On	14.55	14.88	1,742	2	1		4,000	448		3,793	4,000	748		4,130
SR-242 NB On	to	Port Chicago On	14.88	15.75	4,615	4		3	7,500		4,545	8,338	7,500		4,745	8,875
Port Chicago On	to	Willow Pass W Off	15.75	16.67	4,821	3+1H		1	7,650		201	8,539	7,650		371	9,246
Willow Pass W Off	to	Willow Pass W On	16.67	17.18	2,719	3+1H	1		7,650	151		8,388	7,650	251		8,995
Willow Pass W On	to	San Macro Off	17.18	18.57	7,308	4+1H		1	9,650		310	8,698	9,650		480	9,475
San Macro Off	to	Willow Pass On	18.57	18.73	855	3+1H	1		7,650	1,606		7,092	7,650	1,706		7,769
Willow Pass On	to	San Macro On	18.73	18.96	1,251	3+1H		1	7,650		314	7,406	7,650		484	8,253
San Macro On	to	Bailey SB Off	18.96	19.88	4,821	3+1H		1	7,650		198	7,604	7,650		368	8,621
Bailey SB Off	to	Bailey NB Off	19.88	20.17	1,521	3+1A+1H	1		8,615	1,100		6,504	8,685	1,150		7,471
Bailey NB Off	to	Bailey NB On	20.17	20.29	681	3+1H	1		7,650	965		5,539	7,650	1,035		6,436
Bailey NB On	to	Railroad Off	20.29	22.88	13,639	3+1H		1	7,650		810	6,349	7,650		1,010	7,446
Railroad Off	to	Railroad On	22.88	23.16	1,499	3+1H	1		7,650	1,894		4,455	7,650	1,913		5,534
Railroad On	to	Loveridge Off	23.16	24.11	4,995	3+1A+1H		1	8,238		600	5,055	8,246		740	6,274
Loveridge Off	to	Loveridge NB On	24.11	24.40	1,560	3+1H	2		7,650	588		4,467	7,650	596		5,677
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Loveridge NB On	to	Somerville SB Off	24.40	25.85	7,630	3+1A+1H		1	8,361		1,230	5,697	8,510		1,684	7,361
Somerville SB Off	to	Somerville NB On	25.85	26.27	2,255	3+1H	1		7,650	711		4,986	7,650	860		6,501
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Somerville NB On	to	L St Off	26.27	26.89	3,231	3+1A+1H		1	7,936		810	5,796	8,060		1,173	7,674
L St Off	to	L St On	26.89	27.23	1,800	3+1H	1		7,650	286		5,510	7,650	410		7,264
L St On	to	A St Off	27.23	27.72	2,600	3+1A+1H	1		8,051		401	5,911	8,059		409	7,673
A St Off	to	A St On	27.72	28.01	1,515	3+1H	2		7,650	864		5,047	7,650	1,220		6,453
A St On	to	Hillcrest Off	28.01	28.82	4,293	3+1A+1H		1	11,103		453	5,500	11,103		453	6,906
Hillcrest Off	to	Hillcrest On	28.82	29.16	1,811	3+1H	2		7,650	1,844		3,656	7,650	2,215		4,691
Hillcrest On	to	160 Off	29.16	30.09	4,910	3+1H		1	7,650		218	3,874	7,650		255	4,946
160 Off	to	Laurel Off	30.09	0.00	6,582	3	2		6,000	1,202		2,672	6,000	1,442		3,504
Laurel Off	to	Laurel SB On	31.34	1.00	1,913	2	2		4,000	102		2,570	4,000	138		3,366
Laurel SB On	to	Laurel NB On	31.70	2.00	1,280	2		1	4,000		94	2,664	4,000		127	3,493
Laurel NB On	to	Lone Tree Off	31.94	3.00	3,507	2		1	4,000		86	2,750	4,000		116	3,609
Lone Tree Off	to	Sand Creek	32.61	4.00	5,280	2	1		4,000	410		2,340	4,000	869		2,740

Appendix B: Peak and Shoulder Factors Used to Create Multiple Analysis Hours in FREQ12

Time Slice Hour	2007						2015						2030					
	Westbound AM Peak Hour			Eastbound PM Peak Hour			Westbound AM Peak Hour			Eastbound PM Peak Hour			Westbound AM Peak Hour			Eastbound PM Peak Hour		
	Lone Tree Way to Willow Pass Rd	Willow Pass Rd to Solano Way	Lone Tree Way to Willow Pass Rd	San Pablo to Solano Way	Solano Way to Willow Pass Road	Willow Pass Rd to Lone Tree Way	Lone Tree Way to Willow Pass Rd	Willow Pass Rd to Solano Way	Lone Tree Way to Willow Pass Rd	Willow Pass Rd to Solano Way	Lone Tree Way to Willow Pass Rd	Willow Pass Rd to Solano Way	Lone Tree Way to Willow Pass Rd	Willow Pass Rd to Solano Way	Lone Tree Way to Willow Pass Rd	Willow Pass Rd to Solano Way	Lone Tree Way to Willow Pass Rd	Willow Pass Rd to Solano Way
1	1.00	0.89	0.78	0.86	0.85	0.96	1.01	0.92	0.84	0.87	0.85	0.96	0.94	0.93	0.90	0.90	0.88	0.98
2	1.05	1.11	112	0.95	0.88	0.94	1.24	1.26	1.36	0.94	0.86	0.92	1.02	1.11	1.16	0.96	0.90	0.97
3	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4	0.91	0.78	0.64	0.94	0.97	0.91	0.68	0.76	0.69	0.95	0.97	0.93	0.99	0.98	0.95	0.96	0.97	0.94

Appendix C: Existing (2007) and Projected Future (2015 & 2030) Performance Measures

Existing and Future Performance Measures on SR 4 – Peak Hour						
Measure (Full Analysis Area – 33 miles)	**Westbound - AM Peak Hour (8-9 AM)**			**Eastbound - PM Peak Hour (5-6 PM)**		
	2007	**2015**	**2030**	**2007**	**2015**	**2030**
Veh. Hours of Travel (VHT)	3,700	5,300	7,800	3,000	3,900	6,800
Veh. Miles of Travel (VMT)	91,000	111,000	101,000	118,000	132,000	142,000
Average Speed (mph)	28 (HOV: 40)	25 (HOV: 49)	14 (HOV: 42)	38 (HOV: 45)	31 (HOV: 32)	13 (HOV: 13)
Corridor Travel Time (h:mm)	1:07 (HOV: 0:47)	1:20 (HOV: 0:41)	2:26 (HOV: 0:48)	0:49 (HOV: 0:42)	1:06 (HOV: 1:04)	2:32 (HOV: 2:29)
Total Delay (VHT for speeds less than 60 mph)	2,180	3,440	6,190	1,040	1,780	4,550
Congestion Delay (VHT for speeds less than 35 mph)	1,690	2,730	5,450	690	1,400	4,030
Miles of Congested Segments (Speeds less than 35 mph)	8.0	12.0	17.0	3.5	6.5	16.0

Existing and Future Performance Measures on SR 4 – Peak Period						
Measure (Full Analysis Area – 33 miles)	**Westbound - AM Peak Period (6-10 AM)**			**Eastbound - PM Peak Period (3-7 PM)**		
	2007	**2015**	**2030**	**2007**	**2015**	**2030**
Veh. Hours of Travel (VHT)	11,000	16,500	22,700	10,200	12,100	19,400
Veh. Miles of Travel (VMT)	359,000	446,000	459,000	444,000	532,000	594,000
Average Speed (mph)	38 (HOV: 45)	34 (HOV: 53)	26 (HOV: 45)	43 (HOV: 47)	44 (HOV: 45)	28 (HOV: 29)
Average Corridor Travel Time (h:mm)	0:53 (HOV: 00:42)	1:05 (HOV: 0:38)	1:35 (HOV: 0:44)	0:44 (HOV: 0:40)	0:49 (HOV: 0:47)	1:31 (HOV: 1:28)
Total Delay (VHT for speeds less than 60 mph)	5,170	9,270	15,140	2,980	3,580	9,780
Congestion Delay (VHT for speeds less than 35 mph)	3,720	7,000	12,270	1,900	2,430	8,070
Miles of Congested Segments (Speeds less than 35 mph)	1.0 - 8.0 (Avg. 5.0)	3.0 -12.0 (Avg. 8.5)	7.0 – 17.0 (Avg. 13.0)	1.5 – 3.5 (Avg. 2.0)	1.0 – 6.5 (Avg. 4.0)	4.0 – 16.0 (Avg. 10.0)

Existing and Future Performance Measures on SR 4 – Daily						
Measure (Full Analysis Area – 33 miles)	**Westbound - Daily**			**Eastbound - Daily**		
	2007	**2015**	**2030**	**2007**	**2015**	**2030**
Veh. Hours of Travel / Hr. (VHT)	36,000	69,000	134,600	62,600	89,900	182,100
Veh. Miles of Travel / Hr. (VMT)	1,490,000	2,115,000	2,554,000	1,877,000	2,848,000	3,553,000
Total Delay (VHT/hr for speeds less than 60 mph)	5,200	10,900	25,200	3,000	4,200	16,300

State Route 4

Section 5: Recommended Strategies and Improvements

The Congestion Mitigation Strategies Technical Memorandum summarizes mitigation strategies for State Route 4 (SR-4) in Contra Costa County proposed to address the performance problems identified in the previous ECT and FCT technical memoranda. This improvement package was developed with input from the SR-4 CSMP Corridor TAC. The primary objective of this analysis is to identify candidate congestion mitigation strategies for the SR-4 CSMP Corridor for the short-term (2009-2015) and long-term (2016–2030).

This Prioritized Congestion Mitigation Strategies Technical Memorandum presents the results of the technical analysis and recommended prioritization of congestion mitigation strategies for the SR-4 CSMP Corridor. The improvement package evaluated was based on the Congestion Mitigation Strategies Technical Memorandum. The primary objectives of the Prioritized Congestion Mitigation Strategies Technical Memorandum are 1) to estimate and compare benefits and costs of the proposed corridor improvements and 2) to provide a prioritized list of recommended corridor improvements.

Attached Documents

- **SR-4 Corridor in Contra Costa County**
  Congestion Mitigation Strategies Technical Memorandum
  Final - November 9, 2009
  Prepared by: PBS&J under contract with the Metropolitan Transportation Commission
- **SR-4 Corridor in Contra Costa County**
  Prioritized Congestion Mitigation Strategies Technical Memorandum
  Final - November 9, 2009
  Prepared by: PBS&J under contract with the Metropolitan Transportation Commission

Metropolitan Transportation Commission

SR 4 Corridor in Contra Costa County

Congestion Mitigation Strategies Technical Memorandum

Prepared by: PBS&J
For: Metropolitan Transportation Commission
Final
November 9, 2009

Table of Contents

Metropolitan Transportation Commission

SR 4 Corridor in Contra Costa County

Congestion Mitigation Strategies Technical Memorandum

Prepared by: PBS&J
For: Metropolitan Transportation Commission
Final
November 9, 2009

Introduction

This memorandum summarizes the mitigation strategies for State Route 4 (SR 4) in Contra Costa County based on the *Future Conditions Technical Memorandum* (FCT) completed for this corridor on October 9, 2009. The primary objective of this analysis is to identify candidate congestion mitigation strategies for the SR 4 Corridor to be considered in the short-term (2009 - 2015) and long-term (2016 - 2030). In the next phase of this study, the short- and long-term strategies will be finalized and a cost/benefits evaluation will be used to develop a prioritized list of mitigation strategies for SR 4.

Section 1: Key Findings

Congestion mitigation strategies for the SR 4 Corridor for 2015 and 2030 are based upon the calibrated FREQ models and the traffic forecasts presented and documented in the FCT. This analysis has been conducted to identify mitigation strategies that address congestion along the SR 4 Corridor including capacity improvements (e.g., additional lanes, HOV facilities), operational improvements (e.g., auxiliary lanes) and transportation management strategies (e.g., ramp metering, changeable message signs).[1]

In this summary, the mitigation strategies are separated into short-term needs (2009 through 2015) and long-term needs (2016 through 2030). The strategies are grouped into packages that are based on either individual projects or logical groupings of projects. The strategies are not prioritized within the short-term or long-term categories; the prioritization of strategy packages will be addressed in the next phase of the study.

Short-term (2009 – 2015) Mitigation Strategies

Short-term Strategy Package A: Deploy ITS technologies on SR 4 throughout Contra Costa County: This ITS-based strategy package includes the installation and operation of closed circuit television (CCTV), traffic detection and changeable message signs (CMS). The goal of this strategy package is to reduce non-recurrent congestion along SR 4 in Contra Costa County. This package includes the following:

- Activate existing ITS installations that currently are not fully operational (e.g., no power, no connection to the Transportation Management Center);
- Assess gaps in the current and programmed ITS installations and supplement as needed (e.g., SR 4 between I-680 and SR 160) to reduce and/or close significant detection gaps; and
- Extend ITS coverage to fill the gap between I-80 and I-680 and along the SR 4 Bypass.

Short-term Strategy Package B: Address existing and projected bottleneck locations through the implementation of transportation management and capacity enhancement strategies on westbound SR 4 between I-680 and Hillcrest Avenue and on the SR 4 Bypass: In 2015, these deficiencies are primarily focused between the Solano Way on-ramp and I-680 northbound off-ramp and between the Willow Pass Road (West) on-ramp and the Port Chicago Highway off-ramp. A combination of capacity enhancements and transportation management strategies are under consideration to address these deficiencies:

- Implement ramp metering in the westbound direction on SR 4 between SR 160 and I-680;[2] [3]
- Add a westbound mixed-flow lane from the SR 242 off-ramp to the I-680 NB off-ramp; and
- Extend the existing westbound mixed-flow lane from the Willow Pass Road (West) off-ramp to the lane-add located 4,200 feet west of the Willow Pass (West) on-ramp.

Short-term Strategy Package C: Address existing and projected bottleneck locations through the implementation of transportation management and capacity enhancement strategies on eastbound SR 4 between I-80 and SR 160 and on the SR 4 Bypass: In 2015, these deficiencies are primarily focused between the Port Chicago Highway on-ramp and the Willow Pass Road (West) off-ramp. A combination of capacity enhancements and transportation management strategies are under consideration to address these deficiencies:

- Implement ramp metering in the eastbound direction between Alhambra Avenue and Willow Pass Road (East); and

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1 Mitigation strategies were not considered for freeway-connector ramps because congestion on connecting freeways (e.g., I-680, I-80) is not reflected in the FREQ model used for this analysis. Without an understanding of mainline congestion on the connecting freeways, the effectiveness of mitigation measures would not be quantifiable.

2 Caltrans' goal is for all ramp metering installations to be adaptive.

3 In the prioritization and implementation of ramp metering on this segment, the segment between I-680 and Loveridge Road may be accelerated, while the segment between Loveridge Road and SR 160 is contingent on completion of the SR 4 East Widening Project.

- Add an eastbound mixed-flow lane from the lane drop located 1,500 feet west of the Port Chicago Highway on-ramp to the Willow Pass Road (West) on-ramp.[4]

Long-term (2016 – 2030) Mitigation Strategies

Long-term Strategy Package D: Further address existing and projected bottleneck locations through the implementation of transportation management and capacity enhancement strategies on westbound SR 4 between I-680 and Hillcrest Avenue: In 2030, these deficiencies are primarily focused between the Solano Way on-ramp and the I-680 northbound off-ramp and between the Willow Pass Road (West) on-ramp and the Port Chicago Highway off-ramp. The following additional capacity enhancement is under consideration to further address these deficiencies:

- Add a westbound mixed-flow lane from the lane drop located 3,500 feet east of the Willow Pass Road (East) off-ramp to the Willow Pass Road (West) off-ramp.

Long-term Strategy Package E: Further address existing and projected bottleneck locations through the implementation of transportation management and capacity enhancement strategies on eastbound SR 4 between I-80 and SR 160: In 2030, these deficiencies are primarily focused between the Port Chicago Highway on-ramp and the Willow Pass Road (West) off-ramp. Although there are no bottlenecks identified west of I-680 in 2030, queuing from bottlenecks to the east is projected to affect operations west to Hercules. The following capacity enhancement strategy is under consideration to address these deficiencies:

- Extend the existing eastbound mixed-flow lane from the lane drop located to 1,500 feet west of the Pacheco Boulevard off-ramp to the Pacheco Boulevard off-ramp.
- Extend the exiting eastbound HOV lane from the I-680 NB off-ramp to its start 3,000 feet west of the Port Chicago Highway on-ramp.
- Extend the existing eastbound mixed-flow lane from the Willow Pass Road (East) on-ramp to the lane add located 4,000 feet east of the Willow Pass Road (East) on-ramp.

Long-term Strategies Package F: Address gaps in ramp metering on westbound SR 4: The following transportation management measure will improve mobility and is consistent with the Ramp Metering Development Plan *(Caltrans, July 2009)* for SR 4:

- Implement ramp metering in the westbound direction on the SR 4 Bypass and on SR 4 between I-680 and I-80.

Long-term Strategies Package G: Address gaps in ramp metering on eastbound SR 4: The following transportation management measure will improve mobility and is consistent with the Ramp Metering Development Plan *(Caltrans, July 2009)* for SR 4:

- Implement ramp metering in the eastbound direction between I-80 and Alhambra Avenue, between Willow Pass Road (East) and SR 160, and on the SR 4 Bypass.[5]

Short-term and Long-term (2009 – 2030) Transit Mitigation Strategies

Transit Strategy Package H: Implement transit strategies in the SR 4 Corridor: These strategies address transit improvements that would increase transit ridership and capacity, effectively reducing travel demand on SR 4 in both the eastbound and westbound directions. The recommendations include:

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4 An HOV lane was not recommended for this segment because there is already an existing HOV lane between Port Chicago Highway and Willow Pass Road (West).

