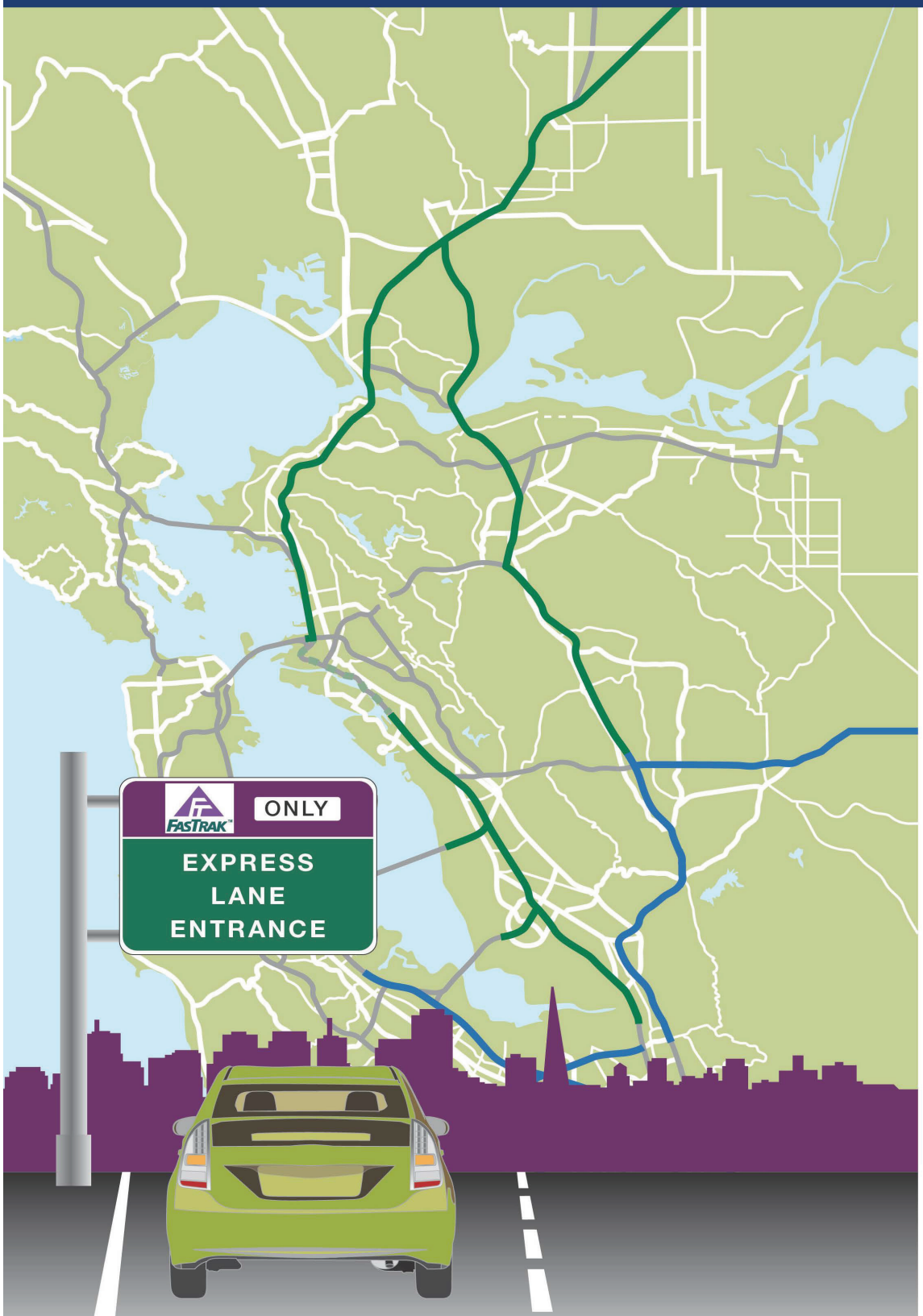
BAY AREA EXPRESS LANES

Concept of Operations

May 23, 2013



METROPOLITAN TRANSPORTATION COMMISSION

In collaboration with:

ALAMEDA County Transportation Commission

CHP

Caltrans

CONTRA COSTA transportation authority

U.S. Department of Transportation Federal Highway Administration

STA Solano Transportation Authority

VTA

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ACRONYMS AND ABBREVIATIONS

AADT	Average annual daily traffic
AASHTO	American Association of State Highway and Transportation Officials
ACTC	Alameda County Transportation Commission
ATCAS	Advanced Toll Collection and Accounting System
ATM	Active Traffic Management
ATMS	Advanced Transportation Management System
AVDS	Automatic Vehicle Detection System
AVI	Automatic Vehicle Identification
BAIFA	Bay Area Infrastructure Financing Authority
BART	Bay Area Rapid Transit
BATA	Bay Area Toll Authority
BAVU	Bay Area Video Upgrade
CAD	Computer-Aided Dispatch
CBP	Call Box Program
CCCTA	Central Costa County Transit Authority
CCTA	Contra Costa Transportation Authority
CCTV	Close-Circuit Television
CHP	California Highway Patrol
CMA	Congestion Management Agency
CSC	Customer Service Center
CTC	California Transportation Commission
CTFA	California Transportation Financing Authority
CTOC	California Toll Operators Committee
DMV	Department of Motor Vehicles
ESC	Executive Steering Committee
ETC	Electronic Toll Collection
FAST	Fairfield/Suisun Transit
FasTrak®	Electronic toll collection system used in California
FCC	Federal Communications Commission
FHWA	Federal Highway Administration
FPI	Freeway Performance Initiative
FSP	Freeway Service Patrol
GHz	Gigahertz
GPS	Global Positioning System
HDM	Highway Design Manual
HOT	High-occupancy/toll
HOV	High-occupancy vehicle
HOV 2	Vehicles with two occupants
HOV 2+	Vehicles with two or more occupants
HOV 3+	Vehicles with three or more occupants
ICM	Integrated Corridor Management
ISO	International Organization for Standardization

ITE	Institute of Transportation Engineers
ITS	Intelligent Transportation System
LA Metro	Los Angeles County Metropolitan Transportation Authority
LAVTA	Livermore Amador Valley Transit Authority
LPR	License Plate Recognition
MAP-21	Moving Ahead for Progress in the 21st Century
MHz	Megahertz
MOMS	Maintenance Online Management System
MOU	Memorandum of Understanding
MER	Mobile Enforcement Reader
MPH	Miles-per-hour
MTC	Metropolitan Transportation Commission
MUTCD	Manual on Uniform Traffic Control Devices
NB	Northbound
NEMA	National Electrical Manufacturers Association
OBU	On-board Unit
OCR	Optical Character Recognition
ORT	Open Road Tolling
PeMS	Performance Measurement System
PII	Personal Identifiable Information
RCSC	Regional Customer Service Center
RF	Radio Frequency
RFID	Radio Frequency Identification
RTP	Regional Transportation Plan
SAFE	Service Authority for Freeways and Expressways
SANDAG	San Diego Association of Governments
SB	Southbound
SOV	Single occupant vehicle
STA	Solano Transportation Authority
SR	State Route
Sunol JPA	Sunol Smart Carpool Lane Joint Powers Authority
TIP	Transportation Improvement Program
TMC	Transportation Management Center
TOPD	Traffic Operations Policy Directive
TWG	Technical Working Group
UPS	Uninterruptable Power Supply
VES	Violation Enforcement System
VPH	Vehicles-per-hour
VMS	Variable Message Sign
VTA	Santa Clara Valley Transportation Agency
WestCAT	West Contra Costa Transit Authority

CHAPTER 1 INTRODUCTION

1.1 PURPOSE OF DOCUMENT AND INTENDED AUDIENCE

This Concept of Operations is intended to describe how express lanes being implemented by the Metropolitan Transportation Commission (MTC)[1], referred to as Bay Area Express Lanes, will operate from a user perspective and to set the framework for the design and operational characteristics of the express lane system. As such, this document serves as a bridge between the needs and expectations of the express lane user and the technical specifications to be developed for the toll system. The express lane system includes the hardware and software that will be procured to implement and operate the express lanes.

As the first document developed as part of the systems engineering process, this Concept of Operations does not specify detailed design requirements of the express lane system. Instead, this document is meant to describe the desired operational characteristics of the MTC express lanes for future translation into detailed design requirements. This document also preserves flexibility to account for policy and design characteristics that are not yet fully defined or that may evolve in the future.

1.2 BACKGROUND

1.2.1 EXPRESS LANES DEFINED

Express lanes, also commonly referred to as high-occupancy/toll (HOT) lanes, function as high-occupancy vehicle (HOV) lanes that allow vehicles not meeting eligibility requirements to pay a toll to travel in the lane. Eligibility requirements to use HOV lanes typically include occupancy restrictions and vehicle type (e.g., motorcycles and low-emission vehicles). The first express lane project was implemented on State Route (SR) 91 in Orange County in 1995 and the concept has since gained national recognition as an effective strategy to improve the efficiency and reliability of HOV lanes and has been implemented and planned in multiple locations around the U.S.

Express lanes maintain toll-free travel for buses, HOVs and other vehicles designated as being eligible to use the lanes, and charge a toll for other passenger vehicles that choose to use the lane. Express lane tolls are collected electronically via electronic toll collection (ETC) systems and typically vary based on the level of congestion to ensure that a high level of service is maintained in the express lane. As traffic in the express lane increases, the toll rate also increases to limit the number of people entering the lane. Toll rates decrease when traffic in the lane decreases to incentivize more vehicles to use the existing capacity in the lane. Shifting vehicles from congested

[1] In April of 2013, MTC entered into a cooperative agreement with the Bay Area Infrastructure Financing Authority (BAIFA) through which MTC delegated authority to BAIFA to develop and operate the 270-mile Bay Area Express Lanes. This Concept of Operations was developed prior to the delegation of express lane responsibilities to BAIFA and therefore refers to MTC as the entity responsible for the development and operation of the express lanes. This is consistent with the CTC action that granted express lane eligibility to MTC.

general purpose lanes to utilize excess capacity in the express lane benefits general purpose lane flow without sacrificing free-flow operations in the express lane.

1.2.2 ENABLING LEGISLATION

In October of 2011, the California Transportation Commission (CTC) found MTC eligible to develop and operate 270 miles of express lanes, consistent with California Streets and Highways Code Section 149.7. These lanes, referred to as the "MTC Program," include portions of Interstates 80, 880 and 680 as well as the Dumbarton and San Mateo-Hayward Bridge approaches (see blue outlined corridors in Figure 1-1). It includes conversion of approximately 150 lane-miles of existing HOV lanes to express lanes and construction of 120 lane-miles of new express lanes. The operational gap closure shown in orange in Figure 1-1 represents a segment with very constrained right-of-way where express lanes are not proposed in the near-term. Instead, operational strategies such as those to be implemented as part of the I-880 Integrated Corridor Management (ICM) project including enhanced ramp metering, increased incident management capabilities and alternate rerouting using parallel arterials could be used to bridge this gap in the express lanes.

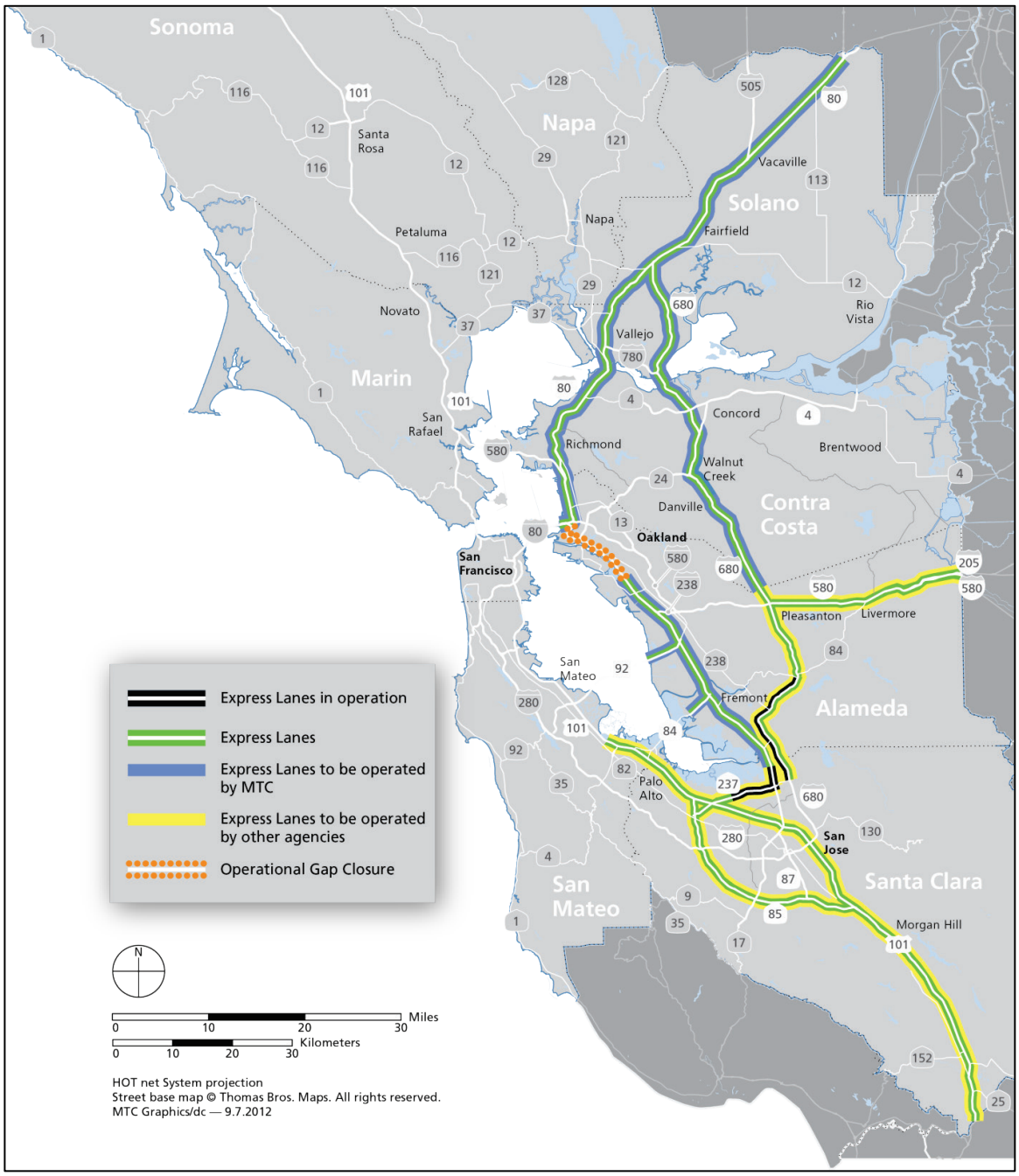


FIGURE 1-1: BAY AREA EXPRESS LANES MAP

In addition to the MTC Program, there are other express lane projects in operation and under development in Alameda and Santa Clara counties that are authorized under Sections 149.5 and 149.6 of the California Streets and Highways Code. The Sunol Smart Carpool Lane Joint Powers Authority (JPA), consisting of members from the Alameda County Transportation Commission (ACTC) and the Santa Clara Valley Transportation Authority (VTA) oversees the operation of the Bay Area's first express lane on Interstate 680 southbound (I-680 SB) over the Sunol Grade. ACTC has authority to operate express lanes on a second corridor in Alameda County. The VTA

separately operates an express lane at the interchange of I-880 and SR-237. Work is underway by these agencies to open additional express lanes in the 2015 to 2020 timeframe, which include: SR-237 extension, I-580, SR-85, US-101 and I-680 northbound over the Sunol Grade. These previously authorized express lanes are shown in yellow highlighting in Figure 1-1.