5 Some benefit may be gained by accelerating the implementation of ramp metering in the eastbound direction between Willow Pass Road (East) and SR 160 in that it would address congestion that will not be alleviated until construction of the SR 4 East Widening Project is completed.

- eBART: Expanded service from the Bay Pittsburg/Bay Point BART station to a new station at Railroad Avenue and a terminus station east of Hillcrest Avenue in Antioch. Also, additional parking at both proposed stations.
- Additional BART parking capacity;
- Increased bus transit access to BART stations[6]; and
- Improvements to existing park-and-ride facilities in Martinez (Pacheco Boulevard), Antioch (Hillcrest Avenue), and Pittsburg (Bliss Avenue), as well as investment in new park-and-ride facilities at proposed/potential eBART stations.[7]
- BART system-wide operational improvements.

6 The type of bus service is to be determined, but can be local and/or regional service.

7 The *Tri Delta Transit Short Range Transit Plan, FY 2007/2008 – FY 2017/2018* (January 2008), calls for the development of additional transit centers/park-and-ride lots to be located at proposed and potential eBART station locations, including Somersville Road in Antioch and Lone Tree Way at the SR 4 Bypass in Brentwood.

Section 2: Short-Term (2009-2015) Mitigation Strategies

2015 Bottleneck Locations

Three controlling bottleneck locations were identified in the 2015 FCT analysis and are shown in Appendix A of this report. Of these three bottlenecks, two are projected to occur during the AM peak period in the westbound direction, and one is projected to occur during the PM peak period in the eastbound direction. These bottlenecks, referred to as Locations 1 through 3 in the FCT, are described as follows:

- **Location 1 -- Westbound between the Solano Way on-ramp and the I-680 northbound off-ramp:** This bottleneck occurs when the SR 4 mainline merges with the on-ramp volumes from Solano Way, causing the demand to exceed capacity on this two-lane section.
- **Location 2 -- Westbound between the Willow Pass Road (West) on-ramp and the Port Chicago Highway off-ramp:** Upstream of Location 1, this bottleneck occurs when the SR 4 mainline merges with the on-ramp volumes from the Willow Pass Road (West) on-ramp, causing the demand to exceed capacity on this four-lane section, consisting of three mixed-flow lanes and one HOV lane.
- **Location 3 – Eastbound between the Port Chicago Highway on-ramp and the Willow Pass Road (West) off-ramp:** This bottleneck occurs when the SR 4 mainline merges with the high on-ramp volumes from SR 242 and Port Chicago Highway causing the demand to exceed capacity on this four-lane section (three mixed-flow lanes and one HOV lane). The two eastbound bottlenecks identified in the existing conditions analysis, between SR 242 and Port Chicago Highway and between I-680 and Solano Way, are projected to be embedded in queues from Location 3 in 2015.

Flow rates and demand volumes, measured in vehicles per hour (vph), were examined for the bottlenecks described above and within the projected queues resulting from these bottlenecks. Because of the proximity of the bottlenecks at Location 1 and Location 2, it is recommended that these bottleneck locations be addressed as a pair since mitigating the bottleneck at Location 2 would shift the controlling bottleneck downstream to Location 1.

The methodology used to address bottlenecks was to first consider strategies such as auxiliary lanes between interchanges and ramp metering, because of their low construction costs and short implementation time. In cases where auxiliary lanes and ramp metering are not sufficient to address the bottlenecks, capacity improvement strategies such as additional mixed-flow lanes and HOV facilities are considered.

Westbound Short-Term Mitigation Strategies (Locations 1 & 2)

For the bottleneck at Location 1, the proposed strategies under consideration are (a) ramp metering in the westbound direction between SR 160 and I-680 and (b) a westbound mixed-flow lane from the SR 242 off-ramp to the I-680 NB off-ramp (a portion of Phase III of the *I-680/SR 4 Interchange Improvements Project)*. Ramp metering is considered as a traffic management strategy that will primarily serve to provide uniform flow from the on-ramps by dissipating platoons of vehicles. A mixed-flow lane between the Solano Way on-ramp and the I-680 northbound off-ramp would address capacity deficiencies approaching the I-680 interchange.

For the bottleneck at Location 2, the proposed strategies under consideration are (a) ramp metering in the westbound direction between SR 160 and I-680 (mentioned above for Location 1) and (b) extend the existing westbound mixed-flow lane from the Willow Pass Road (West) off-ramp to the lane-add located 4,200 feet west of the Willow Pass (West) on-ramp. The extension of the existing mixed-flow lane is under consideration because it will address heavy on-ramp volumes from Willow Pass (West), (1,000 to 1,300 vph) and increase the section from four lanes to five lanes to match the five-lane section immediately downstream. The demand on this section before the proposed strategy is nearly 2,000 vph over the capacity. This bottleneck will be further addressed with transit improvements in 2030, when travel demands on SR 4 are projected to be significantly higher. The existing HOV lane allows eligible vehicles to bypass most of the congestion approaching this bottleneck.

Eastbound Short-Term Mitigation Strategies (Location 3)

For the bottleneck at Location 3, the proposed strategies under consideration are (a) ramp metering in the eastbound direction between Alhambra Avenue and Willow Pass Road (East) and (b) an eastbound mixed-flow lane from the lane drop located 1,500 feet west of the Port Chicago Highway on-ramp to the Willow Pass Road (West) on-ramp. The mixed-flow lane is under consideration because the demand on that section is between 700 and 1,000 vph over the capacity. This mixed-flow lane would widen the freeway from four lanes (three mixed-flow lanes and one HOV lane) to five lanes (four mixed-flow lanes and one HOV lane) to match the configuration of the downstream segment between the Willow Pass Road (West) on-ramp and the Willow Pass Road (East)/San Marco Boulevard off-ramp.

Short-Term Intelligent Transportation Systems (ITS) Strategies

The proposed strategies under consideration to address non-recurrent delay, also known as incident delay, are (a) activate existing ITS installations that currently are not fully operational (e.g., no power, no connection to the Transportation Management Center), (b) assess gaps in the current and programmed ITS installations and supplement as needed (e.g., SR 4 between I-680 and SR 160) to reduce and/or close significant detection gaps, and (c) extend ITS coverage to fill the gap between I-80 and I-680.[8] Existing ITS infrastructure in the SR 4 Corridor, such as closed-circuit television cameras (CCTVs), changeable message signs (CMSs), and traffic monitoring stations (TMSs, also known as detectors), do not currently meet Caltrans' desired coverage. Several existing ITS installations would require maintenance to bring them to a fully-functioning state. ITS coverage in the portion of the SR 4 Corridor between I-680 and SR 160 is substantial, but there are still gaps that need to be addressed. The segment of the SR 4 Corridor between I-80 and I-680 includes significant detection gaps. Incident delay accounts for a substantial portion of all delay. These strategies are intended to reduce incident delay (improve reliability) by decreasing accident recovery times.

Summary of Short-Term Mitigation Strategies

Suggested 2015 strategies for SR 4 in both the eastbound and westbound directions of travel include:

- **Activate existing ITS installations that are not fully operational.** As depicted in the *SR 4 Existing Conditions Technical Memorandum* (ECT), there are numerous ITS installations that are in place, but are not considered fully operational for a variety of reasons (e.g., no power, not connection to the TMC).
- **Assess gaps in the current and programmed ITS installations and supplement as needed to reduce and/or close significant detection gaps**. A significant number of ITS installations exist on sections of SR 4 (e.g., SR 4 between I-680 and SR 160), but additional ITS installations would be needed to meet the ITS coverage goal for SR 4.[9]
- **Extend ITS coverage to fill the gap between I-80 and I-680 and the along the SR 4 Bypass.** The proposed ITS extension would complete the ITS package for the SR 4 Corridor.
- **Implement ramp metering in the westbound direction between SR 160 and I-680**. Operate as to dissipate platoons without impacts to the local roadway network.
- **Add a westbound mixed-flow lane from the SR 242 off-ramp to the I-680 NB off-ramp.** This improvement will help mitigate the relatively high exiting volumes that occur between these two interchanges.
- **Extend the existing westbound mixed-flow lane from the Willow Pass Road (West) off-ramp to the lane-add located 4,200 feet west of the Willow Pass (West) on-ramp.** This improvement in the westbound direction addresses the capacity constraint of the controlling bottleneck on this segment.
- **Implement ramp metering in the eastbound direction between Alhambra Avenue and Willow Pass Road (East).** Operate as to dissipate platoons without impacts to the local roadway network.

8 ITS Strategies can also address recurrent delay.
9 ITS coverage goals are outlined in the SR 4 ECT.

- **Add an eastbound mixed-flow lane from the lane drop located 1,500 feet west of the Port Chicago Highway on-ramp to the Willow Pass Road (West) on-ramp.** This improvement in the eastbound direction addresses the capacity constraint of the controlling bottleneck on this segment.

Section 3: Long-Term (2016-2030) Mitigation Strategies

2030 Bottleneck Locations

The same three controlling bottleneck locations identified for 2015 were also identified for 2030, as documented in the SR 4 FCT analysis and shown in Appendix A of this report. Additionally, a fourth bottleneck was identified for 2030, also documented in the SR 4 FCT analysis. These bottlenecks, labeled as Locations 1, 2, and 3 are described below:

- **Location 1 -- Westbound between the Solano Way on-ramp and the I-680 northbound off-ramp:** This bottleneck occurs when the SR 4 mainline merges with the on-ramp volumes from Solano Way, causing the demand to exceed capacity on this two-lane section.
- **Location 2 -- Westbound between the Willow Pass Road (West) on-ramp and the Port Chicago Highway off-ramp:** Upstream of Location 1, this bottleneck occurs when the SR 4 mainline merges with the on-ramp volumes from the Willow Pass Road (West) on-ramp, causing the demand to exceed capacity on this four-lane section, consisting of three mixed-flow lanes and one HOV lane.
- **Location 3 – Eastbound between the Port Chicago Highway on-ramp and the Willow Pass Road (West) off-ramp:** This bottleneck occurs when the SR 4 mainline merges with the high on-ramp volumes from SR 242 and Port Chicago Highway, causing the demand to exceed capacity on this four-lane section, consisting of three mixed-flow lanes and one HOV lane.

Flow rates and demand volumes, measured in vehicles per hour (vph), were examined for the bottlenecks described above and within the projected queues resulting from these bottlenecks.

Westbound Long-Term Mitigation Strategies (Locations 1 & 2)

In addition to the short-term mitigation strategies under consideration, discussed in Section 2, the following additional strategy is under consideration under long-term conditions (2016-2030) to address the same bottlenecks at Location 1 and Location 2.

The strategy under consideration to address these bottlenecks is a westbound mixed-flow lane from the lane drop located 3,500 feet east of the Willow Pass Road (East) off-ramp to the Willow Pass Road (West) off-ramp. The additional mixed-flow lane, in addition the westbound capacity improvements recommended for 2015, is under consideration because the demand on that section is projected to be 1,100 to 2,200 vph over capacity in 2030.

Although it does not specifically addressing a controlling bottleneck location, a gap-filling westbound ramp metering strategy is being considered: ramp metering in the westbound direction on the SR 4 Bypass and on SR 4 between I-680 and I-80. This traffic management strategy will improve mobility through these sections and is consistent with the Ramp Metering Development Plan *(Caltrans, July 2009)*.

Eastbound Long-Term Mitigation Strategies (Location 3)

In addition to the 2015 traffic management and capacity improvement strategies under consideration, discussed in Section 1, the following additional strategies are under consideration for 2030 to address the same controlling bottleneck at Location 3 and eastbound upstream and downstream bottlenecks.

For the controlling bottleneck at Location 3 and eastbound upstream and downstream bottlenecks, the proposed strategies under consideration are (a) extend the existing eastbound mixed-flow lane from the lane drop located to 1,500 feet west of the Pacheco Boulevard off-ramp to the Pacheco Boulevard off-ramp, (b) extend the eastbound HOV lane from the I-680 NB off-ramp to its start 3,000 feet west of the Port Chicago Highway on-ramp, and (c) extend the existing eastbound mixed-flow lane from the Willow Pass Road (East) on-ramp to the lane add located 4,000 feet east of the Willow Pass Road (East) on-ramp. The HOV lane extension from the I-680 NB off-ramp to its start 3,000 feet west of the Port Chicago Highway on-ramp would be implemented in conjunction with the planned HOV flyover ramp from I-680 northbound to SR 4 eastbound and would also increase capacity on this section of SR 4, which is projected to be 700 to 1,300 vph over capacity throughout this section. The mixed-flow lane extension at the Pacheco Boulevard off-ramp would provide additional capacity to relieve an upstream embedded bottleneck at this location. The mixed-flow lane extension at the Willow Pass Road (East) on-ramp would provide additional capacity to relieve a downstream bottleneck at this location.

Similar to the westbound direction, a gap-filling eastbound ramp metering strategy is being considered: ramp metering in the eastbound direction between I-80 and Alhambra Avenue, between Willow Pass Road (East) and SR 160, and on the SR 4 Bypass. This traffic management strategy will improve mobility through these sections and is consistent with the Ramp Metering Development Plan *(Caltrans, August 2006)*.

Summary of Long-Term Mitigation Strategies

Suggested 2030 strategies for SR 4 in both the eastbound and westbound directions of travel include:

- **Add a westbound mixed-flow lane from the lane drop located 3,500 feet east of the Willow Pass Road (East) off-ramp to the Willow Pass Road (West) off-ramp.** This improvement in the westbound direction addresses the capacity constraint of the controlling bottleneck at Location 2.
- **Extend the existing eastbound mixed-flow lane from the lane drop located to 1,500 feet west of the Pacheco Boulevard off-ramp to the Pacheco Boulevard off-ramp.** This improvement will relieve an upstream embedded bottleneck at this location.
- **Extend the existing eastbound HOV lane from the I-680 NB off-ramp to its start 3,000 feet west of the Port Chicago Highway on-ramp.** This improvement will allow HOVs in queue to access the HOV lane sooner, while providing additional capacity to this section.
- **Extend the existing eastbound mixed-flow lane from the Willow Pass Road (East) on-ramp to the lane add located 4,000 feet east of the Willow Pass Road (East) on-ramp.** This improvement will relieve a downstream bottleneck at this location.
- **Implement ramp metering in the westbound direction on the SR 4 Bypass and on SR 4 between I-680 and I-80.** Gap-filling ramp metering strategy.
- **Implement ramp metering in the westbound direction between I-80 and Alhambra Avenue, between Willow Pass Road (East) and SR 160, and on the SR 4 Bypass.** Gap-filling ramp metering strategy.

Section 4: Short-term and Long-term (2009 - 2030) Transit Mitigation Strategies

Short-Term and Long-Term Transit Mitigation Strategies (Locations 1, 2 & 3)

To supplement the traffic management and capacity improvements considered above for short-term and long-term mitigation strategies, a package of transit mitigation strategies is provided to address the projected increase in travel demand on SR 4 in 2015 and 2030 in both the eastbound and westbound directions. Transit improvements would encourage travel along the SR 4 Corridor via modes other than the single-occupant vehicle, which would reduce travel demand on SR 4.

Short-term and long-term transit mitigation strategies proposed for the SR 4 Corridor include (a) the proposed eBART project (an expansion of the BART system into East Contra Costa County including additional parking), (b) additional BART parking capacity at the east-most BART station park-and-ride lots along the SR 4 Corridor (Pittsburg/Bay Point), (c) increased bus transit access to the BART stations within the SR 4 Corridor, (d) improvements to existing park-and-ride facilities in Martinez (Pacheco Boulevard), Antioch (Hillcrest Avenue), and Pittsburg (Bliss Avenue), as well as investment in new park-and-ride facilities at proposed/potential eBART stations, and (e) BART system-wide operational improvements. Transit mitigation strategies (a) through (d) would encourage more transit use by increasing access to BART, while (e) would provide the operational enhancements necessary to accommodate ridership increases. All transit mitigation strategies would result in a mode shift from automobile to transit and would effectively reduce demand on the SR 4 freeway.

Other possible transit and complementary Transportation Demand Management strategies for future consideration include shuttle feeder service to park-and-ride facilities (or other transit hubs and major attractions), incentives to increase vanpool/carpool utilization and vehicle occupancy, and incentives to increase participation in employer-offered telework programs.

Summary of Short-Term and Long-Term Transit Mitigation Strategies

Suggested short-term and long-term transit mitigation strategies for SR 4 in both the eastbound and westbound directions of travel include:

- **eBART: Expanded service from Bay Pittsburg/Bay Point BART station to a new station at Railroad Avenue and a terminus station east of Hillcrest Avenue in Antioch.** This strategy, as part of the proposed eBART project would expand BART system into East Contra Costa County from the existing Pittsburg/Bay Point BART station to a new station at Railroad Avenue and to a terminus station east of Hillcrest Avenue. The eBART project includes 300 parking spaces for the proposed station at Railroad Avenue and 2,600 parking spaces for the proposed station at Hillcrest Avenue. This transit improvement, while increasing transit ridership and capacity, would decrease auto travel demand on SR 4 in both the eastbound and westbound directions.
- **Additional BART parking capacity at east-most BART station (Pittsburg/Bay Point)**. This transit improvement will encourage travel along the SR 4 Corridor via transit, reducing single-occupant vehicle travel demand on SR 4.
- **Increased bus transit access to the BART stations.** This transit improvement would improve access to existing BART stations along the SR 4 Corridor (North Concord/Martinez and Pittsburg/Bay Point) and encourage travel via transit.
- **Improvements to existing park-and-ride facilities in Martinez (Pacheco Boulevard), Antioch (Hillcrest Avenue), and Pittsburg (Bliss Avenue), as well as investment in new park-and-ride facilities at proposed/potential eBART stations.** This transit improvement would improve access to existing and programmed bus service lines.
- **BART system-wide operational improvements.** This operational improvement strategy would allow BART to accommodate increased ridership.