1.2.3 GEOGRAPHICAL LIMITS

This Concept of Operations applies only to the MTC Program, which includes the following corridors:

- I-80 between San Francisco/Oakland Bay Bridge and Solano/Yolo County Line (130 lane-miles), including westbound approaches (I-80, I-880 and I-580) to the San Francisco-Oakland Bay Bridge that carry vehicles to the Bay Bridge metering lights
- I-680 between I-80 and Contra Costa/Alameda County Line (77 lane-miles)
- Interstate 880 (I-880) – between Hegenberger Road and State Route 237 (53 lane-miles)
- SR-84 WB from I-880 to Dumbarton Bridge Toll Plaza (3 lane-miles)
- SR-92 WB from I-880 to San Mateo-Hayward Bridge Toll Plaza (3 lane-miles)

Based on the financial and operational analyses for the CTC application, MTC selected an initial set of HOV conversion segments to move forward with the first phase of implementation. These segments are approximately 76 lane-miles in total and are collectively referred to as the MTC Phase 1 Project and include the following conversion projects (also shown in Figure 1-2):

- I-680 northbound (NB) in Contra Costa County between Alcosta Boulevard and Livorna Road and I-680 SB between Rudgear Road and Alcosta Boulevard
- I-880 NB in Alameda and Santa Clara counties between SR-237 and Lewelling Boulevard and I-880 SB between Hegenberger Road and SR-237
- Westbound approaches to the San Francisco-Oakland Bay Bridge, including the I-80, I-880, I-580 and West Grand Avenue approaches
- SR-84 WB from I-880 to the Dumbarton Bridge toll plaza
- SR-92 WB from I-880 to the San Mateo-Hayward Bridge toll plaza

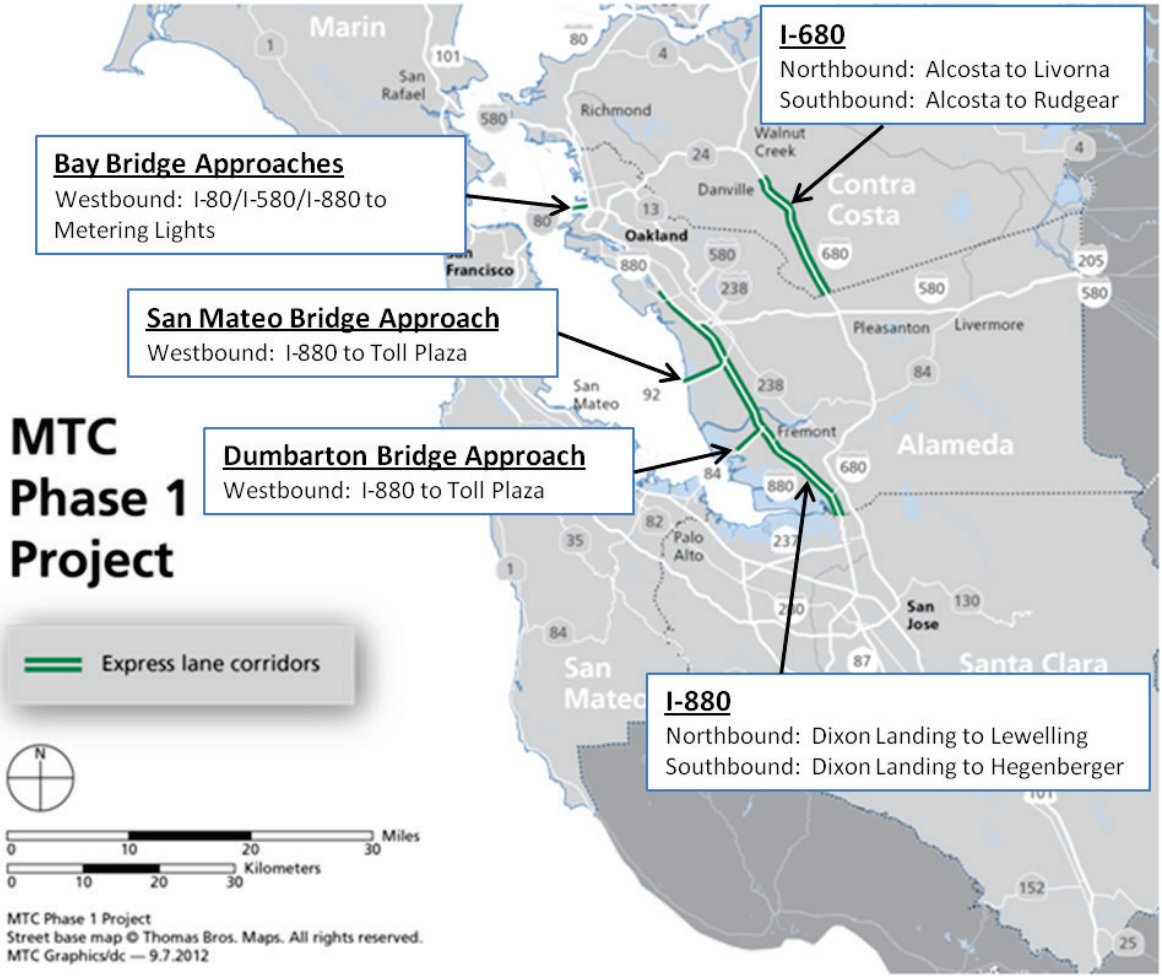


FIGURE 1-2: MTC PHASE 1 PROJECT MAP

Concurrently and in coordination with efforts on the MTC Phase 1 Project, the Solano Transportation Authority (STA) is undertaking environmental studies for an express lane on I-80 between Red Top Road and I-505 in Solano County. This project, which is part of the MTC Program, includes conversion of the existing HOV lane between Red Top Road and Air Base Parkway and construction of a new lane between Air Base Parkway and I-505. Construction of the I-80 express lanes in Solano County is expected to be complete by 2017.

1.3 REGIONAL GOALS AND OBJECTIVES

1.3.1 EXPRESS LANES GOALS

Goals of the MTC express lanes include:

- Connectivity: Close gaps within the existing HOV lane system to increase travel time savings and reliability for carpools and buses. Express lanes provide a funding mechanism to expedite completion of this network of HOV lanes.

- Efficiency: Optimize capacity in Bay Area freeway corridors to better meet current and future traffic demands. Efficiency of freeway facilities can be maximized by better using excess capacity in the existing HOV system.
- Reliability: Provide a reliable, congestion-free transportation option for buses, carpools and single-occupant vehicles.

1.3.2 CONSISTENCY WITHIN BAY AREA AND CALIFORNIA

This Concept of Operations has been developed in collaboration with Caltrans, Congestion Management Agencies (CMAs), California Highway Patrol (CHP) and Federal Highway Administration (FHWA) with a primary goal of establishing maximum feasible consistency of practice for all express lanes in the Bay Area. The involved CMAs include ACTC, Contra Costa Transportation Authority (CCTA), STA and VTA. An operations-focused Technical Working Group (TWG) and Executive Steering Committee (ESC) were instituted including representatives from the agencies mentioned above to discuss and provide feedback on the topics included in this Concept of Operations. Individual meetings with Caltrans and the CHP were also held.

Although the ultimate Bay Area regional express lane network will include express lanes that are currently being planned, implemented and operated by various agencies, the goal is to present a seamless network to users. This requires a large degree of consistency in terms of design treatments and operational policies. The TWG and ESC will continue to be forums for discussion and collaboration as MTC and other agencies move forward with express lane implementation and operation.

To maintain consistency and interoperability with other express lane and toll facilities in California, tolls on MTC express lanes will be collected electronically according to specifications detailed in California Code of Regulations, Title 21, or any other specification that may be adopted by the time the MTC express lanes system requirements are finalized.

1.4 ORGANIZATION OF THE REPORT

This document includes the following chapters:

- **Chapter 2 – Current Characteristics**: Describes the geographical limits and current physical and operating characteristics of express lane corridors.
- **Chapter 3 – Facility Design**: Describes typical cross-section, access, striping, signing, toll zone layout, enforcement and other considerations related to physical design of express lane facilities.
- **Chapter 4 – Operating Concept**: Describes how the express lanes will operate, including guidelines for use of the lane by eligible HOVs and toll-paying vehicles. Also includes considerations for hours of operation, pricing and integration with other projects such as the Freeway Performance Initiative (FPI) and Integrated Corridor Management (ICM).
- **Chapter 5 – Roles and Responsibilities**: Describes the areas of responsibility related to express lane operations and the assumed roles of each of the stakeholders.
- **Chapter 6 – Technical Requirements**: Describes the various hardware and software elements of the toll system.
- **Chapter 7 – Enforcement and Incident Management**: Describes how express lanes will be enforced and how express lanes will be operated during freeway incidents.

- **Chapter 8 – Motorist Perspective**: Describes how the express lanes will operate from the perspective of the motorist.