Section 5: Express Lanes Mitigation Strategy

In addition to the physical roadway mitigation improvements described in previous sections of this memorandum and the transit mitigation improvement measures described in Section 4, the option of converting the HOV lanes on SR 4 to Express Lanes (also referred to as High-Occupancy Toll Lanes, or HOT Lanes) is discussed here. Express Lanes allow HOV users to continue to use the carpool lane for free, but also allow single-occupant vehicles to access the carpool lane by paying a toll.

MTC's *Transportation 2035 Plan for the San Francisco Bay Area* (T-2035) proposes a Regional Express Lane Network for the Bay Area, which includes Express Lanes on SR 4 between I-680 and SR 160.[10] On July 16, 2009, the California Senate Transportation and Housing Committee passed Assembly Bill 744 (Torrico), which authorizes the creation of an 800-mile express lane network on Bay Area freeways. This bill must still be passed by the Senate Appropriations Committee before moving on to the Senate floor for authorization.

The conversion of HOV lanes to Express Lanes on SR 4 would increase the total number of vehicles using the HOV lanes, provided those lanes have available "vacant" capacity that can be "bought" by single-occupant drivers who are willing to pay a toll in exchange for a faster trip in the HOV lane. Toll-paying single-occupant vehicles are allowed to enter the HOV lane; however, as the volume of traffic in the lane begins to reach a pre-determined capacity level, the toll amount charged to single-occupant users increases dynamically in response to the demand. Real-time, variable pricing of the "vacant" capacity in the HOV lanes is used as a mechanism to limit the number of vehicles entering the lane. The Express Lane operator is required, through pricing and changeable message signs, to maintain free-flow conditions in the Express Lane at all times.

All existing Express Lanes in the United States are limited access facilities. In the Bay Area design, Express Lanes are separated from the adjacent mixed-flow lanes by a double-stripe line, similar to facilities in Seattle and Minneapolis. Lane markings, such as a single-dashed stripe or transition lane, designate ingress and egress zones. Non-carpools using the Express Lanes pay their tolls using electronic FasTrak® toll tags, which are already in use on the region's eight toll bridges; as a vehicle enters the Express Lane, an electronic reader detects the toll tag and deducts the toll from a prepaid account.

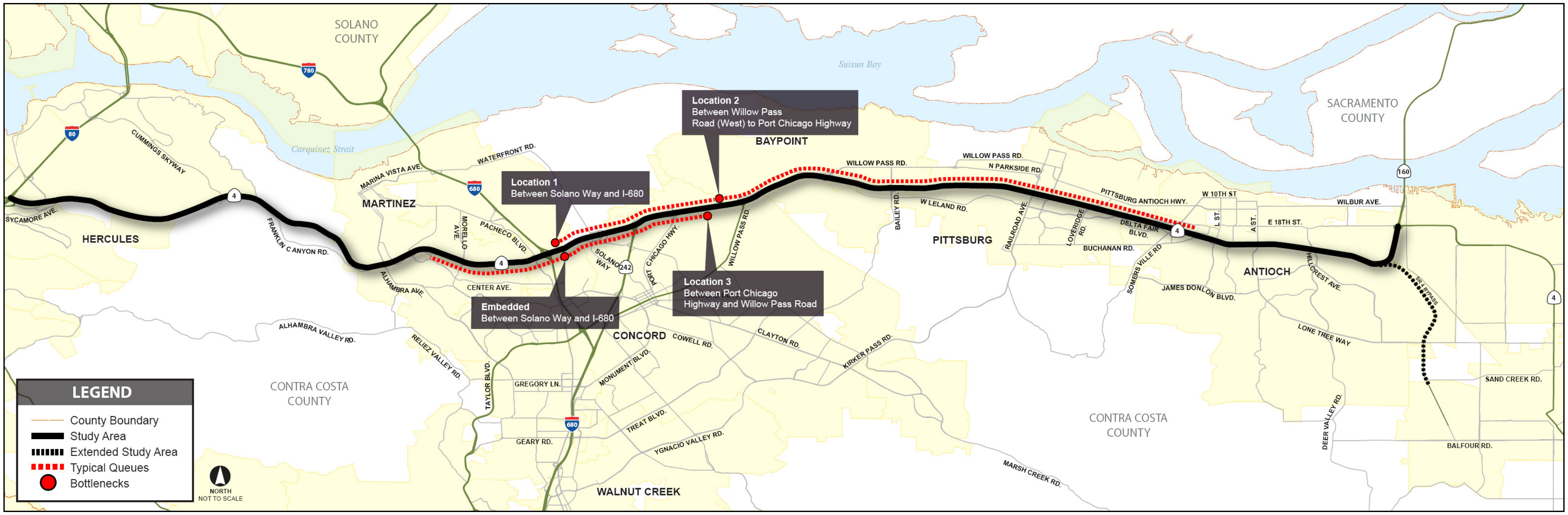
Documented benefits of Express Lanes in operation in the United States include: improved travel speeds in the mixed-flow lanes; increased corridor throughput; ability to provide a reliable travel option that can be used when most needed (most express lane travelers use the lanes no more than a few times a week); and, in some cases, revenue to support transit service. Further, there is no evidence that Express Lanes reduce carpool levels or transit ridership.

Should AB 744 or similar legislation be signed into law at some point in the future, significant further analysis and consultation with affected jurisdictions along the corridor will be required to determine the feasibility, cost-effectiveness and appropriateness of converting the HOV lanes to Express Lanes in the SR 4 Corridor. This process will inform whether and how (e.g., timing and phasing, design and operations policies) to pursue Express Lanes in the corridor.

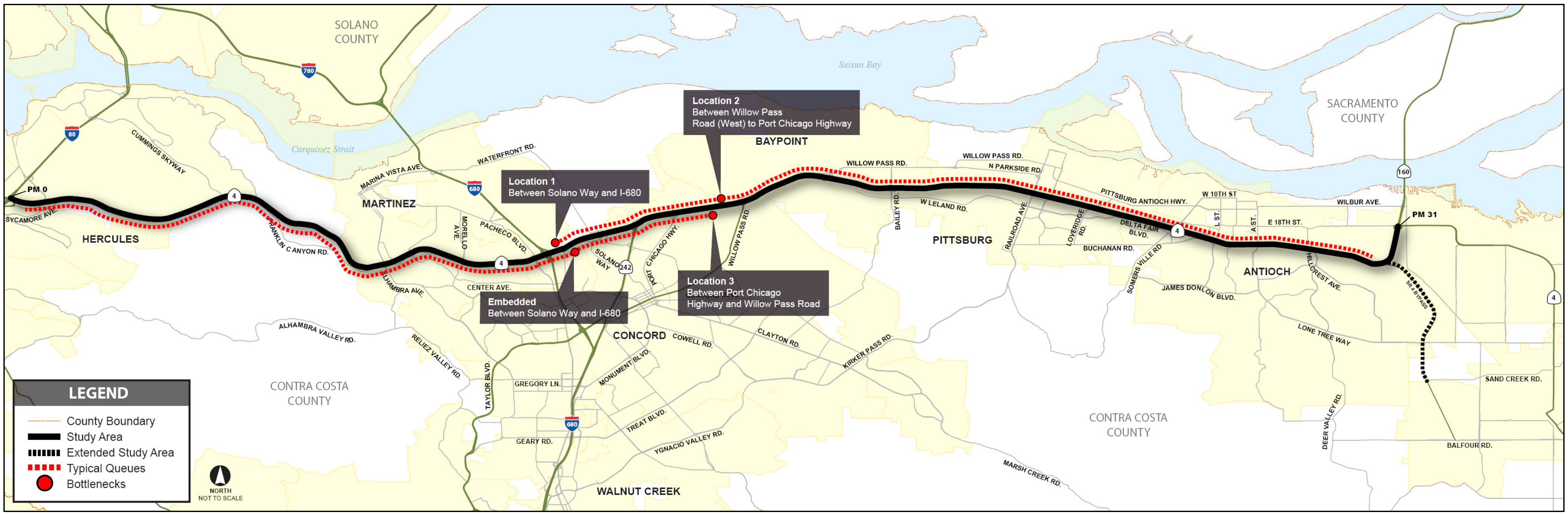
10 http://www.mtc.ca.gov/planning/hov/index.htm

Appendix A: Locations of Bottlenecks and Recurrent Congestion

Locations of Bottlenecks and Recurrent Congestion on SR 4 in 2015



Locations of Bottlenecks and Recurrent Congestion on SR 4 in 2030



Metropolitan Transportation Commission

SR 4 Corridor in Contra Costa County

Prioritized Congestion Mitigation Strategies Technical Memorandum

Prepared by: PBS&J
For: Metropolitan Transportation Commission
Final
November 9, 2009

Table of Contents

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SR 4 Corridor in Contra Costa County

Prioritized Congestion Mitigation Strategies Technical Memorandum

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Introduction

This report presents the cost-effectiveness analysis and prioritization of congestion mitigation strategies for the State Route 4 (SR 4) Corridor in Contra Costa County based on the *Congestion Mitigation Strategies Technical Memorandum*, (PBS&J, November 9, 2009) completed for this corridor. The methods and performance measures used for the analysis and prioritization are based on those set forth in the *Freeway Performance Initiative Traffic Analysis: Performance and Analysis Framework* (MTC, October 2007). Consistent with the guidance provided by this document, the primary objectives of the *Prioritized Congestion Mitigation Strategies Technical Memorandum* are 1) to estimate and compare life-cycle benefits and life-cycle costs of the proposed corridor improvements and, 2) to provide a prioritized list of corridor improvements based on the cost-effectiveness. Corresponding to these objectives, the report is presented in nine sections:

- **Section 1: Key Findings.** An executive summary of the findings in this analysis.
- **Section 2: Proposed Congestion Mitigation Strategies.** A list of the proposed congestion mitigation strategies for the SR 4 Corridor.
- **Section 3: Methodology.** A description of the quantitative and qualitative performance measures, calculation of benefits value, methodology for determining capital costs, life-cycle benefit cost calculations and prioritization of proposed congestion mitigation strategies.
- **Section 4: Performance Measures.** Results of the performance measures used in the benefits analysis and a comparison of Baseline and Improved scenarios.
- **Section 5: Life-Cycle Benefits.** Results of the life-cycle benefits analysis for the quantitative benefits and discussion of qualitative benefits analysis.
- **Section 6: Capital Costs.** Results of the life-cycle cost analysis to include values for capital costs, and operation and maintenance (O&M) costs.
- **Section 7: Cost-Effectiveness Analysis.** Results of the comparison of life-cycle benefits and life-cycle costs.
- **Section 8: Prioritization.** Ranking of congestion mitigation strategies based solely on the results of the cost-effectiveness analysis conducted for each mitigation strategy package.
- **Section 9: Transit Mitigation Strategies.** A list of proposed transit mitigation strategies.
- **Section 10: Express Lane Mitigation Strategy.** Discussion of express lanes as a potential mitigation strategy.

Section 1: Key Findings

The cost-effectiveness analysis and the subsequent prioritization of congestion mitigation strategies along the SR 4 Corridor through Contra Costa County evaluated a total of 14 Improvements grouped into seven packages. These seven packages represent approximately 228 million hours of life-cycle benefits and $212 million in life-cycle costs.

The packages are ranked below, as determined by the cost-effectiveness analysis:

Short-term Package Ranking

1. **Package B (Short-term, Westbound):**
    - Improvement #4: Implement ramp metering in the westbound direction on SR 4 between SR 160 and I-680.
    - Improvement #5: Add a westbound mixed-flow lane from the SR 242 off-ramp to the I-680 NB off-ramp.
    - Improvement #6: Extend the existing westbound mixed-flow lane from the Willow Pass Road (West) off-ramp to the lane-add located 4,200 feet west of the Willow Pass Road (West) on-ramp.

2. **Package C (Short-term, Eastbound):**
    - Improvement #7: Implement ramp metering in the eastbound direction between Alhambra Avenue and Willow Pass Road (East).[1]
    - Improvement #8: Add an eastbound mixed-flow lane from the lane drop located 1,500 feet west of Port Chicago Highway on-ramp to the Willow Pass Road (West) on-ramp.

3. **Package A (Short-term, Eastbound & Westbound):**
    - Improvement #1: Activate existing ITS installations that currently are not fully operational.
    - Improvement #2: Assess gaps in the current and programmed ITS installations and supplement as needed.
    - Improvement #3: Extend ITS coverage to fill the gap between I-80 and I-680, and along the SR 4 Bypass.

Long-term Package Ranking

1. **Package G (Long-term, Eastbound):**
    - Improvement #14: Implement ramp metering in the eastbound direction between I-80 and Alhambra Avenue, between Willow Pass Road (East) and SR 160, and on the SR 4 Bypass.[2]

2. **Package E (Long-term, Eastbound):**
    - Improvement #10: Extend the existing eastbound mixed-flow lane from the lane drop located to 1,500 feet west of the Pacheco Boulevard off-ramp to the Pacheco Boulevard off-ramp.
    - Improvement #11: Extend the existing eastbound HOV lane from the I-680 NB off-ramp its start 3,000 feet west of the Port Chicago Highway on-ramp.
    - Improvement #12: Extend the existing eastbound mixed-flow lane from the Willow Pass Road (East) on-ramp to the lane add located 4,000 feet east of the Willow Pass Road (East) on-ramp.

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[1] Caltrans' goal is for all ramp metering to be adaptive.

[2] Although listed here as a long-term strategy, some benefit may be gained by accelerating the implementation of ramp metering in the eastbound direction between Willow Pass Road (East) and SR 160 in that it would address congestion that will not be alleviated until construction of the SR 4 East Widening Project is completed.

3. **Package D (Long-term, Westbound):**
   - Improvement #9: Extend the existing westbound mixed-flow lane from the lane drop located 3,500 feet east of the Willow Pass Road (East) off-ramp to the Willow Pass Road (West) off-ramp.

4. **Package F (Long-term, Westbound):**
   - Improvement #13: Implement ramp metering in the westbound direction on the SR 4 Bypass and on SR 4 between I-680 and I-80.

It should be noted that this prioritization is a result of the cost-effectiveness analysis of the quantitative benefits (mobility and reliability), and does not incorporate qualitative benefits (goods movement, HOV connectivity, and access management), or subjective matters such as funding or political influences. Information on the qualitative benefits of the proposed packages is included in this report to provide a comprehensive analysis for regional prioritizations.

In addition to the freeway mitigation strategies, a package of short-term and long-term transit mitigation strategies, Package H, is also included. These unranked transit mitigation improvements are listed below and discussed further in Section 9.

Package H (Short-term & Long-term, Eastbound & Westbound):

- Improvement #15: eBART.
- Improvement #16: Additional BART parking capacity.
- Improvement #17: Increased bus transit access to the BART stations.
- Improvement #18: Improvements to existing park-and-ride facilities in Martinez (Pacheco Boulevard), Antioch (Hillcrest Avenue), and Pittsburg (Bliss Avenue), as well as investment in new park-and-ride facilities at proposed/potential eBART stations.
- Improvement #19: BART system-wide operational improvements.

Section 2: Proposed Congestion Mitigation Strategies

Congestion mitigation strategies for the SR 4 Corridor incorporated for the analysis and prioritization were based on the short-term (2015) and long-term (2030) mitigation measures proposed in the *Congestion Mitigation Strategies Technical Memorandum* (MST), (PBS&J, November 9, 2009).

These congestion mitigation strategies were first screened for effectiveness. This screening process was performed with an analysis using the same macroscopic simulation model, FREQ12, as was used in the *Future Conditions Technical Memorandum* (PBS&J, October 9, 2009) to validate the effectiveness of the proposed mitigation improvements.

Based on the results of the FREQ12 testing of the performance of the mitigation strategies proposed in the MST, some strategies were modified, added, or deleted and were then combined to build logical packages of mitigation improvements; the proposed congestion mitigation improvements are listed below in Exhibit 2-1. Packages A through C are short-term improvement packages, and Packages D through G are long-term improvement packages. Those strategies that entail physical expansion of SR 4 to accommodate new HOV or mixed-flow facilities are illustrated in Appendix A.[3]

Exhibit 2-1: Proposed Mitigation Improvements on SR 4

Package	Year	Direction	ID	Mitigation Improvement
A	2015	Both	1	Activate existing ITS installations that currently are not fully operational.
			2	Assess gaps in the current and programmed ITS installations and supplement as needed.
			3	Extend ITS coverage to fill the gap between I-80 and I-680, and along the SR 4 Bypass.
B	2015	WB	4	Implement ramp metering in the westbound direction on SR 4 between SR 160 and I-680.
			5	Add a westbound mixed-flow lane from the SR 242 off-ramp to the I-680 NB off-ramp.
			6	Extend the existing westbound mixed-flow lane from the Willow Pass Road (West) off-ramp to the lane-add located 4,200 feet west of the Willow Pass Road (West) on-ramp.
C	2015	EB	7	Implement ramp metering in the eastbound direction between Alhambra Avenue and Willow Pass Road (East).
			8	Add an eastbound mixed-flow lane from the lane drop located 1,500 feet west of Port Chicago Highway on-ramp to the Willow Pass Road (West) on-ramp.
D	2030	WB	9	Extend the existing westbound mixed-flow lane from the lane drop located 3,500 feet east of the Willow Pass Road (East) off-ramp to the Willow Pass Road (West) off-ramp.
E	2030	EB	10	Extend the existing eastbound mixed-flow lane from the lane drop located to 1,500 feet west of the Pacheco Boulevard off-ramp to the Pacheco Boulevard off-ramp.
			11	Extend the existing eastbound HOV lane from the I-680 NB off-ramp to its start 3,000 feet west of the Port Chicago Highway on-ramp.
			12	Extend the existing eastbound mixed-flow lane from the Willow Pass Road (East) on-ramp to the lane add located 4,000 feet east of the Willow Pass Road (East) on-ramp.
F	2030	WB	13	Implement ramp metering in the westbound direction on the SR 4 Bypass and on SR 4 between I-680 and I-80.
G	2030	EB	14	Implement ramp metering in the eastbound direction between I-80 and Alhambra Avenue, between Willow Pass Road (East) and SR 160, and on the SR 4 Bypass.