1.5 PLANNED FUTURE REVISIONS TO THIS DOCUMENT

The MTC Program will be built out in phases. Consequently, it is envisioned that this Concept of Operations will be updated as appropriate to account for the incorporation of future express lanes. Following the MTC Phase 1 Project, the I-80 express lanes in Solano County will likely be the next project to be implemented as part of the MTC Program. The flow chart presented in Figure 1-3 portrays how future express lane corridors could be incorporated into the Concept of Operations.

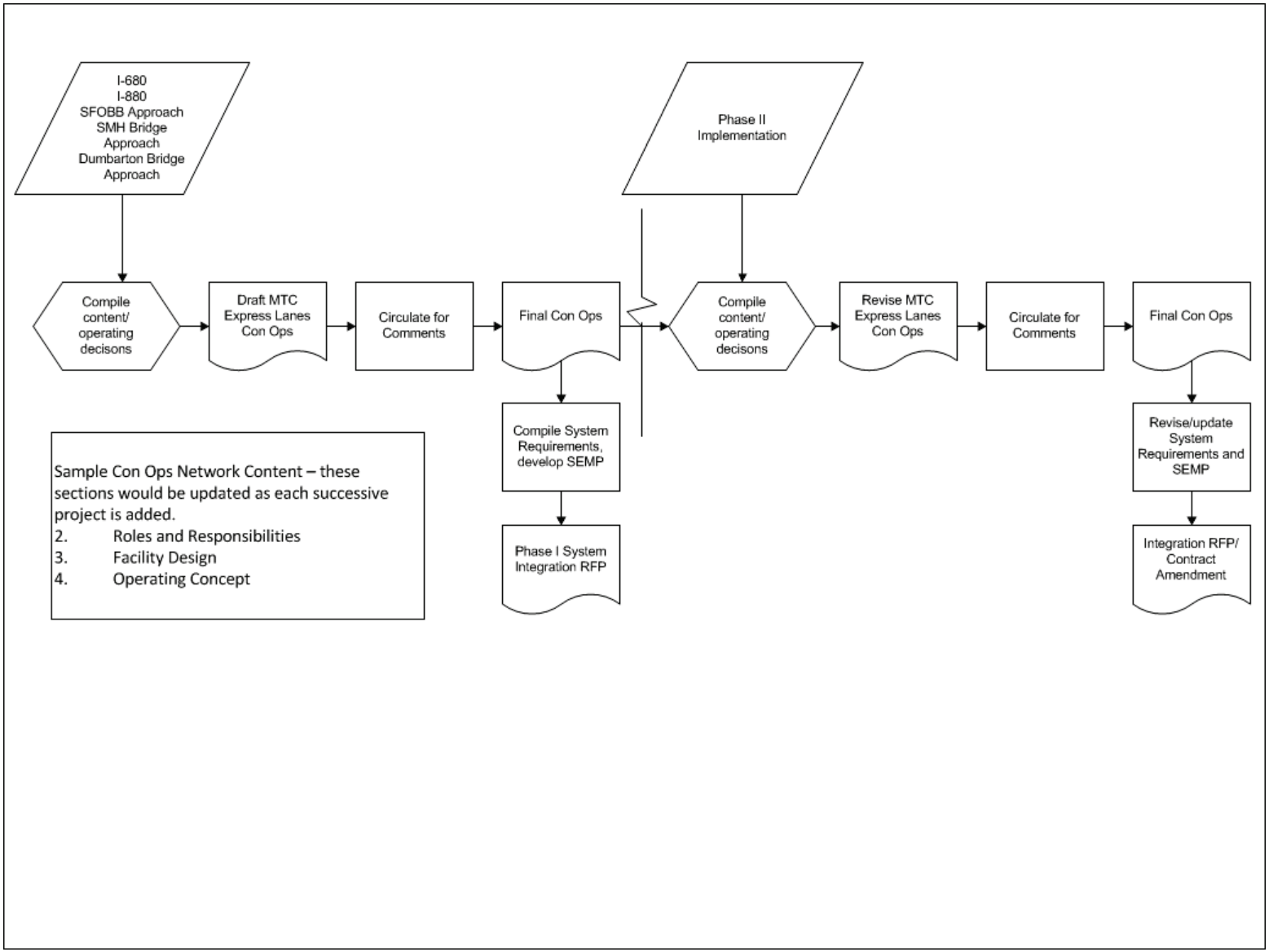


FIGURE 1-3: CONCEPT OF OPERATIONS UPDATE PROCESS FLOWCHART

CHAPTER 2 CURRENT CHARACTERISTICS

This chapter describes the existing physical and operational characteristics of the corridors making up the MTC Phase 1 Project, including segments of the I-880 corridor in Alameda County, the I-680 corridor in Contra Costa County, and the westbound approaches to the San Francisco-Oakland Bay Bridge, San Mateo-Hayward and Dumbarton bridges. A segment on the I-80 corridor in Solano County is expected to open shortly after the MTC Phase 1 Project, and is also described below. A summary of the characteristics of each of these segments is included in Table 2-1.

TABLE 2-1: PROJECT CHARACTERISTICS FOR INITIAL PROJECTS IN THE MTC PROGRAM

Corridor	County	Project Limits	HOV Lane Characteristics	
			Operating Hours	Occupancy Requirement
MTC PHASE 1 PROJECT				
I-880	Alameda	Hegenberger/Lewelling Road to SR-237	5-9 a.m. and 3-7 p.m.	HOV 2+
I-680	Contra Costa	Rudgear/Livorna Road to Alcosta Boulevard	5-9 a.m. and 3-7 p.m.	HOV 2+
Bay Bridge Approaches	Alameda	I-80, I-580, I-880 and West Grand Avenue approaches to the Bay Bridge metering lights	5-10 a.m. and 3-7 p.m.	HOV 3+
SR-84	Alameda	I-880 to Toll Plaza	5-10 a.m. and 3-7 p.m.	HOV 2+
SR-92	Alameda	I-880 to Toll Plaza	5-10 a.m. and 3-7 p.m.	HOV 2+
SOLANO COUNTY I-80 PROJECT				
I-80	Solano	Red Top Road to I-505	5-10 a.m. and 3-7 p.m.	HOV 2+

2.1 I-880

2.1.1 GENERAL CHARACTERISTICS

The I-880 corridor, shown in Figure 2-1, is an approximately 42-mile, north-south route that runs through Alameda and Santa Clara Counties in the East Bay. The corridor connects the San Francisco-Oakland Bay Bridge with the South Bay and serves the Port of Oakland, Oakland International Airport and Mineta San Jose International Airport. As such, the I-880 corridor is a key international trade corridor and has the highest truck volume of any corridor in the region. This urban corridor also serves as a commuter link between Silicon Valley and the East Bay, and serves transbay traffic from three bridges: the Bay Bridge, the San Mateo-Hayward Bridge and the Dumbarton Bridge.

FIGURE 2-1: I-880 PROJECT LIMITS

2.1.2 PHASE 1 PROJECT LIMITS AND DESCRIPTION

As shown in Figure 2-1, the MTC Phase 1 Project includes conversion of HOV lanes to express lanes on I-880 SB between Hegenberger Road in Oakland and Dixon Landing Road in Milpitas (27.5 miles) and on I-880 NB between Dixon Landing Road and Lewelling Boulevard in San Leandro (22.3 miles). Southbound HOV lanes currently begin at Marina Boulevard, but construction is scheduled to begin in 2013 on a three-mile northward extension of the southbound HOV lane so that it begins at Hegenberger Road. The MTC Phase 1 Project limits assume that construction of this extension

will be completed in time for conversion to express lanes. At the southern end of the I-880 project limits, the I-880 HOV lanes connect to the express lanes being operated by VTA. The VTA express lanes opened to traffic on March 20, 2012 and operate between Dixon Landing Road on I-880 and Lawrence Expressway on SR-237 in Santa Clara County.

Within the project limits, the I-880 typical cross-section varies between eight and ten lanes with auxiliary lanes provided in some locations. The southbound segment of I-880 between Hegenberger Road and Dixon Landing Road includes 23 interchanges and the northbound segment from Lewelling Boulevard to Dixon Landing Road includes 17 interchanges, resulting in an average interchange spacing of approximately 1.2 to 1.3 miles. All of the freeway on-ramps within this segment are metered although not all are operational. Many of the metered ramps include HOV bypass lanes that allow HOVs to enter the freeway at a faster metered rate.

2.1.2.1 I-880 INTEGRATED CORRIDOR MANAGEMENT (ICM) PROJECT

A concept of operations for the I-880 ICM project was developed for the Federal Highway Administration (FHWA) in 2008, defining a number of Intelligent Transportation Systems (ITS) strategies to enhance safety, efficiency and mobility for the I-880 corridor. Building on the initial concept of operations, a prioritized list of ICM strategies was developed for the I-880 corridor in 2012. These strategies include comparative travel times, alternate routes, real-time parking information and adaptive ramp metering. Additionally, the I-880 ICM project identified the need for the development of operational procedures for express lane management during incidents.

As part of the I-880 ICM project, a coordinated freeway and arterial incident management strategy was identified for rapid deployment within the northern segment of the I-880 corridor. The goal of the project is to identify and design intelligent transportation infrastructure to facilitate the active management of traffic that naturally diverts onto local streets caused by major incidents that occur on I-880. The I-880 ICM North Alameda Segment is approximately 12 miles long, between Davis Street in San Leandro and the junction with I-80 in Oakland (Bay Bridge distribution structure). Construction for the I-880 ICM project is scheduled to begin in 2014 and be completed by 2015.

2.1.3 CURRENT HOV OPERATING POLICY

Like all HOV lanes in the Bay Area, the HOV lanes on I-880 operate only during weekday peak periods and serve as general purpose lanes during all other times. Peak periods on I-880 HOV lanes are defined as 5 a.m. to 9 a.m. and 3 p.m. to 7 p.m. Access to the HOV lanes on I-880 is unrestricted along the entire length.

HOV lane eligibility requirements on I-880 require two or more passengers in a vehicle during peak periods. Other eligible vehicles include buses, motorcycles and single-occupant vehicles that meet specified emissions standards. The Department of Motor Vehicles (DMV) issues green and white decals to vehicles that meet the specified emission standards, which allow drivers of these vehicles to use HOV lanes without having two or more vehicle occupants. Any vehicle pulling a trailer and large trucks with more than two axles are not permitted to use HOV lanes.

2.1.4 CURRENT EXPRESS LANE OPERATING POLICY

The SR-237/I-880 express lane direct connectors opened to traffic on March 20, 2012, allowing single-occupant vehicles (SOVs) to use the direct connectors for a toll. When the express lane

opened, the morning peak period hours of operation were extended by one hour to 5 a.m. to 10 a.m. in the southbound-to-westbound direction to accommodate heavy traffic volumes during the 9 a.m. to 10 a.m. hour. On southbound I-880, signing designates the start of the express lane at Dixon Landing Road (see Figure 2-2) and access to the lane is restricted approximately one-mile downstream using double white solid striping. Access to the express lane is also restricted in the northbound direction for a distance of approximately one-half mile after the direct connector touches down. Signs designate the end of the northbound express lane at Dixon Landing Road, at which point all single-occupant, toll paying vehicles are required to have exited the lane. Similar signs are in place on westbound SR-237 where the express lane terminates at Lawrence Expressway.

The operating concept for the I-880 express lanes to be operated by MTC differs from the current operating policy on the SR-237/I-880 express lane direct connectors. These differences in operating policy are described in Chapter 4 along with the need for coordination among MTC and VTA to ensure seamless operations between the two projects.

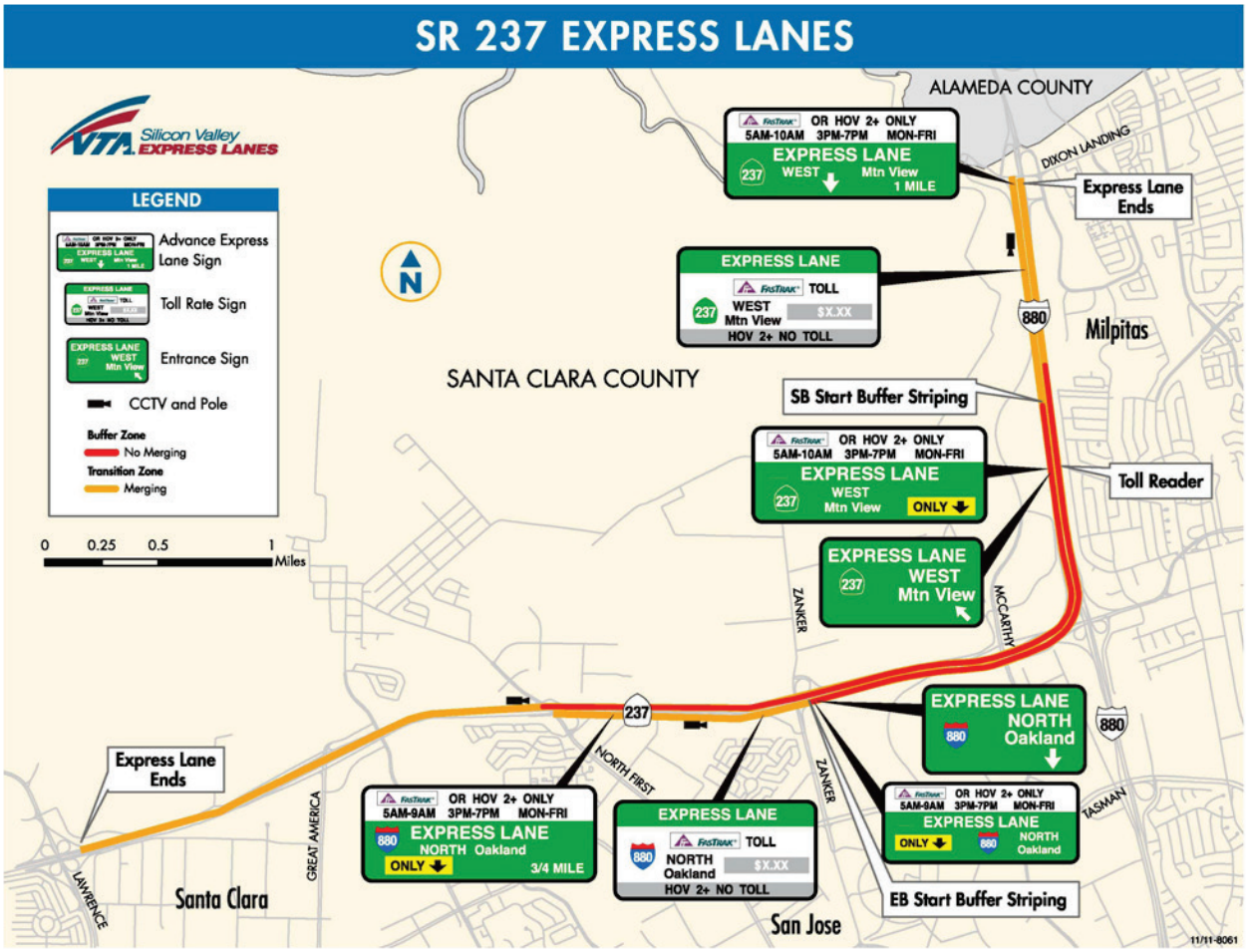


FIGURE 2-2: SR-237/I-880 EXPRESS LANE PROJECT MAP

2.1.5 TRAFFIC CHARACTERISTICS

Travel time and traffic volume data were collected for the I-880 corridor in April of 2012 to support the Project Approval/Environmental Document (PA/ED) effort for the MTC Phase 1 Project. Table 2-2 compares the average travel times by hour during the morning and afternoon peak periods for travel in the HOV lanes and the general purpose lanes. As shown, the longest travel times are experienced during the afternoon peak period in the northbound direction and during the morning peak period in the southbound direction. These are also the time periods during which the HOV lanes provide the greatest travel time savings. For example, a driver traveling southbound on the I-880 corridor using HOV lanes during 8 a.m. to 9 a.m. saves about 22 minutes on average compared to traveling in the general purpose lanes.

The most congested hour during the morning peak period is from 8 a.m. to 9 a.m. in both the northbound and southbound directions. In the afternoon peak period, the most congested hour occurs from 6 p.m. to 7 p.m. in the northbound direction and from 5 p.m. to 6 p.m. in the southbound direction.