Abbreviations: ITS = Intelligent Transportation System; HOV = High Occupancy Vehicle; WB = westbound; EB = eastbound

[3] ITS and ramp metering congestion mitigation strategies were not illustrated in the map format because the text descriptions adequately describe the limits of those strategies.

Section 3: Methodology

This section provides an explanation of the methodology that was used to prepare the cost-effectiveness analysis and prioritization of congestion mitigation strategies for this report.

A cost-effectiveness analysis is a systematic evaluation of the economic advantages (benefits) and disadvantages (costs) of a set of investment alternatives. The primary objective of a cost-effectiveness analysis is to compare the proposed mitigation improvements based on their projected benefits and estimated costs. The cost- effectiveness analysis accounts for the fact that benefits generally accrue over a long period of time, while capital costs are incurred primarily in the initial years.[4]

The methods and performance measures used for the analysis and prioritization presented in this section were selected based on the guidance set forth in the FPI Framework, with the following two exceptions:[5]

(1) The quantitative performance measures were not monetized. This was agreed upon by this project's sponsoring agencies (MTC, Caltrans and CCTA) so that the performance measures would be presented in their fundamental units (e.g., person-hours of delay saved).

(2) Safety was not evaluated as part of this analysis. As noted under exception (1), the measure of person-hours of delay saved was selected to compare the quantitative performance measures, which is incompatible with the measures typically used to assess safety (i.e., number of fatality, injury and property damage collisions saved). Therefore, safety cannot be equitably evaluated side-by-side with the other performance measures according to the prioritization methodology.[6]

The following describes the data and calculations required for performing the cost-effectiveness analysis.

Benefits

The proposed mitigation improvements for the SR 4 Corridor in Contra Costa County were evaluated individually to assess the benefits of each improvement. These benefit performance measures include two quantitative performance measures and three qualitative performance measures. The quantitative performance measures are Mobility and Reliability; the qualitative performance measures are Goods Movement, HOV Connectivity, and Access Management. All values for the quantitative performance measures are represented in person-hours of delay saved.

Mobility

Mobility is a quantitative performance measure that describes how well the SR 4 Corridor moves people. Mobility can be measured in terms of recurrent vehicle delay, which is delay incurred on a typical travel day due to congested conditions in the corridor. Delay is measured as the amount of time lost for a vehicle traveling below 35 miles per hour (mph) within the corridor. By using a 35 mph standard, the recurrent delay calculated is the congested delay, not the total delay (which uses a 60 mph standard). The mobility performance measure is estimated for the implementation of each proposed mitigation improvement package.

Reliability

Reliability is a quantitative performance measure that captures the relative predictability of the public's travel time. This performance measure focuses on the extent to which mobility varies from day-to-day. Reliability can be measured in terms of

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4 http://www.oim.dot.state.mn.us/EASS/
5 FPI Framework is the *Freeway Performance Initiative Traffic Analysis: Performance and Analysis Framework* (MTC, October 2007).
6 Exclusion of the safety performance measure did not affect the rankings presented in Sections 1 and 8.

non-recurrent delay, which is delay caused by irregular events, such as accidents, special events, maintenance, short-term construction, and weather. The reliability performance measure is estimated for the implementation of each proposed mitigation improvement package. It should be noted that based on Federal Highway Administration (FHWA) research, motorists consider non-recurrent delay (i.e., reliability hours) to be equivalent to three times that of recurrent delay (i.e., mobility hours).[7] This factor of three will be reflected in the prioritization of mitigation strategy packages shown in Section 8 and Appendix B of this technical memorandum.

Goods Movement

The goods movement performance measure is a qualitative measure that determines whether the corridor provides adequate freight mobility and reliability. As outlined in the FPI Framework, the goods movement measure will be assigned a "Yes" ranking if the improvement is located in one of the designated goods movements corridors.[8] A list of the goods movement corridors identified in MTC's submittal for Trade Corridor Improvement Funds (TCIF) under the 2006 Infrastructure Bond can be found in the FPI Framework. SR 4 is not designated as a goods movement corridor in the TCIF submittal and, therefore, will be given a "No" ranking for all improvements. It should be noted, however, that just because SR 4 is not designated as a goods movement corridor does not mean that the listed improvements have no impact on goods movement in the corridor. For the purposes of the FPI analysis, the goods movement performance measure is used specifically for comparing multiple corridors.

HOV System Connectivity

The HOV system connectivity performance measure is a qualitative measure that is used to evaluate if a corridor has an effective network of HOV lanes. This performance measure is significant because HOV lanes provide a travel-time savings incentive, increased reliability and air quality benefits. Proposed mitigation improvements that would increase HOV system connectivity can be ranked higher because of this qualitative benefit.

Access Management

The access management performance measure is a qualitative measure that evaluates the existing access management in the corridor, in terms of the number of access points such as ramps. The access management performance measure is an additional measure of safety and mobility that is not captured in those specific quantitative measures. Fewer access points along a corridor typically signifies improved mobility and safety. Mitigation measures that would improve access management by reducing the number of access points will be assigned a "Yes" ranking and can be placed higher in the prioritization.

Costs

Cost performance measures estimate the total costs associated with the proposed mitigation improvements to the corridor. The two cost performance measures are capital costs (also known as construction costs or upfront costs) and operation and maintenance (O&M) costs (also known as ongoing costs). These costs are described below and are all presented in dollars at their 2007 value. As with the benefit performance measures, a discount rate of 4% per year is used to convert future values to present values by accounting for inflation and interest rates as well as inclusion of a risk factor.

Capital Costs

Capital costs include the construction, right-of-way acquisition, vehicle procurement (transit), and mitigation costs. Construction costs include mainline, ramps, intersections, bridges, signalization, erosion control, drainage, maintenance-of-traffic and

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[7] This factor is from FHWA's ITS Deployment Analysis System (IDAS), which is based on the FHWA Highway Economic Requirements System (HERS).
[8] *Freeway Performance Initiative Traffic Analysis: Performance and Analysis Framework* (MTC, October 2007).

mobilization. Unit prices of the construction items were obtained from Caltrans' Contract Cost Database and were applied to the quantity estimates.[9] Capital costs also include costs for engineering, administration, legal services, and a contingency add-in.

Operation and Maintenance (O&M) Costs

O&M costs are the annual costs estimated for operating and maintaining the proposed mitigation improvements. O&M costs include labor and materials for maintenance and repairs, utilities, financing, etc.

Scenarios

Benefits for the SR 4 Corridor were evaluated under two scenarios, Baseline Conditions and Improved Conditions (for a time period beginning after construction, referred to as Year 1, to the long-term future in 2030). A summary of all scenarios is listed below:

- Baseline Conditions, 2007
- Baseline Conditions, Year 1
- Baseline Conditions, 2015
- Baseline Conditions, 2030
- Improved Conditions, Year 1
- Improved Conditions, 2015
- Improved Conditions, 2030

Baseline Conditions

Benefits for Baseline Conditions were evaluated under 2007, 2015 and 2030 conditions and interpolated for all other years within the 2007 to 2030 timeline. Baseline 2007 Conditions were evaluated using 2007 data. Baseline 2015 Conditions incorporate existing 2007 conditions, projected growth in the area, and committed improvements in the SR 4 Corridor to be built between 2007 and 2015. Baseline 2030 Conditions also incorporate existing 2007 conditions, projected growth in the area, and committed projects.[10] A theoretical scenario of Baseline Year 1 is included in the interpolated values between Baseline 2007 Conditions and Baseline 2015 Conditions representing conditions after construction has been completed.

Improved Conditions

Benefits for Improved Conditions were evaluated under 2015 and 2030 conditions and interpolated for years in between. Data for a theoretical scenario of Improved Year 1 conditions were not modeled, but rather calculated based on available data from other scenarios.[11] Benefits are calculated from the end of construction, which varies by project, to 2030.

Analysis Approach for Prioritization

The benefit performance measures will be evaluated for all proposed mitigation improvements and for all scenarios described above. From these scenarios, the net increase in the quantitative benefits will be calculated from the end of construction (Year 1), to year 2030. This is known as the life-cycle benefits. Exhibit 3-4 illustrates the calculation of life-cycle benefits.

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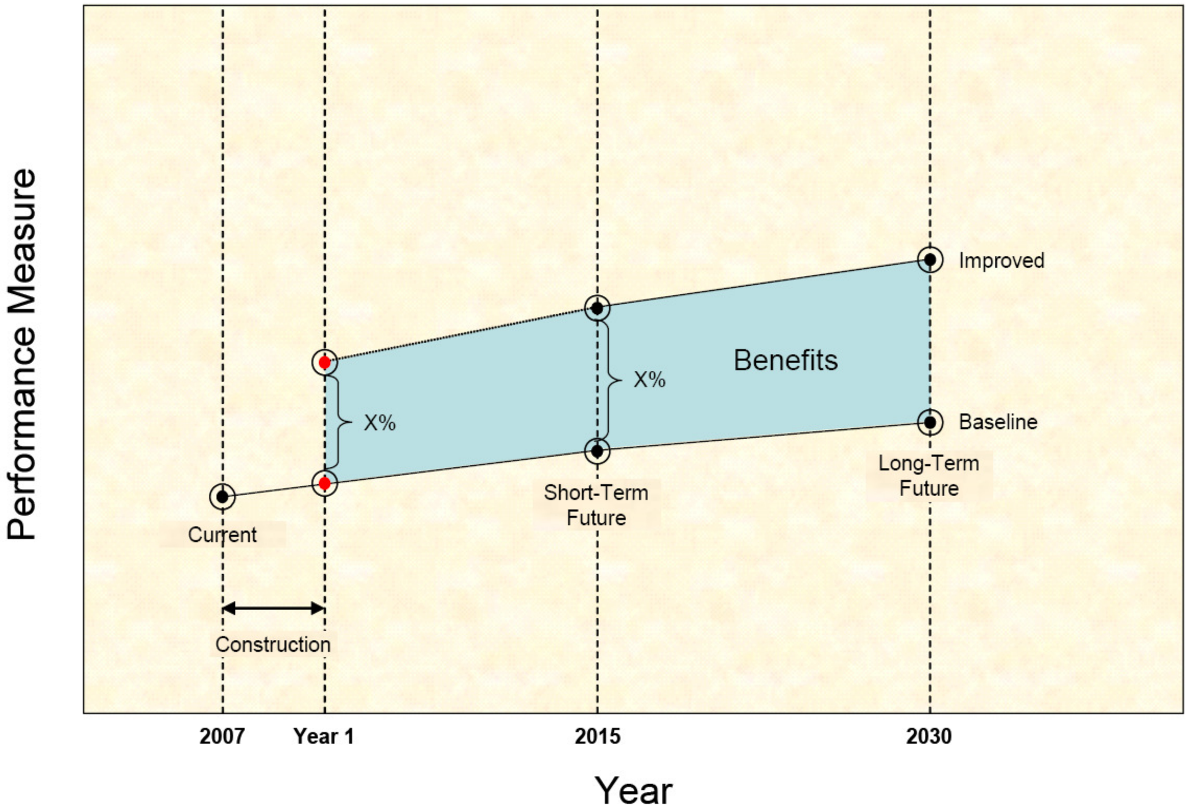
9 http://sv08data.dot.ca.gov/contractcost/

10 Committed projects are the (1) *SR 4 East Widening Project (Loveridge Road to SR160)*, and (2) Segments 1 and 2 of the SR 4 Bypass.

11 Benefit values for Baseline Year 1, Baseline 2015 and Improved 2015 are known; therefore, Improved Year 1 benefit values were estimated by assuming constant growth (see Exhibit 3-4).

Exhibit 3-4: Life-Cycle Benefits



Source: Freeway Performance Initiative Traffic Analysis: Performance and Analysis Framework (October 2007)

Detailed benefit cost estimates for each project would normally require inclusion of the duration of construction to determine when the improvement is completed and will begin accumulating benefits. However, for the purposes of this analysis, which compares a wide variety of improvements with varying construction schedules, all improvements were evaluated assuming the same length of construction such that Year 1 is the same year for all improvements.

The summation of the benefits from Year 1 to 2030 (the life-cycle benefits), will be compared to the cost performance measures of all the mitigation improvements.

Analysis Tools

A variety of analysis tools were used to evaluate the benefits of the proposed mitigation improvements. These tools include a combination of software calculations and manual calculations. The selection of the tools was mandated by the modeling capacity of the software programs and varies by the type of proposed mitigation improvement and the type of benefit. A summary of the tools used is presented in Exhibit 3-5.

Exhibit 3-5: Analysis Tools used for Developing Benefits

Type of Proposed Mitigation Improvement	Type of Benefit	
	Mobility	Reliability
Auxiliary Lane	FREQ	Manual Calculation (based on IDAS methodology)
Mixed-Flow Lane		
HOV Lane		
Ramp Metering		
ITS System Enhancements	N/A	Manual Calculation (based on IDAS methodology)

The formulas for the manual calculations are applied to the data (volumes, capacities, etc.) from FREQ, which ensures consistency between the differing analysis tools and benefits. The full methodologies and calculations of the above analysis tools used for developing mobility and reliability are available by request. Descriptions of the analysis tools follow below.

Software Calculations: FREQ

FREQ was used to evaluate recurrent congestion (mobility) for existing and future highway operating conditions. The version used was FREQ12 PE/PL, Version 3.01. The two models contained within FREQ12 are FREQ12PE, an entry control macroscopic model for analyzing ramp metering, and FREQ12PL, an on-freeway priority macroscopic model for analyzing HOV facilities. The analysis output from FREQ was used in the calculations of benefits and performance measures. The only mobility condition that FREQ was not used for was ITS System Enhancements. FREQ does not analyze ITS Improvements. Additionally, the ITS Improvements recommended target non-recurrent delay (reliability), and therefore show negligible mobility benefits.

Manual Calculations: IDAS and AASHTO

Two sources of formulas and methodology, IDAS and AASHTO, were utilized in the manual calculations.

The methodology from the ITS Deployment Analysis System (IDAS) software was used to perform manual calculations to evaluate all the ITS improvements for reliability benefits. These formulas and methodology are outlined in the IDAS User's Manual.

In addition to being used to evaluate ITS improvements, the IDAS methodology was also used to perform manual calculations to evaluate the reliability benefits of the other proposed mitigation improvements (auxiliary lanes, mixed-flow lanes, HOV lanes and ramp metering). This analysis relates the number of lanes and volume-over-capacity (V/C) ratios to travel time reliability rates.

Section 4: Performance Measures

Performance measures, such as vehicle demand, travel speed, travel time and vehicle delay, were calculated and used in the benefits analysis. Exhibits 4-1 through 4-4 present the performance measures for the following scenarios:

- Baseline Conditions, 2007 (no improvements)
- Baseline Conditions, 2015 (committed improvements)
- Baseline Conditions, 2030 (committed improvements)
- Improved Conditions, 2015 (committed improvements + short-term strategies)
- Improved Conditions, 2030 (committed improvements + short-term strategies + long-term strategies)

Additionally, exhibits 4-5 through 4-9 show the projected changes in bottleneck locations and their associated queues for the above scenarios.