TABLE 2-2: I-880 AVERAGE TRAVEL TIMES[1]

	Time Period	Average Travel Time (minutes)		
		Using GP Lanes	Using HOV lane	HOV lane travel time savings
Northbound	**Morning Peak Period**			
	5 a.m. - 6 a.m.	27.7	26.9	0.8
	6 a.m. - 7 a.m.	28.5	27.2	1.3
	7 a.m. - 8 a.m.	30.9	28.6	2.3
	8 a.m. - 9 a.m.	33.8	30.1	3.7
	Afternoon Peak Period			
	3 p.m. - 4 p.m.	37.3	30.7	6.6
	4 p.m. - 5 p.m.	42.9	33.5	9.4
	5 p.m. - 6 p.m.	44.1	36.7	7.4
	6 p.m. - 7 p.m.	44.3	40.9	3.4
Southbound	**Morning Peak Period**			
	5 a.m. - 6 a.m.	28.5	27.1	1.4
	6 a.m. - 7 a.m.	33.8	28.5	5.3
	7 a.m. - 8 a.m.	49.9	34.8	15.1
	8 a.m. - 9 a.m.	57.6	35.3	22.3
	Afternoon Peak Period			
	3 p.m. - 4 p.m.	30.1	28.0	2.1
	4 p.m. - 5 p.m.	33.9	30.0	3.9
	5 p.m. - 6 p.m.	37.8	32.1	5.7
	6 p.m. - 7 p.m.	31.5	29.0	2.5

Note: Travel time is measured between Montague Expressway and 66th Avenue. HOV lane travel times include travel in the general purpose lanes where no HOV lanes exist.

Federal law specifies that the average operating speed on HOV lanes that allow low emission and energy-efficient vehicles or HOT lanes should not fall below a minimum of 45 miles-per-hour (mph). The maximum traffic flow rate at which this speed can be reliably maintained on Bay Area HOV lanes is commonly assumed to be approximately 1650 vehicles per hour (vph), referred to herein as the operating capacity of the HOV lanes.

Average travel speeds and traffic volumes for the peak hours, identified from the largest travel times above, are shown in Figure 2-3 through Figure 2-5 for the northbound direction of the I-880 corridor. These figures reveal that the northbound HOV lane generally provides higher speeds compared with the general purpose lanes, although speeds in the HOV lane during the p.m. peak hour are more variable and fall below the federally mandated 45 mph threshold in some spot locations.

The HOV volumes shown in Figure 2-5 represent all vehicles traveling in the HOV lane during the 8 a.m. to 9 a.m. period, including motorcycles, hybrids and violators. Data from the Caltrans District 4

[1] MTC Express Lane Phase I Project – Weekday Data Collection Results for Interstate 880. Metropolitan Transportation Commission. September 28, 2012.

2010 Bay Area HOV Lanes Report suggests that violation rates are as high as 10 percent on some Bay Area corridors. The presence of these violators may account for volumes in the HOV lane being above the operating capacity and may cause speeds to drop. The incorporation of access restrictions where needed for operational and/or safety reasons and an automated violation enforcement system upon conversion to express lanes is likely to deter many violators from using the lanes, which would free up capacity and improve operating speeds in the lanes.

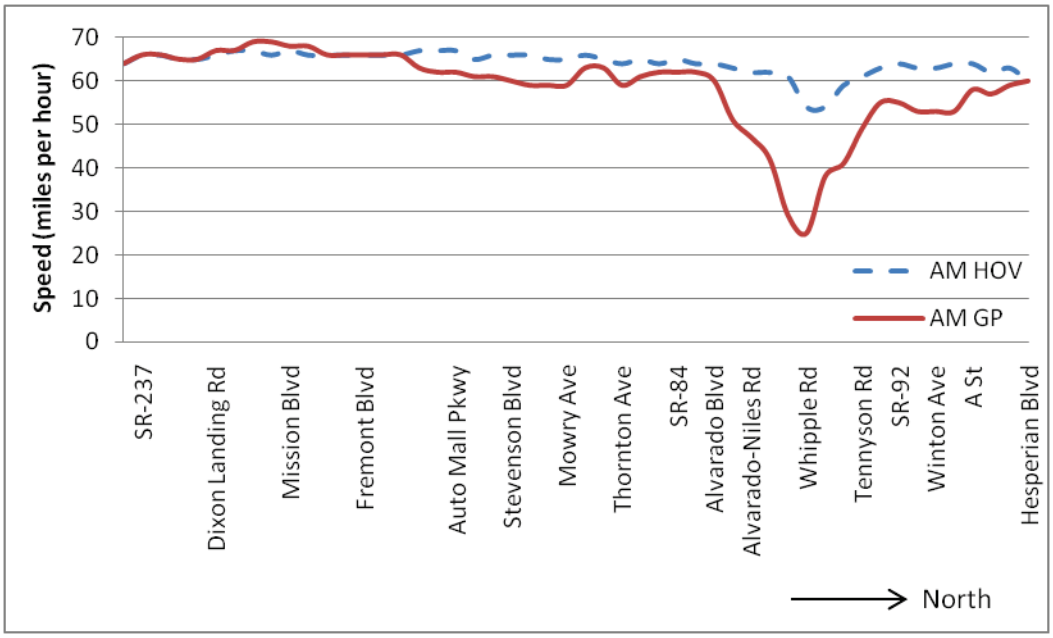


FIGURE 2-3: I-880 NORTHBOUND A.M. PEAK HOUR (8 A.M. TO 9 A.M.) AVERAGE SPEEDS[1]

[1] MTC Express Lane Phase I Project – Weekday Data Collection Results for Interstate 880. Metropolitan Transportation Commission. September 28, 2012.

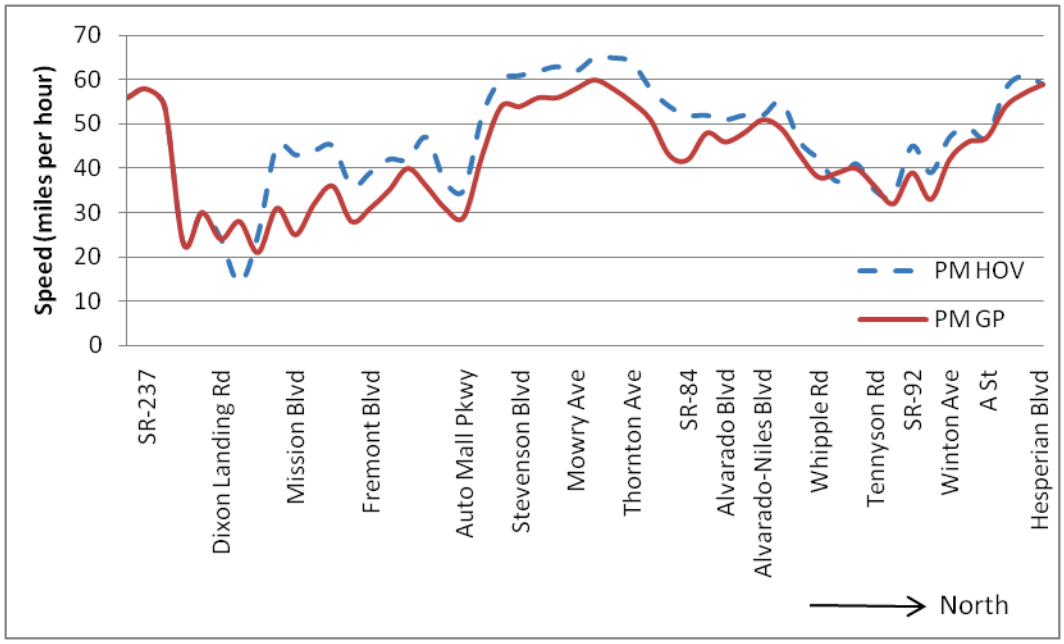
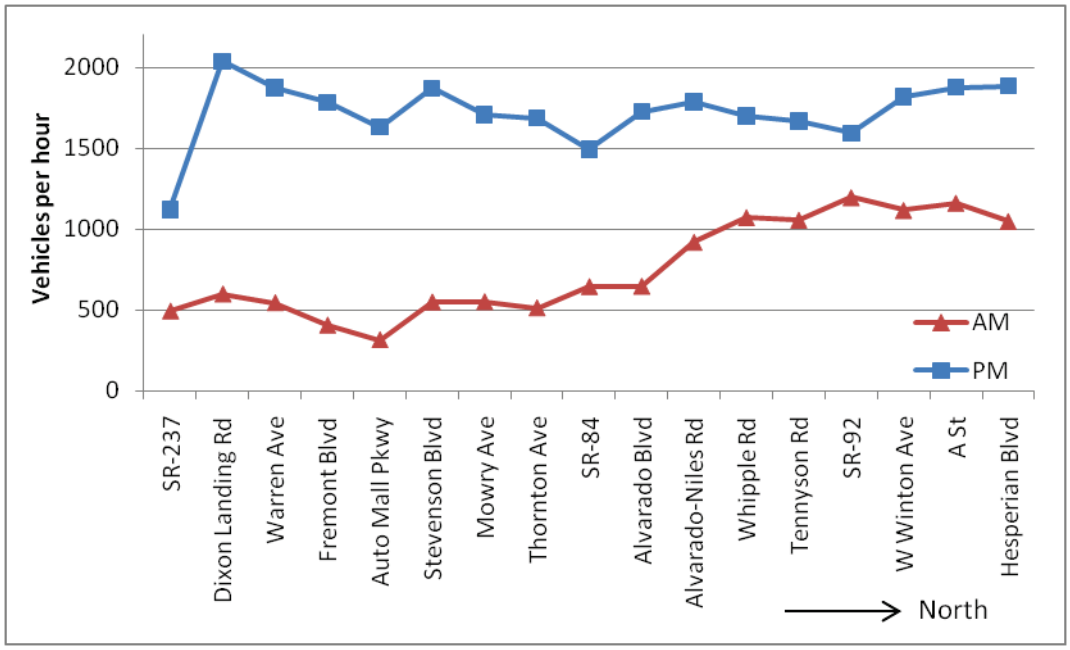


FIGURE 2-4: I-880 NORTHBOUND P.M. PEAK HOUR (6 P.M. TO 7 P.M.) AVERAGE SPEEDS[1]



Note: Volumes shown include all vehicles traveling in the HOV lane, including motorcycles, hybrid vehicles and single-occupant violators

FIGURE 2-5: I-880 NORTHBOUND A.M. PEAK HOUR (8 A.M. TO 9A.M.) AND P.M. PEAK HOUR (6 P.M. TO 7 P.M.) AVERAGE HOV LANE VOLUMES[1]

[1] MTC Express Lane Phase I Project – Weekday Data Collection Results for Interstate 880. Metropolitan Transportation Commission. September 28, 2012.

Average speeds and traffic volumes for the southbound direction of I-880 are presented in Figure 2-6 through Figure 2-8. As shown, speeds in the HOV lane during the a.m. and p.m. peak hours are generally maintained at or above the 45 mph threshold even as speeds in the general purpose lanes during the a.m. peak hour fall to as low as 15 mph. Traffic volumes in the HOV lane, shown in Figure 2-8, approach the operating capacity between Tennyson Road and Hesperian Boulevard during the p.m. peak hour. However, the southbound HOV lane generally operates at below 1500 vph along most of its length during the peak hours.

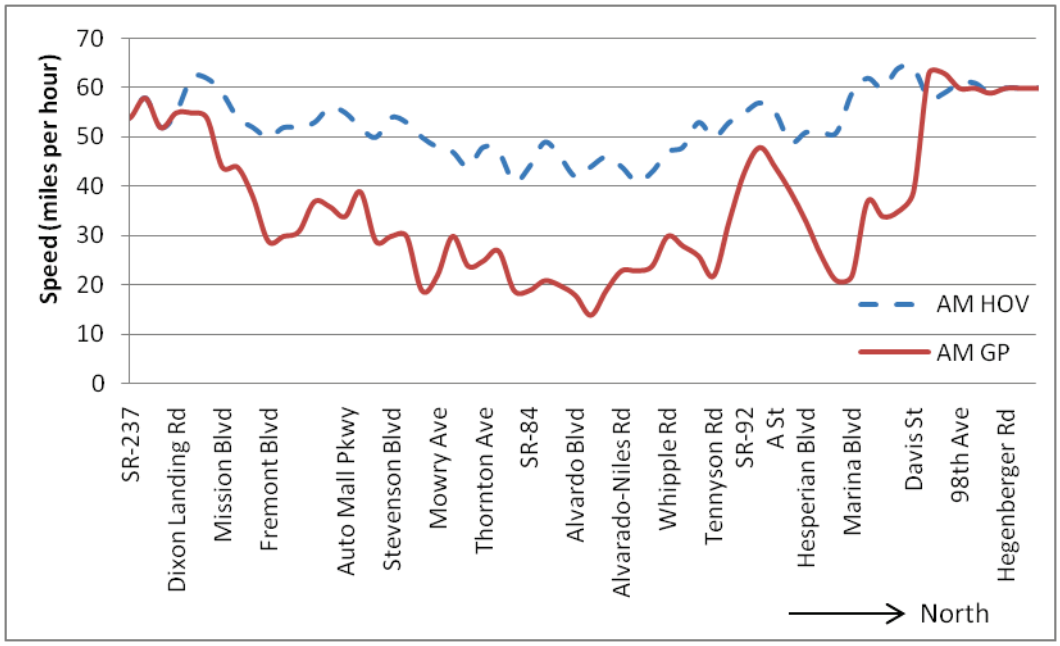


FIGURE 2-6: I-880 SOUTHBOUND A.M. PEAK HOUR (8 A.M. TO 9 A.M.) AVERAGE SPEEDS[1]

[1] MTC Express Lane Phase I Project – Weekday Data Collection Results for Interstate 880. Metropolitan Transportation Commission. September 28, 2012.

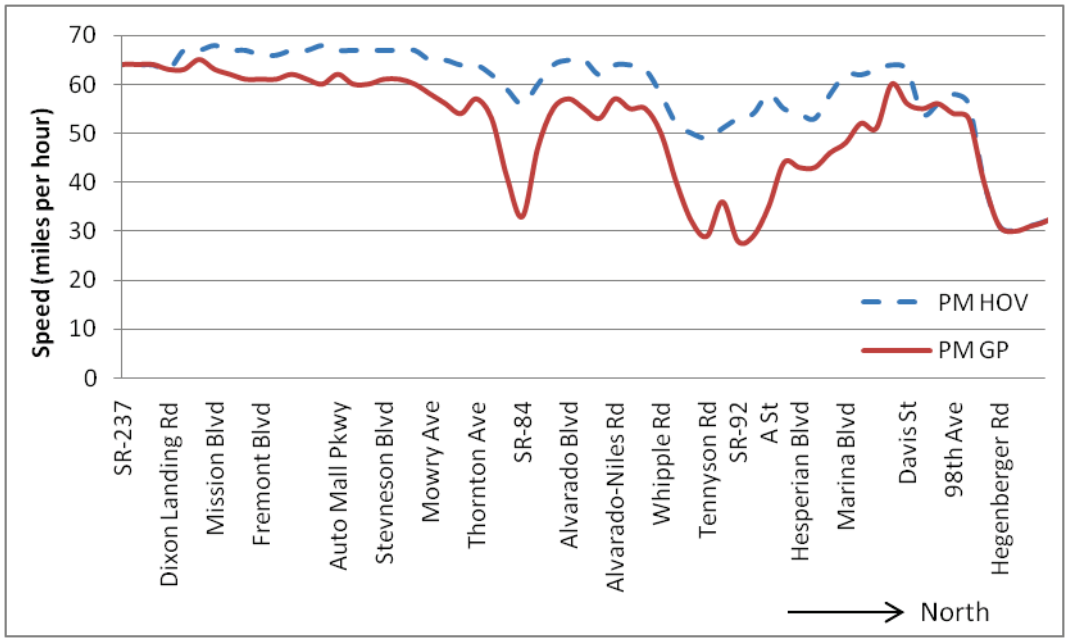
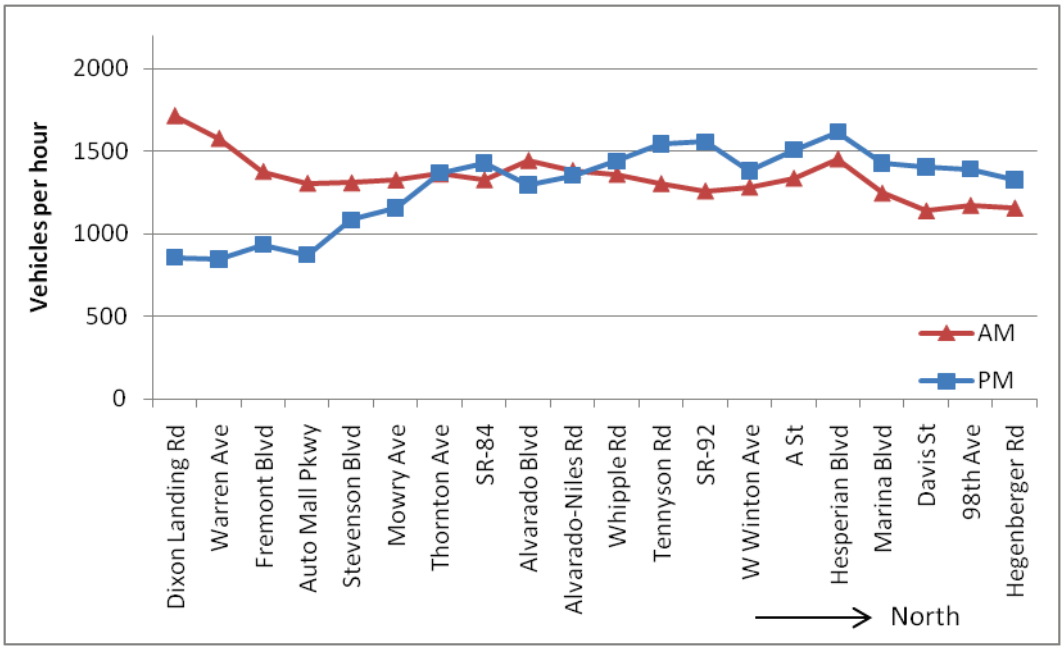