Exhibit 4-1: Performance Measures on SR 4 – Westbound – AM Peak Hour

Measure (Full Analysis Area – 33 miles)	SR 4 Westbound - AM Peak Hour						
	Baseline			Improved			
	2007	2015	2030	2015	Change	2030	Change
Veh. Hours of Travel (VHT)	3,700	5,300	7,800	2,400	-55%	3,400	-56%
Veh. Miles of Travel (VMT)	91,000	111,000	101,000	123,000	+11%	146,000	+45%
Average Speed (mph)	28 (HOV: 40)	25 (HOV: 49)	14 (HOV: 42)	52 (HOV: 58)	+108% (HOV: +18%)	43 (HOV: 56)	+207% (HOV: +33%)
Delay Index (free-flow speed of 60 mph / average speed)	2.1 (HOV: 1.5)	2.4 (HOV: 1.2)	4.3 (HOV: 1.4)	1.2 (HOV: 1.0)	---	1.4 (HOV: 1.1)	---
Average Corridor Travel Time (h:mm)	1:07 (HOV: 0:47)	1:20 (HOV: 0:41)	2:26 (HOV: 0:48)	0:39 (HOV: 0:34)	-51% (HOV: -17%)	0:46 (HOV: 0:36)	-68% (HOV: -25%)
Total Delay (VHT for speeds less than 60 mph)	2,180	3,440	6,190	430	-88%	1,060	-83%
Congestion Delay (VHT for speeds less than 35 mph)	1,690	2,730	5,450	190	-93%	570	-90%
Miles of Congested Segments (Speeds less than 35 mph)	8.0	12.0	17.0	2.0	-83%	5.0	-71%

Exhibit 4-2: Performance Measures on SR 4 – Eastbound – PM Peak Hour

Measure (Full Analysis Area – 33 miles)	SR 4 Eastbound - PM Peak Hour						
	Baseline			Improved			
	2007	2015	2030	2015	Change	2030	Change
Veh. Hours of Travel (VHT)	3,000	3,900	6,800	2,800	-28%	4,900	-28%
Veh. Miles of Travel (VMT)	118,000	132,000	142,000	137,000	+4%	162,000	+14%
Average Speed (mph)	38 (HOV: 45)	31 (HOV: 32)	13 (HOV: 13)	46 (HOV: 46)	+48% (HOV: +44%)	28 (HOV: 29)	+115% (HOV: +123%)
Delay Index (free-flow speed of 60 mph / average speed)	1.6 (HOV: 1.3)	1.9 (HOV: 1.9)	4.6 (HOV: 4.6)	1.3 (HOV: 1.3)	---	2.1 (HOV: 2.1)	---
Average Corridor Travel Time (h:mm)	0:49 (HOV: 0:42)	1:06 (HOV: 1:04)	2:32 (HOV: 2:29)	0:44 (HOV: 0:44)	-33% (HOV: -31%)	1:13 (HOV: 1:09)	-52% (HOV: -54%)
Total Delay (VHT for speeds less than 60 mph)	1,040	1,780	4,550	630	-65%	2,310	-49%
Congestion Delay (VHT for speeds less than 35 mph)	690	1,400	4,030	430	-69%	1,770	-56%
Miles of Congested Segments (Speeds less than 35 mph)	3.5	6.5	16.0	2.5	-62%	10.5	-34%

Exhibit 4-3: Performance Measures on SR 4 – Westbound – AM Peak Period

Measure (Full Analysis Area – 33 miles)	SR 4 Westbound - AM Peak Period						
	Baseline			Improved			
	2007	2015	2030	2015	Change	2030	Change
Veh. Hours of Travel (VHT)	11,000	16,500	22,700	8,700	-47%	11,700	-48%
Veh. Miles of Travel (VMT)	359,000	446,000	459,000	482,000	+8%	560,000	+22%
Average Speed (mph)	38 (HOV: 45)	34 (HOV: 53)	26 (HOV: 45)	54 (HOV: 58)	+59% (HOV: +9%)	48 (HOV: 57)	+85% (HOV: +27%)
Delay Index (free-flow speed of 60 mph / average speed)	1.6 (HOV: 1.3)	1.8 (HOV: 1.1)	2.3 (HOV: 1.3)	1.1 (HOV: 1.0)	---	1.3 (HOV: 1.1)	---
Average Corridor Travel Time (h:mm)	0:53 (HOV: 0:42)	1:05 (HOV: 0:38)	1:35 (HOV: 0:44)	0:37 (HOV: 0:34)	-43% (HOV: -11%)	0:42 (HOV: 0:35)	-56% (HOV: -20%)
Total Delay (VHT for speeds less than 60 mph)	5,170	9,270	15,140	1020	-89%	2,680	-82%
Congestion Delay (VHT for speeds less than 35 mph)	3,720	7,000	12,270	340	-95%	1,250	-90%
Miles of Congested Segments (Speeds less than 35 mph)	1.0 - 8.0 (Avg. 5.0)	3.0 - 12.0 (Avg. 8.5)	7.0 – 17.0 (Avg. 13.0)	0.0 - 2.0 (Avg. 1.0)	-88%	0.5 – 5.0 (Avg. 2.5)	-81%

Exhibit 4-4: Performance Measures on SR 4 – Eastbound – PM Peak Period

Measure (Full Analysis Area – 33 miles)	SR 4 Eastbound - PM Peak Period						
	Baseline			Improved			
	2007	2015	2030	2015	Change	2030	Change
Veh. Hours of Travel (VHT)	10,200	12,100	19,400	9,900	-18%	15,100	-22%
Veh. Miles of Travel (VMT)	444,000	532,000	594,000	545,000	+2%	643,000	+8%
Average Speed (mph)	43 (HOV: 47)	44 (HOV: 45)	28 (HOV: 29)	53 (HOV: 53)	+20% (HOV: +18%)	41 (HOV: 43)	+46% (HOV: +48%)
Delay Index (free-flow speed of 60 mph / average speed)	1.4 (HOV: 1.3)	1.4 (HOV: 1.3)	2.1 (HOV: 2.1)	1.1 (HOV: 1.1)	---	1.5 (HOV: 1.4)	---
Average Corridor Travel Time (h:mm)	0:44 (HOV: 0:40)	0:49 (HOV: 0:47)	1:31 (HOV: 1:28)	0:38 (HOV: 0:38)	-22% (HOV: -19%)	0:54 (HOV: 0:51)	-41% (HOV: -42%)
Total Delay (VHT for speeds less than 60 mph)	2,980	3,580	9,780	1,210	-66%	4,700	-52%
Congestion Delay (VHT for speeds less than 35 mph)	1,900	2,430	8,070	590	-76%	3,330	-59%
Miles of Congested Segments (Speeds less than 35 mph)	1.5 – 3.5 (Avg. 2.0)	1.0 – 6.5 (Avg. 4.0)	4.0 – 16.0 (Avg. 10.0)	0.0 – 2.5 (Avg. 1.0)	-75%	0.5 – 10.5 (Avg. 5.0)	-50%

Exhibit 4-5: Locations of Bottlenecks and Recurrent Congestion on SR 4 - Baseline Conditions, 2007 (No Improvements)

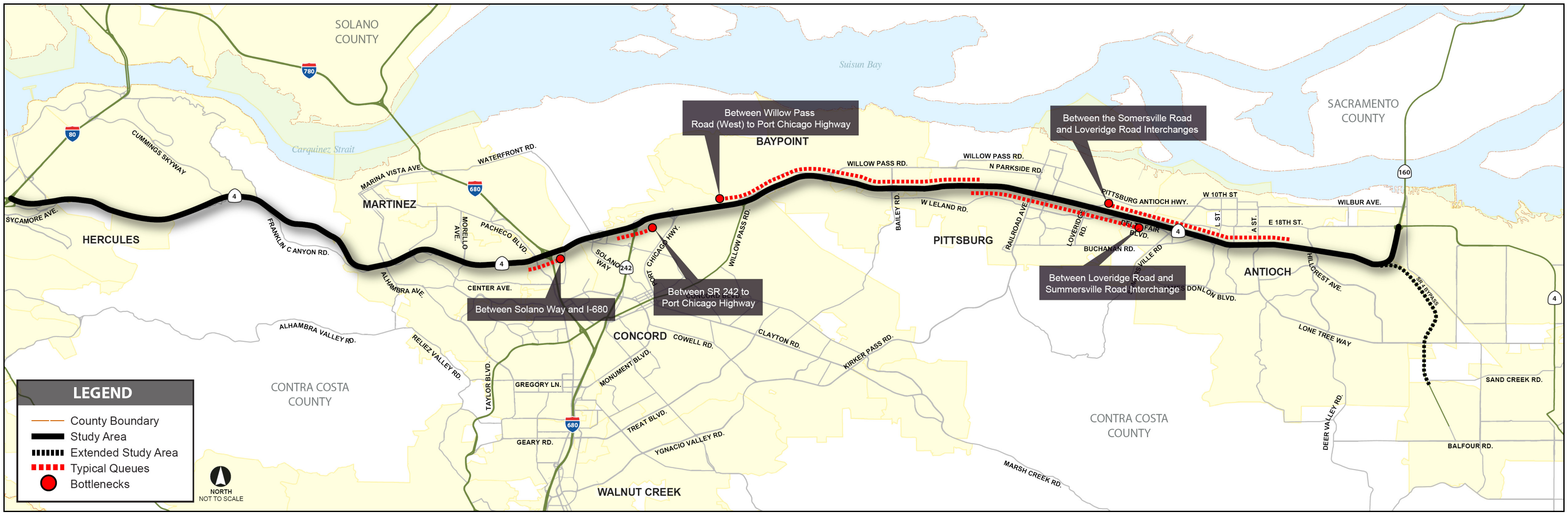


Exhibit 4-6: Locations of Bottlenecks and Recurrent Congestion on SR 4 - Baseline Conditions, 2015 (Committed Improvements)

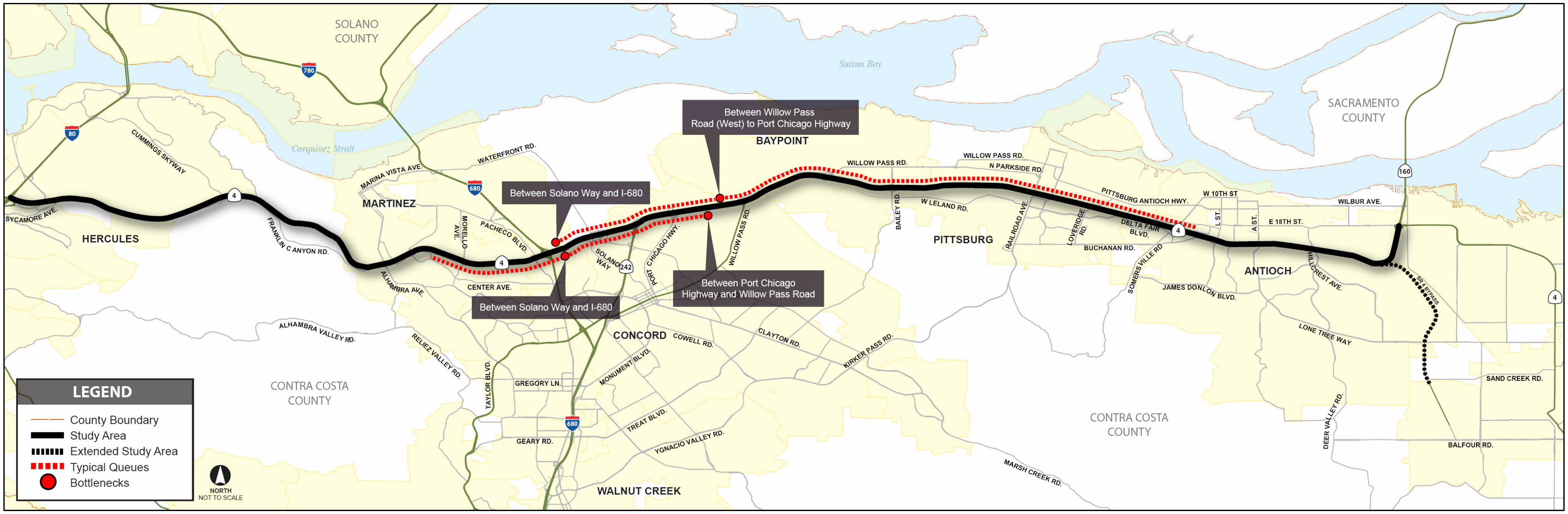


Exhibit 4-7: Locations of Bottlenecks and Recurrent Congestion on SR 4 - Improved Conditions, 2015 (Committed Improvements + Short-Term Strategies)

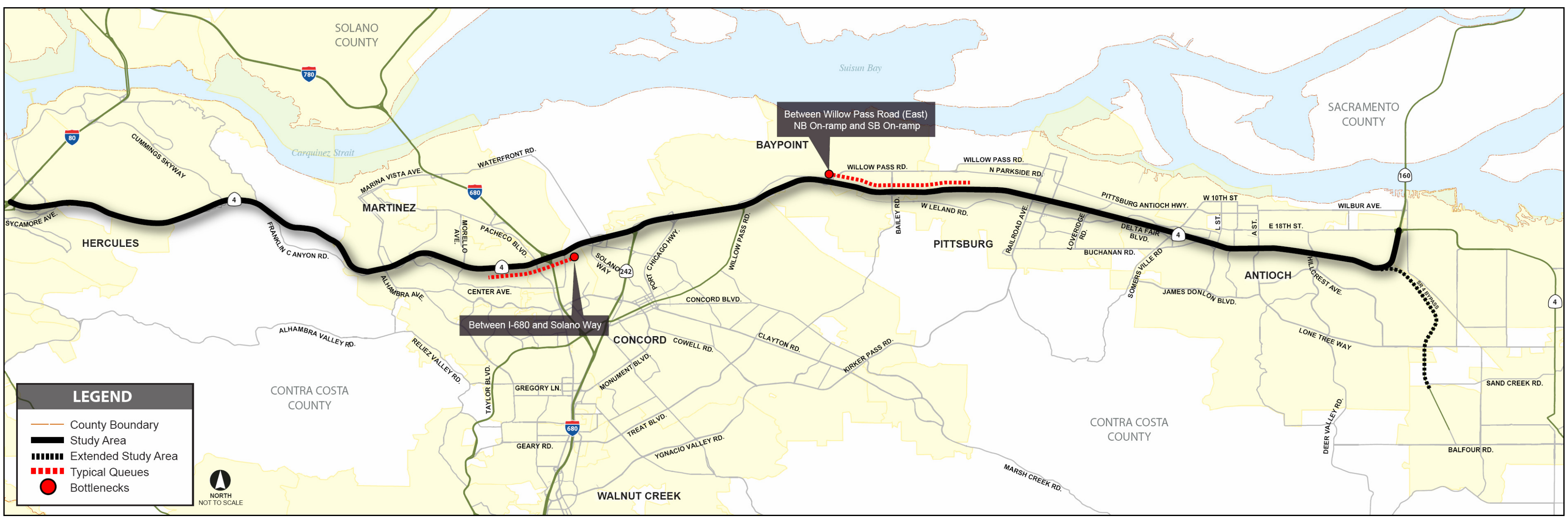


Exhibit 4-8: Locations of Bottlenecks and Recurrent Congestion on SR 4 - Baseline Conditions, 2030 (Committed Improvements)

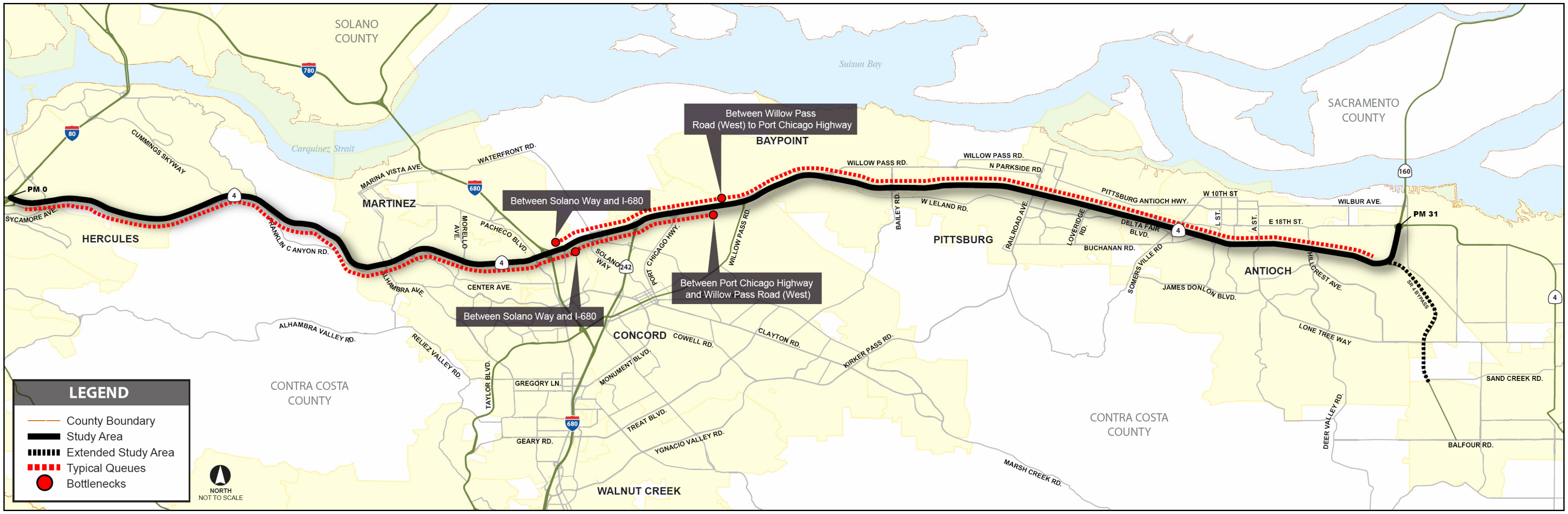
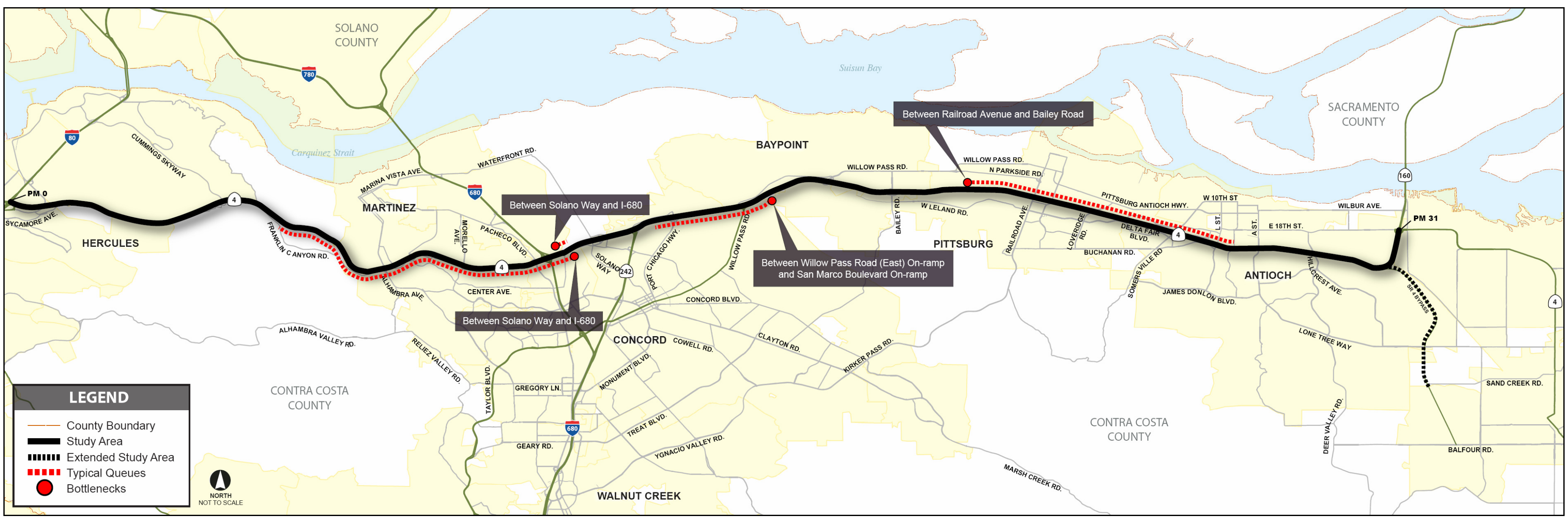


Exhibit 4-9: Locations of Bottlenecks and Recurrent Congestion on SR 4 - Improved Conditions, 2030 (Committed Improvements + Short-Term Strategies + Long-Term Strategies)



Section 5: Life-Cycle Benefits

The proposed mitigation improvements were evaluated to assess the quantitative and qualitative benefits of the improvements. The quantitative benefits, (mobility and reliability), were evaluated to estimate their life-cycle benefits. The qualitative benefits, (goods movement, HOV connectivity and access management), are also evaluated for subjective prioritization applications.

Quantitative Benefits

The quantitative benefits, mobility and reliability, were calculated for all proposed mitigation improvements as presented in Exhibit 5-1 using the analysis program (i.e., FREQ).

All calculations were performed on segment levels (e.g., Loveridge Road on-ramp to Somersville Road off-ramp) and then summed for the entire SR 4 Corridor. The mobility and reliability benefits shown in Exhibit 3-1 are the life-cycle values for 21 years, from 2009 (also known as Year 1) to 2030. These benefits include a 4% discount rate. Additional notes and assumptions of each of these benefits are provided in the following text.

Mobility

All mobility benefits were estimated using FREQ. Mobility was evaluated using actual volumes (as opposed to demand volumes) and measured in hours of recurrent delay. Specifically, congested delay was used as the type of recurrent delay used to calculate mobility.

In coordination with MTC and Caltrans staff, it was determined that mobility benefits would be quantified by evaluating recurrent delay by using congested delay, which is defined as delay resulting from vehicle speeds of less than 35 mph. Congested delay was used instead of total delay, which is defined as delays from vehicles speeds of less than 60 mph.

As a result of using congested delay instead of total delay, some improvements show no mobility benefits. This is not because the speeds remain unchanged with the addition of these improvements, but rather the absence of one of these improvements alone does not cause a decrease in speed below the 35 mph threshold. This is also due to the “All-In Differential” method.

The mobility benefit model is based on the following calculations:

1. Distances are divided by vehicle speeds to estimate travel times.
2. Calculated travel times are compared to 35 mph travel time standards of congested delay and their difference is the recurrent delay.
3. Factors are applied to convert the recurrent delay from peak period to daily and from daily to life-cycle.

Values of the life-cycle mobility benefits are presented in Exhibit 5-1.

Reliability

Reliability benefits were estimated either in IDAS or by manual computations using the travel time reliability rates provided in the IDAS User’s Manual Table B 2.14. Reliability was evaluated using unconstrained volumes to calculate V/C ratios and Vehicle Miles Traveled (VMT). Unconstrained volumes were used instead of constrained volumes because the constrained volumes are lower in oversaturated conditions as a result of vehicles in queue.

The reliability benefit model is based on the following calculations:

1. Unconstrained volumes multiplied by distance results in unconstrained VMT.

2. Travel time reliability rates from IDAS are a function of number of lanes and V/C. The travel time reliability rate is the number of vehicle hours of non-recurrent delay per VMT.
3. Unconstrained VMT values multiplied by the travel time reliability rates yields the non-recurrent delay.
4. Factors are applied to convert the non-recurrent delay from peak period to daily and from daily to life-cycle.

Values of the life-cycle reliability benefits are presented in Exhibit 5-1.

Exhibit 5-1: Quantitative Measures of Life-Cycle Benefits

Pkg	Year	Dir.	ID	Mitigation Improvement	Life-Cycle Benefits		
					Mobility (per-hrs saved)	**Reliability** (per-hrs saved)	**TOTAL** (per-hrs saved)
A	2015	Both	1	Activate existing ITS installations that currently are not fully operational.	0	11,480,000	34,440,000
			2	Assess gaps in the current and programmed ITS installations and supplement as needed.			
			3	Extend ITS coverage to fill the gap between I-80 and I-680, and along the SR 4 Bypass.			
B	2015	WB	4	Implement ramp metering in the westbound direction on SR 4 between SR 160 and I-680.	77,809,000	7,243,000	99,538,000
			5	Add a westbound mixed-flow lane from the SR 242 off-ramp to the I-680 NB off-ramp.			
			6	Extend the existing westbound mixed-flow lane from the Willow Pass Road (West) off-ramp to the lane-add located 4,200 feet west of the Willow Pass Road (West) on-ramp.			
C	2015	EB	7	Implement ramp metering in the eastbound direction between Alhambra Avenue and Willow Pass Road (East).	22,324,000	5,270,000	38,134,000
			8	Add an eastbound mixed-flow lane from the lane drop located 1,500 feet west of Port Chicago Highway on-ramp to the Willow Pass Road (West) on-ramp.			
D	2030	WB	9	Extend the existing westbound mixed-flow lane from the lane drop located 3,500 feet east of the Willow Pass Road (East) off-ramp to the Willow Pass Road (West) off-ramp.	2,926,000	5,011,000	17,959,000
E	2030	EB	10	Extend the existing eastbound mixed-flow lane from the lane drop located to 1,500 feet west of the Pacheco Boulevard off-ramp to the Pacheco Boulevard off-ramp.	8,595,000	6,058,000	26,769,000
			11	Extend the existing eastbound HOV lane from the I-680 NB off-ramp to its start 3,000 feet west of the Port Chicago Highway on-ramp.			
			12	Extend the existing eastbound mixed-flow lane from the Willow Pass Road (East) on-ramp to the lane add located 4,000 feet east of the Willow Pass Road (East) on-ramp.			
F	2030	WB	13	Implement ramp metering in the westbound direction on the SR 4 Bypass and on SR 4 between I-680 and I-80.	367,000	368,000	1,471,000
G	2030	EB	14	Implement ramp metering in the eastbound direction between I-80 and Alhambra Avenue, between Willow Pass Road (East) and SR 160, and on the SR 4 Bypass.	1,551,000	2,607,000	9,372,000

Abbreviations: ITS = Intelligent Transportation System; HOV = High Occupancy Vehicle

Note: Based on FHWA research, motorists consider non-recurrent delay (i.e., reliability hours) to be equivalent to three times that of recurrent delay (i.e., mobility hours). This factor is reflected in the "Total Life-Cycle Benefits" value.

Qualitative Benefits

The qualitative benefits were addressed for all proposed mitigation improvements as summarized below. These benefits were evaluated by determining if the proposed mitigation measure provided improvements in the SR 4 Corridor that cannot be easily quantified, but should be considered in the regional prioritization (i.e., comparing proposed mitigation improvements on SR 24 with proposed mitigation measures within other corridors in the region). These qualitative benefits, as outlined in the FPI Framework, are: goods movement, HOV connectivity, and access management. An improvement for these benefits is denoted by a "Yes." These qualitative benefits are not included in the ranking/prioritization of mitigation strategy packages because there is no specific dollar value associated with them. In accordance with the methodology described in Section 3 of this memorandum, the qualitative benefits are outlined below.

Goods Movement

For the goods movement performance measure, no mitigation improvements were given a "Yes" ranking. This is due to the fact that SR 4 is not designated as a goods movement corridor.

HOV System Connectivity

For the HOV system connectivity performance measure, the following mitigation improvement was given a "Yes" ranking:

- Improvement #11 of Package E: Extend the existing eastbound HOV lane from the I-680 NB off-ramp its start 3,000 feet west of the Port Chicago Highway on-ramp.

Access Management

For the access management performance measure, no mitigation improvements were given a "Yes" ranking. This is due to the fact that there are no proposed mitigation improvements that reduce the number of access points on the SR 4 Corridor.

As noted previously, the final prioritization does not incorporate the above qualitative performance measures. However, these qualitative "Yes" rankings are important in that they provide a more comprehensive analysis to inform the regional prioritization process.

Section 6: Life-Cycle Costs

Capital costs and O&M costs were calculated for all proposed mitigation improvements and are presented in Exhibit 6-1. Details on the methodology of the cost estimations are provided in Section 3. Capital costs were incurred during construction years and O&M costs were accrued annually after construction. Life-cycle costs were calculated for a life-cycle of 21 years, from 2009 to 2030 as with the life-cycle benefits. Life-cycle costs include a 4% discount rate.

Exhibit 6-1: Life-Cycle Costs

Pkg	Year	Dir.	ID	Mitigation Improvement	Capital Cost	O&M Cost (per year)	Life-Cycle Costs
A	2015	Both	1	Activate existing ITS installations that currently are not fully operational.	$9,906,000	$297,200	$40,110,000
			2	Assess gaps in the current and programmed ITS installations and supplement as needed.			
			3	Extend ITS coverage to fill the gap between I-80 and I-680, and along the SR 4 Bypass.	$18,074,000	$542,200	
B	2015	WB	4	Implement ramp metering in the westbound direction on SR 4 between SR 160 and I-680.	$12,976,000	$648,800	$68,220,000
			5	Add a westbound mixed-flow lane from the SR 242 off-ramp to the I-680 NB off-ramp.	$23,851,000	$9,300	
			6	Extend the existing westbound mixed-flow lane from the Willow Pass Road (West) off-ramp to the lane-add located 4,200 feet west of the Willow Pass Road (West) on-ramp.	$21,577,000	$10,900	
C	2015	EB	7	Implement ramp metering in the eastbound direction between Alhambra Avenue and Willow Pass Road (East).	$2,978,000	$148,900	$33,070,000
			8	Add an eastbound mixed-flow lane from the lane drop located 1,500 feet west of Port Chicago Highway on-ramp to the Willow Pass Road (West) on-ramp.	$27,697,000	$9,000	
D	2030	WB	9	Extend the existing westbound mixed-flow lane from the lane drop located 3,500 feet east of the Willow Pass Road (East) off-ramp to the Willow Pass Road (West) off-ramp.	$22,172,000	$13,800	$22,400 ,000
E	2030	EB	10	Extend the existing eastbound mixed-flow lane from the lane drop located to 1,500 feet west of the Pacheco Boulevard off-ramp to the Pacheco Boulevard off-ramp.	$2,117,000	$1,800	$31,880,000
			11	Extend the existing eastbound HOV lane from the I-680 NB off-ramp to its start 3,000 feet west of the Port Chicago Highway on-ramp.	$25,687,000	$16,800	
			12	Extend the existing eastbound mixed-flow lane from the Willow Pass Road (East) on-ramp to the lane add located 4,000 feet east of the Willow Pass Road (East) on-ramp.	$3,757,000	$6,000	
F	2030	WB	13	Implement ramp metering in the westbound direction on the SR 4 Bypass and on SR 4 between I-680 and I-80.	$5,396,000	$7,600	$5,510,000
G	2030	EB	14	Implement ramp metering in the eastbound direction between I-80 and Alhambra Avenue, between Willow Pass Road (East) and SR 160, and on the SR 4 Bypass.	$10,448,000	$12,900	$10,640,000
Abbreviations: ITS = Intelligent Transportation System; HOV = High Occupancy Vehicle							

Section 7: Life-Cycle Cost-Effectiveness Analysis

Life-cycle benefits and life-cycle costs were compared to estimate the life-cycle benefit cost for all proposed mitigation improvement packages, with the exception of the transit improvement package (Package H), and are presented in Exhibit 7-1. Details on the methodology used for the cost-effectiveness analysis are provided in Section 3. For each mitigation strategy package, life-cycle costs were divided by life-cycle benefits to estimate the life-cycle cost-effectiveness. The cost-effectiveness is presented as the cost for every hour of delay saved as estimated over a 21-year life-cycle, from 2009 to 2030.

Exhibit 7-1: Life-Cycle Cost-Effectiveness Analysis

Pkg	Year	Dir.	ID	Mitigation Improvement	Life-Cycle Benefits	Life-Cycle Costs	Cost-Effectiveness
A	2015	Both	1	Activate existing ITS installations that currently are not fully operational.	34,440,000 person-hours of delay saved	$40,110,000	$1.16 / person-hour of delay saved
			2	Assess gaps in the current and programmed ITS installations and supplement as needed.			
			3	Extend ITS coverage to fill the gap between I-80 and I-680, and along the SR 4 Bypass.			
B	2015	WB	4	Implement ramp metering in the westbound direction on SR 4 between SR 160 and I-680.	99,538,000 person-hours of delay saved	$68,220,000	$0.69 / person-hour of delay saved
			5	Add a westbound mixed-flow lane from the SR 242 off-ramp to the I-680 NB off-ramp.			
			6	Extend the existing westbound mixed-flow lane from the Willow Pass Road (West) off-ramp to the lane-add located 4,200 feet west of the Willow Pass Road (West) on-ramp.			
C	2015	EB	7	Implement ramp metering in the eastbound direction between Alhambra Avenue and Willow Pass Road (East).	38,134,000 person-hours of delay saved	$33,070,000	$0.87 / person-hour of delay saved
			8	Add an eastbound mixed-flow lane from the lane drop located 1,500 feet west of Port Chicago Highway on-ramp to the Willow Pass Road (West) on-ramp.			
D	2030	WB	9	Extend the existing westbound mixed-flow lane from the lane drop located 3,500 feet east of the Willow Pass Road (East) off-ramp to the Willow Pass Road (West) off-ramp.	17,959,000 person-hours of delay saved	$22,400,000	$1.25 / person-hour of delay saved
E	2030	EB	10	Extend the existing eastbound mixed-flow lane from the lane drop located to 1,500 feet west of the Pacheco Boulevard off-ramp to the Pacheco Boulevard off-ramp.	26,769,000 person-hours of delay saved	$31,880,000	$1.19 / person-hour of delay saved
			11	Extend the existing eastbound HOV lane from the I-680 NB off-ramp to its start 3,000 feet west of the Port Chicago Highway on-ramp.			
			12	Extend the existing eastbound mixed-flow lane from the Willow Pass Road (East) on-ramp to the lane add located 4,000 feet east of the Willow Pass Road (East) on-ramp.			
F	2030	WB	13	Implement ramp metering in the westbound direction on the SR 4 Bypass and on SR 4 between I-680 and I-80.	1,471,000 person-hours of delay saved	$5,510,000	$3.75 / person-hour of delay saved
G	2030	EB	14	Implement ramp metering in the eastbound direction between I-80 and Alhambra Avenue, between Willow Pass Road (East) and SR 160, and on the SR 4 Bypass.	9,372,000 person-hours of delay saved	$10,640,000	$1.14 / person-hour of delay saved

Abbreviations: ITS = Intelligent Transportation Systems; HOV = High Occupancy Vehicle

Section 8: Prioritization

All proposed mitigation improvement packages were ranked/prioritized based solely on the calculated cost-effectiveness (described above in Sections 3 and 7) of their respective improvements. For the purposes of this prioritization exercise, qualitative benefits and political considerations were not included. Rankings are shown in ascending order with Rank 1 having the most cost-effectiveness (as determined in Section 7). Exhibit 8-1 shows the ranking for each mitigation improvement package.

Exhibit 8-1: Prioritization of Mitigation Improvements

Pkg	Year	Dir.	ID	Mitigation Improvement	Package Rank	
					Short-Term	Long-Term
B	2015	WB	4	Implement ramp metering in the westbound direction on SR 4 between SR 160 and I-680.	1	---
			5	Add a westbound mixed-flow lane from the SR 242 off-ramp to the I-680 NB off-ramp.		
			6	Extend the existing westbound mixed-flow lane from the Willow Pass Road (West) off-ramp to the lane-add located 4,200 feet west of the Willow Pass Road (West) on-ramp.		
C	2015	EB	7	Implement ramp metering in the eastbound direction between Alhambra Avenue and Willow Pass Road (East). [12]	2	---
			8	Add an eastbound mixed-flow lane from the lane drop located 1,500 feet west of Port Chicago Highway on-ramp to the Willow Pass Road (West) on-ramp.		
A	2015	Both	1	Activate existing ITS installations that currently are not fully operational.	3	---
			2	Assess gaps in the current and programmed ITS installations and supplement as needed.		
			3	Extend ITS coverage to fill the gap between I-80 and I-680, and along the SR 4 Bypass.		
G	2030	EB	14	Implement ramp metering in the eastbound direction between I-80 and Alhambra Avenue, between Willow Pass Road (East) and SR 160, and on the SR 4 Bypass.	---	1
E	2030	EB	10	Extend the existing eastbound mixed-flow lane from the lane drop located to 1,500 feet west of the Pacheco Boulevard off-ramp to the Pacheco Boulevard off-ramp. [13]	---	2
			11	Extend the existing eastbound HOV lane from the I-680 NB off-ramp to its start 3,000 feet west of the Port Chicago Highway on-ramp.		
			12	Extend the existing eastbound mixed-flow lane from the Willow Pass Road (East) on-ramp to the lane add located 4,000 feet east of the Willow Pass Road (East) on-ramp.		
D	2030	WB	9	Extend the existing westbound mixed-flow lane from the lane drop located 3,500 feet east of the Willow Pass Road (East) off-ramp to the Willow Pass Road (West) off-ramp.	---	3
F	2030	WB	13	Implement ramp metering in the westbound direction on the SR 4 Bypass and on SR 4 between I-680 and I-80.	---	4
Abbreviations: ITS = Intelligent Transportation Systems; HOV = High Occupancy Vehicle						

Package B and Package C ranked the highest of all the mitigation strategy packages, addressing westbound and eastbound congestion approaching the SR 242 and I-680 interchanges. The ITS package, Package A, also ranked high providing the full coverage of ITS technology and management needed to address nonrecurrent delay and safety on the SR 4 Corridor.

[12] ITS Installations in Package A may be considered for implementation before the ramp metering mitigation (Improvement #7) in Package C, to so that the benefit of the ramp metering can be fully realized.

[13] Notwithstanding the ranking of this mixed-flow lane extension (Improvement #10) in Package E, this project may be advanced in the regional planning and programming process to advance it in conjunction with the Pacheco Transit Center expansion.

Note that within the analysis period (2007 to 2030) no congestion mitigations exist in the eastern portion of the SR 4 Corridor because the committed SR 4 East Widening Project and SR 4 Bypass Project will mitigate future traffic demands.

Section 9: Transit Mitigation Strategies

While the FPI and CSMP processes focus on freeway mitigation strategies, improved transit service was raised by stakeholders along the SR 4 corridor. In the case of SR 4 these services include eBART and general strategies to increase transit access, including additional parking at BART stations in the corridor, enhanced bus feeder services, and operational enhancements to BART at a system-wide level that could accommodate ridership increases of 10 to 20 percent.[14]

eBART

The East Contra Costa BART Extension (eBART) project is included in the Regional Transportation Plan (RTP). The proposed project is a Diesel Multiple Vehicle (DMU) with expanded service from the Pittsburg/Bay Point BART station to a new station at Railroad Avenue and a terminus station east of Hillcrest Avenue in Antioch. The eBART project includes 300 parking spaces for the proposed station at Railroad Avenue and 2,600 parking spaces for the proposed station at Hillcrest Avenue. Life-cycle benefits and life-cycle costs were not estimated for eBART.

Additional Transit Strategies

As mentioned earlier, the short-term and long-term transit mitigation strategies in Package H include additional BART parking capacity, increased bus transit access to the BART stations, improvements to existing park-and-ride facilities in Martinez (Pacheco Boulevard), Antioch (Hillcrest Avenue), and Pittsburg (Bliss Avenue), as well as investment in new park-and-ride facilities at proposed/potential eBART stations, and BART system-wide operational improvements. A benefit cost ratio could not be estimated for this report, and thus these transit mitigation strategies cannot be ranked against other mitigation strategies for which life-cycle benefits and costs were available. For this reason, no prioritized recommendations are offered on this set of transit strategies and further analysis is recommended to determine the effectiveness of these improvements and their impacts on the corridor.

Exhibit 9-1: Transit Mitigation Improvements

Pkg	ID	Mitigation Improvement
H	15	eBART
	16	Additional BART parking capacity.
	17	Increased bus transit access to the BART stations.
	18	Improvements to existing park-and-ride facilities in Martinez (Pacheco Boulevard), Antioch (Hillcrest Avenue), and Pittsburg (Bliss Avenue), as well as investment in new park-and-ride facilities at proposed/potential eBART stations.
	19	BART system-wide operational improvements.

[14] The feasibility of accommodating ridership increases in this range was discussed with BART as part of the stakeholder coordination process.

Section 10: Express Lanes

As described in the *Congestion Mitigation Strategies Technical Memorandum*, (PBS&J, November 9, 2009), in addition to the physical roadway mitigation improvements described in previous sections of this memorandum and the transit mitigation improvement measures described in Section 9, the option of converting the HOV lanes on SR 4 to Express Lanes (also referred to as High-Occupancy Toll Lanes, or HOT Lanes) is discussed here. Express Lanes allow HOV users to continue to use the carpool lane for free, but also allow single-occupant vehicles to access the carpool lane by paying a toll.

MTC's *Transportation 2035 Plan for the San Francisco Bay Area* (T-2035) proposes a Regional Express Lane Network for the Bay Area, which includes Express Lanes on SR 4 between I-680 and SR 160.[15] On July 16, 2009, the California Senate Transportation and Housing Committee passed Assembly Bill 744 (Torrico), which authorizes the creation of an 800-mile express lane network on Bay Area freeways. This bill must still be passed by the Senate Appropriations Committee before moving on to the Senate floor for authorization.

The conversion of HOV lanes to Express Lanes on SR 4 would increase the total number of vehicles using the HOV lanes, provided those lanes have available "vacant" capacity that can be "bought" by single-occupant drivers who are willing to pay a toll in exchange for a faster trip in the HOV lane. Toll-paying single-occupant vehicles are allowed to enter the HOV lane; however, as the volume of traffic in the lane begins to reach a pre-determined capacity level, the toll amount charged to single-occupant users increases dynamically in response to the demand. Real-time, variable pricing of the "vacant" capacity in the HOV lanes is used as a mechanism to limit the number of vehicles entering the lane. The Express Lane operator is required, through pricing and changeable message signs, to maintain free-flow conditions in the Express Lane at all times.

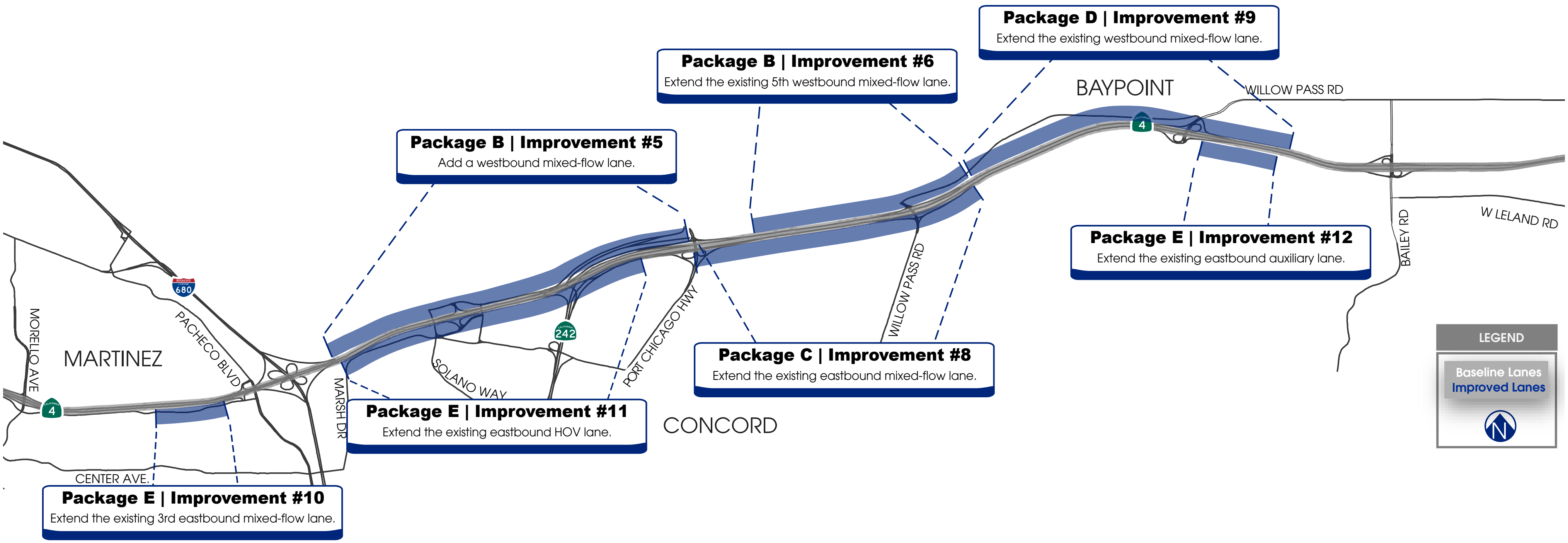
All existing Express Lanes in the United States are limited access facilities. In the Bay Area design, Express Lanes are separated from the adjacent mixed-flow lanes by a double-stripe line, similar to facilities in Seattle and Minneapolis. Lane markings, such as a single-dashed stripe or transition lane, designate ingress and egress zones. Non-carpools using the Express Lanes pay their tolls using electronic FasTrak® toll tags, which are already in use on the region's eight toll bridges; as a vehicle enters the Express Lane, an electronic reader detects the toll tag and deducts the toll from a prepaid account.

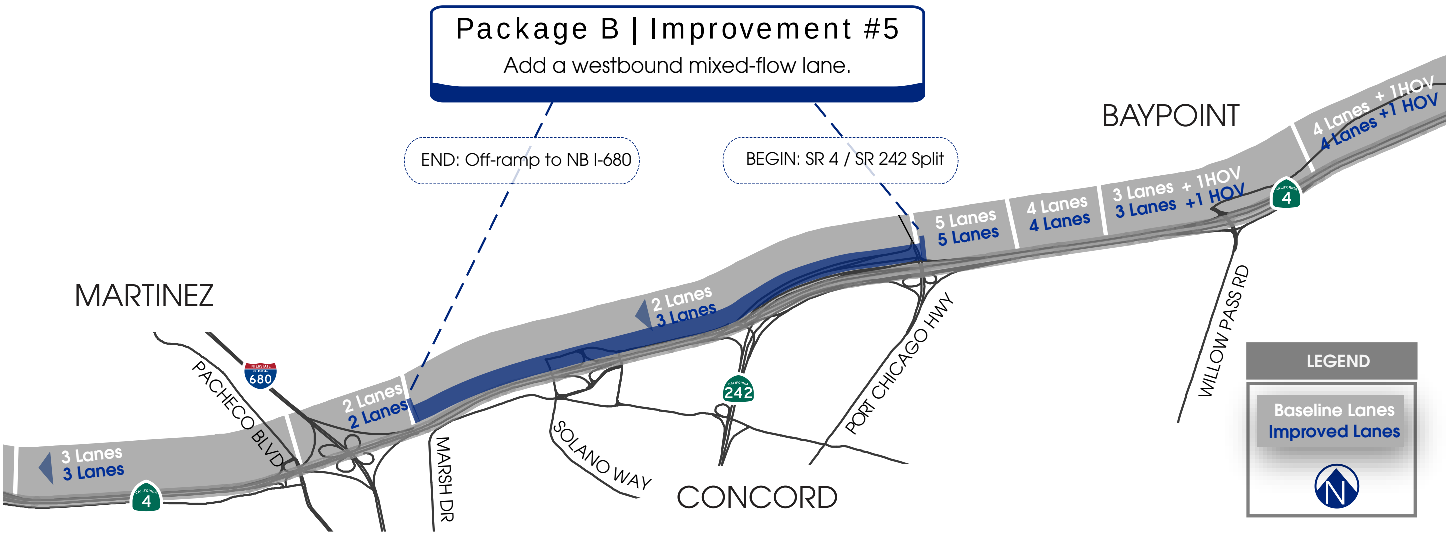
Documented benefits of Express Lanes in operation in the United States include: improved travel speeds in the mixed-flow lanes; increased corridor throughput; ability to provide a reliable travel option that can be used when most needed (most express lane travelers use the lanes no more than a few times a week); and, in some cases, revenue to support transit service. Further, there is no evidence that Express Lanes reduce carpool levels or transit ridership.

Should AB 744 or similar legislation be signed into law at some point in the future, significant further analysis and consultation with affected jurisdictions along the corridor will be required to determine the feasibility, cost-effectiveness and appropriateness of converting the HOV lanes to Express Lanes in the SR 4 Corridor. This process will inform whether and how (e.g., timing and phasing, design and operations policies) to pursue Express Lanes in the corridor.

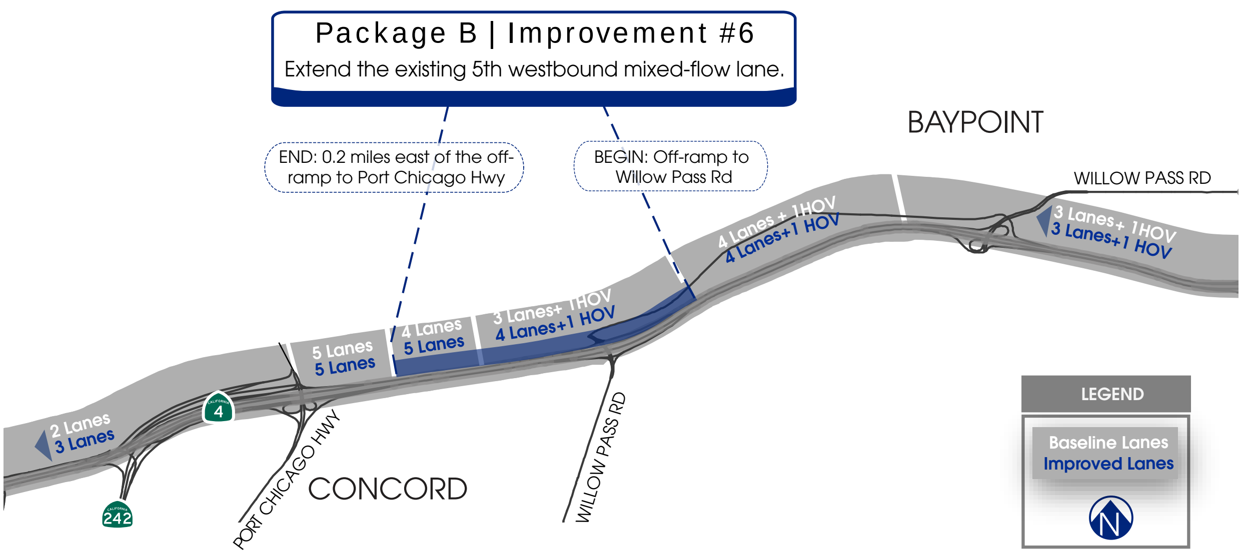
[15] http://www.mtc.ca.gov/planning/hov/index.htm

Appendix A: Illustration of Selected Mitigation Strategies

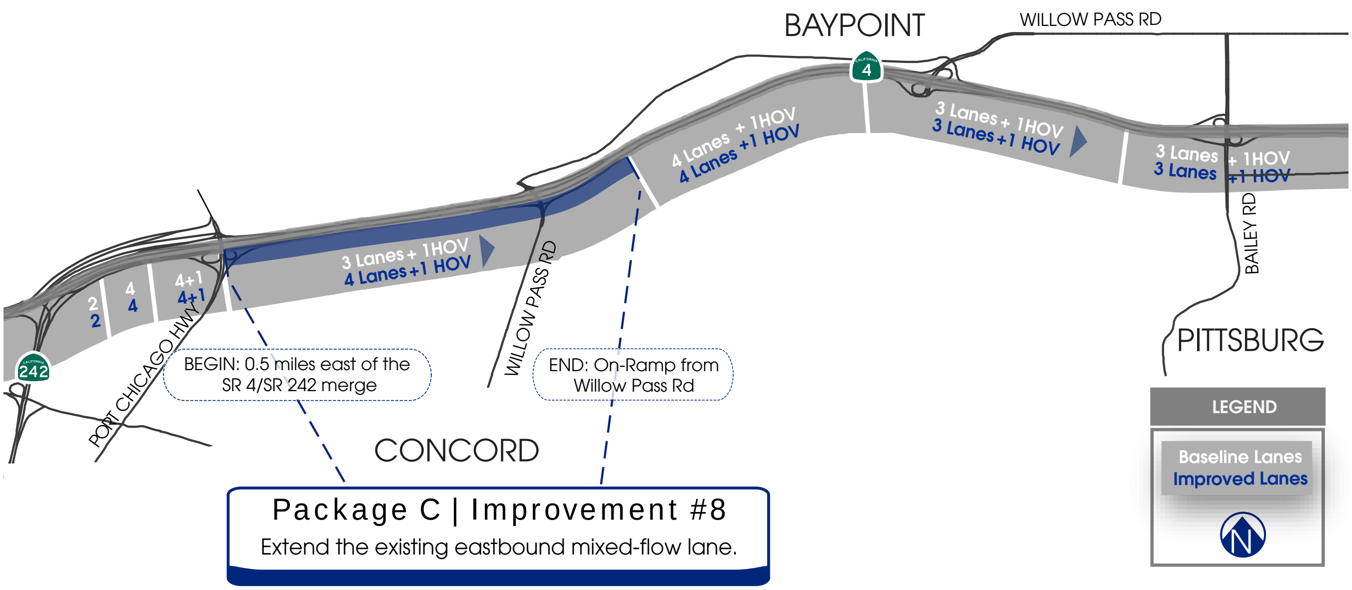

Package D | Improvement #9
Extend the existing westbound mixed-flow lane.
Package B | Improvement #6
Extend the existing 5th westbound mixed-flow lane.
BAYPOINT
WILLOW PASS RD
Package B | Improvement #5
Add a westbound mixed-flow lane.
W LELAND RD
BAILEY RD
Package E | Improvement #12
Extend the existing eastbound auxiliary lane.
680
WILLOW PASS RD
PORT CHICAGO HWY
242
MORELLO AVE
MARTINEZ
PACHECO BLVD
SOLANO WAY
Package C | Improvement #8
Extend the existing eastbound mixed-flow lane.
LEGEND
Baseline Lanes
Improved Lanes
4
MARSH DR
Package E | Improvement #11
Extend the existing eastbound HOV lane.
CONCORD
N
CENTER AVE.
Package E | Improvement #10
Extend the existing 3rd eastbound mixed-flow lane.

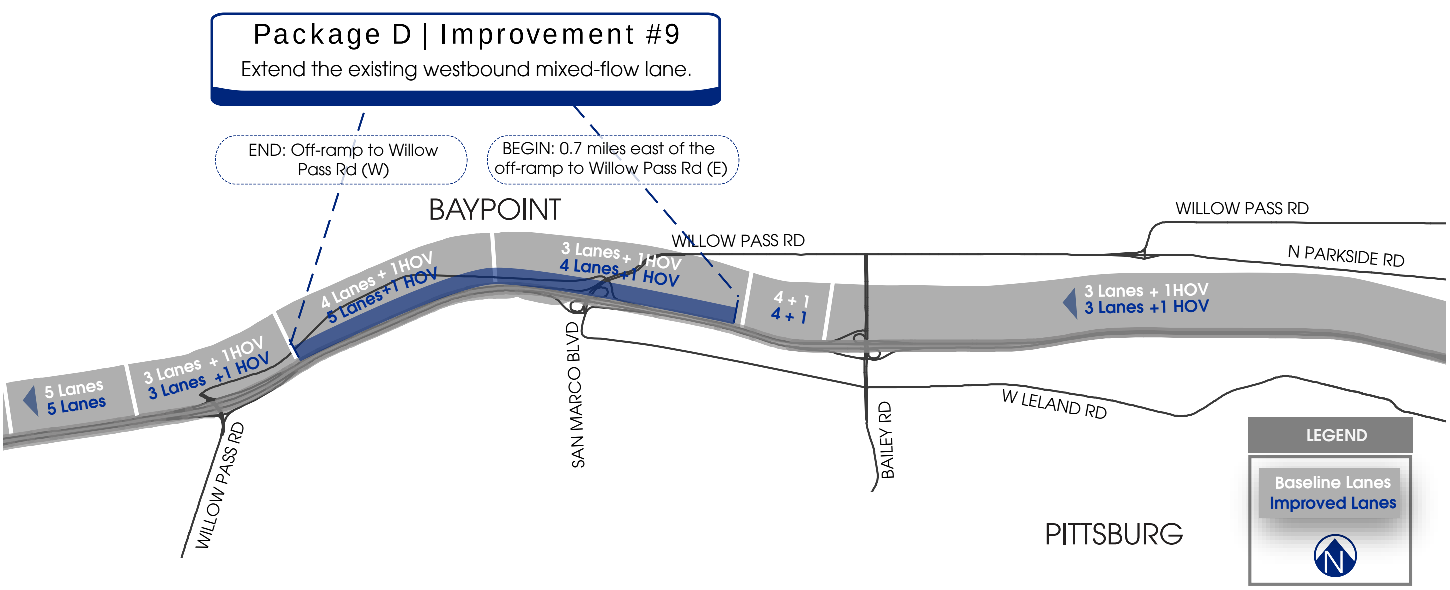


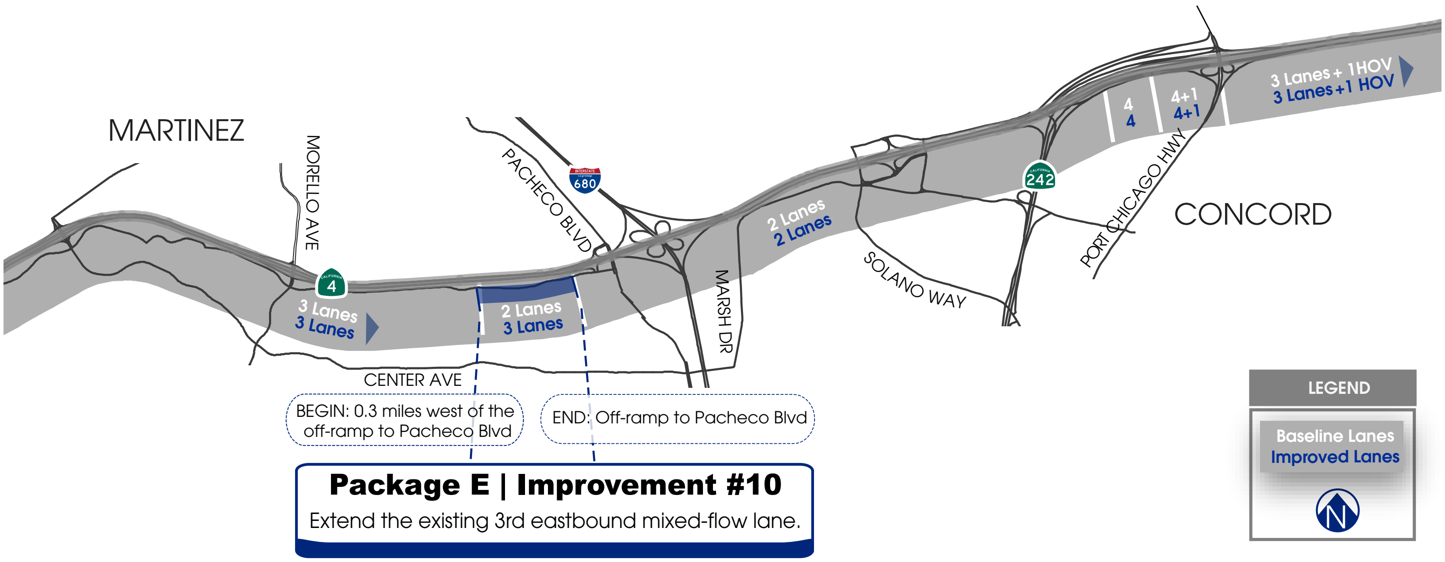
Package B | Improvement #5
Add a westbound mixed-flow lane.
END: Off-ramp to NB I-680
BEGIN: SR 4 / SR 242 Split
BAYPOINT
MARTINEZ
CONCORD
3 Lanes
3 Lanes
2 Lanes
2 Lanes
2 Lanes
3 Lanes
5 Lanes
5 Lanes
4 Lanes
4 Lanes
3 Lanes + 1HOV
3 Lanes +1 HOV
4 Lanes + 1HOV
4 Lanes +1 HOV
PACHECO BLVD
MARSH DR
SOLANO WAY
PORT CHICAGO HWY
WILLOW PASS RD
680
242
4
LEGEND
Baseline Lanes
Improved Lanes
N

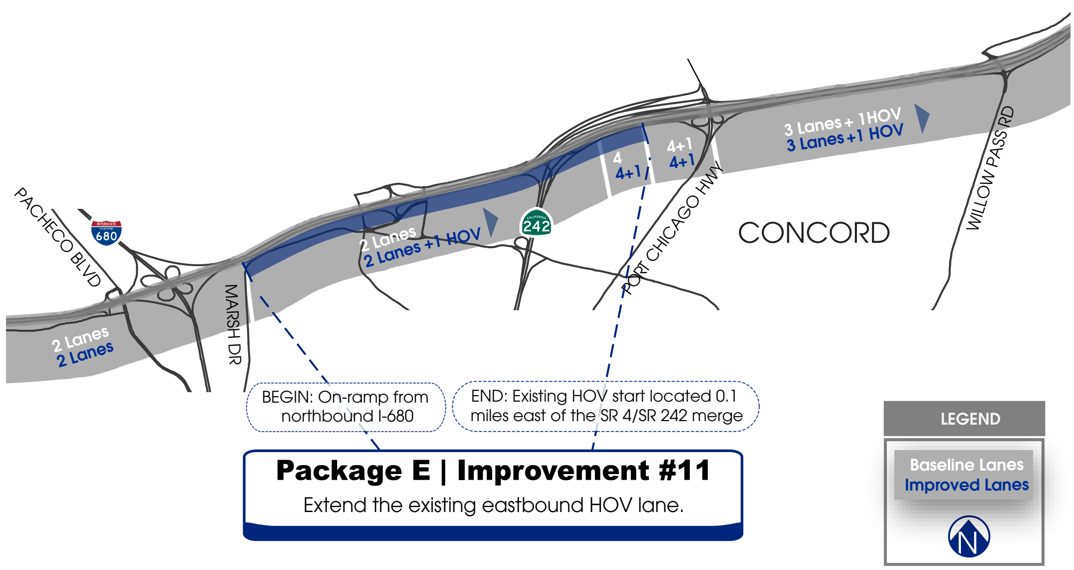


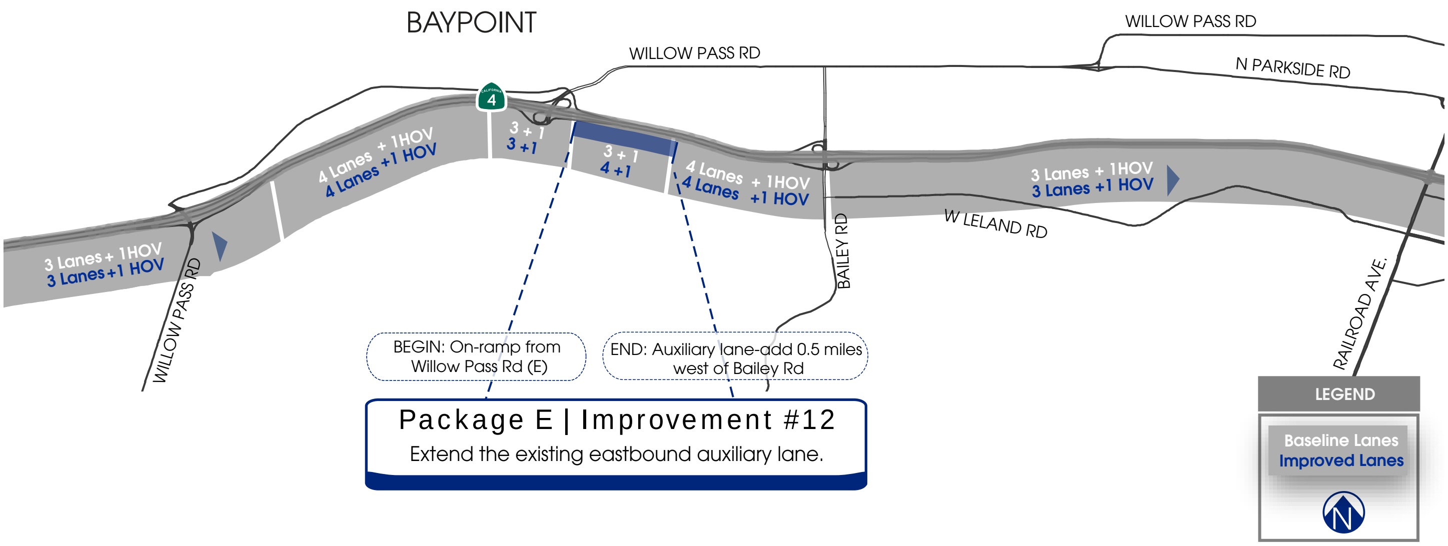
Package B | Improvement #6
Extend the existing 5th westbound mixed-flow lane.
END: 0.2 miles east of the off-ramp to Port Chicago Hwy
BEGIN: Off-ramp to Willow Pass Rd
BAYPOINT
CONCORD
WILLOW PASS RD
2 Lanes
3 Lanes
5 Lanes
5 Lanes
4 Lanes
5 Lanes
3 Lanes+ 1HOV
4 Lanes+1 HOV
4 Lanes + 1HOV
4 Lanes+1 HOV
3 Lanes+ 1HOV
3 Lanes+1 HOV
PORT CHICAGO HWY
WILLOW PASS RD
242
4
LEGEND
Baseline Lanes
Improved Lanes
N


BAYPOINT
WILLOW PASS RD
4
3 Lanes + 1HOV
3 Lanes +1 HOV
3 Lanes + 1HOV
3 Lanes +1 HOV
4 Lanes + 1HOV
4 Lanes +1 HOV
3 Lanes + 1HOV
4 Lanes +1 HOV
2
2
4
4
4+1
4+1
242
PORT CHICAGO HWY
WILLOW PASS RD
BAILEY RD
PITTSBURG
BEGIN: 0.5 miles east of the SR 4/SR 242 merge
END: On-Ramp from Willow Pass Rd
CONCORD
Package C | Improvement #8
Extend the existing eastbound mixed-flow lane.
LEGEND
Baseline Lanes
Improved Lanes
N


Package D | Improvement #9
Extend the existing westbound mixed-flow lane.
END: Off-ramp to Willow Pass Rd (W)
BEGIN: 0.7 miles east of the off-ramp to Willow Pass Rd (E)
BAYPOINT
WILLOW PASS RD
WILLOW PASS RD
N PARKSIDE RD
3 Lanes + 1HOV
4 Lanes +1 HOV
4 Lanes + 1HOV
5 Lanes+1 HOV
4 + 1
4 + 1
3 Lanes + 1HOV
3 Lanes +1 HOV
5 Lanes
5 Lanes
3 Lanes + 1HOV
3 Lanes +1 HOV
WILLOW PASS RD
SAN MARCO BLVD
BAILEY RD
W LELAND RD
PITTSBURG
LEGEND
Baseline Lanes
Improved Lanes
N


MARTINEZ
MORELLO AVE
4
3 Lanes
3 Lanes
PACHECO BLVD
680
2 Lanes
3 Lanes
MARSH DR
2 Lanes
2 Lanes
SOLANO WAY
242
4
4
4+1
4+1
3 Lanes + 1HOV
3 Lanes +1 HOV
PORT CHICAGO HWY
CONCORD
CENTER AVE
BEGIN: 0.3 miles west of the off-ramp to Pacheco Blvd
END: Off-ramp to Pacheco Blvd
Package E | Improvement #10
Extend the existing 3rd eastbound mixed-flow lane.
LEGEND
Baseline Lanes
Improved Lanes
N


PACHECO BLVD
680
2 Lanes
2 Lanes
MARSH DR
2 Lanes
2 Lanes +1 HOV
242
4
4+1
4+1
4+1
3 Lanes + 1HOV
3 Lanes +1 HOV
PORT CHICAGO HWY
CONCORD
WILLOW PASS RD
BEGIN: On-ramp from northbound I-680
END: Existing HOV start located 0.1 miles east of the SR 4/SR 242 merge
Package E | Improvement #11
Extend the existing eastbound HOV lane.
LEGEND
Baseline Lanes
Improved Lanes
N


BAYPOINT
WILLOW PASS RD
WILLOW PASS RD
N PARKSIDE RD
4
3 Lanes + 1HOV
3 Lanes +1 HOV
4 Lanes + 1HOV
4 Lanes +1 HOV
3 + 1
3 +1
3 + 1
4 +1
4 Lanes + 1HOV
4 Lanes +1 HOV
3 Lanes + 1HOV
3 Lanes +1 HOV
W LELAND RD
BAILEY RD
WILLOW PASS RD
RAILROAD AVE.
BEGIN: On-ramp from Willow Pass Rd (E)
END: Auxiliary lane-add 0.5 miles west of Bailey Rd
Package E | Improvement #12
Extend the existing eastbound auxiliary lane.
LEGEND
Baseline Lanes
Improved Lanes
N

Appendix B: Life-Cycle Cost-Effectiveness Analysis and Prioritization

SR 4 Prioritized Congestion Mitigation Strategies: Cost-Effectiveness Analysis

#	Strategy	Life-Cycle Benefits: Mobility Benefits (per·hrs saved)	Life-Cycle Benefits: Reliability Benefits (per·hrs saved)	Life-Cycle Benefits: Total [1 2]	Life-Cycle Costs [3]	Life-Cycle Cost-Effectiveness: Cost to Person-Hour of Delay Saved	Package Rank [4]: Short Term	Package Rank [4]: Long Term
	SHORT-TERM (2009-2015) MITIGATION STRATEGIES							
	Short-term Strategies Package A							
1	Activate existing ITS installations that currently are not fully operational.							
2	Assess gaps in the current and programmed ITS and supplement as needed.	0	11,480,000	34,440,000	$40,110,000	$1.16 / per-hr of delay saved	3	---
3	Extend ITS coverage to fill the gap from I-80 to I-680, to on the SR 4 Bypass.							
	Short-term Strategies Package B							
4	Implement WB ramp metering from SR 160 to I-680.							
5	Add a WB mixed-flow lane from the SR 242 off-ramp to the I-680 NB off-ramp.	77,809,000	7,243,000	99,538,000	$68,220,000	$0.69 / per-hr of delay saved	1	---
6	Extend the WB mixed-flow lane from the the Willow Pass Rd (W) off-ramp to the lane-add 0.8 mi west of the Willow Pass (W) on-ramp.							
	Short-term Strategies Package C							
7	Implement EB ramp metering from Alhambra Ave to Willow Pass Rd (E).	22,324,000	5,270,000	38,134,000	$33,070,000	$0.87 / per-hr of delay saved	2	---
8	Add an EB mixed-flow lane from the lane drop located 0.3 mi west of Port Chicago Hwy on-ramp to the Willow Pass Rd (W) on-ramp.							
	LONG-TERM (2016-2030) MITIGATION STRATEGIES							
	Long-term Strategies Package D							
9	Extend the WB mixed-flow lane from the lane drop 0.7 mi east of the Willow Pass Rd (E) off-ramp to the Willow Pass Rd (W) off-ramp.	2,926,000	5,011,000	17,959,000	$22,400,000	$1.25 / per-hr of delay saved	---	3
	Long-term Strategies Package E							
10	Extend the EB mixed-flow lane from the lane drop 0.3 mi west of the Pacheco Blvd off-ramp to the Pacheco Blvd off-ramp.							
11	Extend the EB HOV lane from the I-680 NB off-ramp to its start 0.6 mi west of the Port Chicago Hwy on-ramp.	8,595,000	6,058,000	26,769,000	$31,880,000	$1.19 / per-hr of delay saved	---	2
12	Extend the EB mixed-flow lane from the Willow Pass Rd (E) on-ramp to the lane add 0.8 mi east of the Willow Pass Rd (E) on-ramp.							
	Long-term Strategies Package F							
13	Implement ramp metering in the WB direction on the SR 4 Bypass and on SR 4 from I-680 to I-80.	367,000	368,000	1,471,000	$5,510,000	$3.75 / per-hr of delay saved	---	4
	Long-term Strategies Package G							
14	Implement EB ramp metering from I-80 to Alhambra Ave, Willow Pass Rd (E) to SR 160, and on the SR 4 Bypass.	1,551,000	2,607,000	9,372,000	$10,640,000	$1.14 / per-hr of delay saved	---	1
	ALL MITIGATION STRATEGIES							
		113,572,000	38,037,000	227,683,000	$211,830,000	$0.93 / per-hr of delay saved	---	---

Source: PBS&J, October 2009.

Notes:
1. Life-Cycle benefits only include mobility and reliability. (No safety or qualitative benefit measures.)
2. Based on FHWA research, motorists consider non-recurrent delay (i.e., reliability hours) to be equivalent to three times that of recurrent delay (i.e., mobility hours). This factor is incorporated into the "Total Life Cycle Benefits" value.
3. Life-Cycle costs include capital, and operating and maintenance.
4. Package rank based on cost effectiveness.