FIGURE 2-7: I-880 SOUTHBOUND P.M. PEAK HOUR (5 P.M. TO 6 P.M.) AVERAGE SPEEDS[1]



Note: Volumes shown include all vehicles traveling in the HOV lane, including motorcycles, hybrid vehicles and single-occupant violators

FIGURE 2-8: I-880 SOUTHBOUND A.M. PEAK HOUR (8 A.M. TO 9 A.M.) AND P.M. PEAK HOUR (5 P.M. TO 6 P.M.) AVERAGE HOV TRAFFIC VOLUMES[1]

[1] MTC Express Lane Phase I Project – Weekday Data Collection Results for Interstate 880. Metropolitan Transportation Commission. September 28, 2012.

2.1.6 TRANSIT

The I-880 corridor serves regional bus service provided by Alameda-Contra Costa Transit (AC Transit) and VTA, as summarized in Table 2-3. AC Transit routes provide transbay service between various locations in the East Bay and downtown San Francisco via the Bay Bridge. VTA routes connect the Fremont BART station to transit centers in Sunnyvale and San Jose and to Mission College in Santa Clara.

TABLE 2-3: TRANSIT SERVICE ON I-880 CORRIDOR

Transit Operator	Route
AC-Transit	S: South Hayward to San Francisco
	SA: San Lorenzo to San Francisco
	SB: Newark to San Francisco
	OX: Harbor Bay/Alameda to San Francisco
	O: Alameda to San Francisco
	W: West Alameda to San Francisco
VTA	120: Fremont BART to Lockheed Martin Transit Center
	140: Fremont BART to Mission College
	181: Fremont BART to San Jose Diridon Transit Center

2.1.7 PARK AND RIDE

Table 2-4 lists the park and ride lots located along the I-880 corridor within the project limits.

TABLE 2-4: I-880 PARK AND RIDE LOTS

Address	City
Union City Boulevard & Horner Street	Union City
Ardenwood Boulevard & SR-84	Fremont

2.2 I-680

2.2.1 GENERAL CHARACTERISTICS

The I-680 corridor is a north-south route that runs through Solano, Contra Costa, Alameda and Santa Clara Counties. I-680 connects I-80 in Solano County at its northern terminus to US-101 and I-280 in San Jose at its southern terminus. The corridor serves many rapidly growing suburban communities through Solano County, central Contra Costa and Alameda counties and provides access to employment centers in the South Bay and the East Bay. The I-680 corridor connects with I-580 in Alameda County, and thus serves as an important route for access from the Central Valley to these employment centers.

2.2.2 PHASE 1 PROJECT LIMITS AND DESCRIPTION

The MTC Phase 1 Project includes conversion of existing HOV lanes to express lanes on the northbound segment of I-680 between Alcosta Boulevard and Livorna Road (11.2 miles) and on the southbound segment between Alcosta Boulevard and Rudgear Road (12.5 miles) through the San Ramon Valley in Contra Costa County (see Figure 2-9). HOV lanes also exist on the northern segment of I-680 in Contra Costa County north of Walnut Creek; however there is a gap in the northbound and southbound HOV lanes through Walnut Creek. There are plans to close the gap in the southbound direction and construction has been completed to extend the southbound HOV lane 1.5 miles to the north of Livorna Road. There are no near-term plans to close the northbound HOV lane gap, although there are plans to shorten the gap by extending the lane from its current southern terminus at SR-242 to North Main Street.

FIGURE 2-9: I-680 PROJECT LIMITS

Within the project limits, the I-680 typical cross-section consists of three general purpose lanes and one HOV lane in each direction. The segment serves a total of nine interchanges in the northbound and southbound directions. The 2011 Caltrans Ramp Metering Design Plan shows that ramp meters are partially constructed or planned (subject to agreement) on all ramps within the project segment.

The construction of HOV Direct Access Ramps (DAR's) in the vicinity of Norris Canyon Road in the city of San Ramon is currently being evaluated. The connectors would provide a direct connection for buses and carpools using the I-680 HOV lanes to a major business park.

2.2.3 CURRENT HOV OPERATING POLICY

HOV lanes on I-680 operate during weekday peak periods and serve as general purpose lanes during all other times. Current peak period hours of operation are defined as 5 a.m. to 9 a.m. and 3 p.m. to 7 p.m. Access to the HOV lanes on I-680 is unrestricted along the entire length.

HOV lane eligibility requirements on I-680 require two or more passengers in a vehicle during peak periods. Other eligible vehicles include buses, motorcycles and SOVs that meet specified emissions standards with DMV issued decals.

2.2.4 TRAFFIC CHARACTERISTICS

Travel time and traffic volume data were collected in April of 2012 for the I-680 corridor between Stoneridge Drive and Treat Boulevard. Table 2-5 compares the average travel times by hour during the peak periods for travel in the general purpose lanes versus travel in the HOV lanes. Drivers traveling in the northbound direction experience the longest travel times during the afternoon peak and drivers traveling in the southbound direction experience the longest travel times during the morning peak. These are also the periods during which the HOV lanes provide the greatest travel time savings. For example, a driver traveling northbound using the HOV lane between 5 p.m. and 6 p.m. saves about 10 minutes compared with traveling in the general purpose lanes.

The most congested hour during the morning peak period is from 8 a.m. to 9 a.m. in both the northbound and southbound directions. In the afternoon peak period, the most congested hour occurs from 5 p.m. to 6 p.m. in both directions.

TABLE 2-5: I-680 AVERAGE TRAVEL TIMES[1]

	Time Period	Average Travel Time (minutes)		
		Using GP Lanes	Using HOV lane	HOV lane travel time savings
Northbound	**Morning Peak Period**			
	5 a.m. - 6 a.m.	17.6	17.4	0.2
	6 a.m. - 7 a.m.	17.4	17.4	0.0
	7 a.m. - 8 a.m.	19.7	17.9	2.8
	8 a.m. - 9 a.m.	23.2	18.4	4.8
	Afternoon Peak Period			
	3 p.m. - 4 p.m.	20.7	19.1	1.6
	4 p.m. - 5 p.m.	29.3	24.4	4.9
	5 p.m. - 6 p.m.	35.7	25.5	10.2
	6 p.m. - 7 p.m.	23.1	19.5	3.6
Southbound	**Morning Peak Period**			
	5 a.m. - 6 a.m.	16.8	16.8	0.0
	6 a.m. - 7 a.m.	18.4	17.8	0.6
	7 a.m. - 8 a.m.	25.0	21.7	3.3
	8 a.m. - 9 a.m.	29.6	24.2	5.4
	Afternoon Peak Period			
	3 p.m. - 4 p.m.	18.1	17.5	0.6
	4 p.m. - 5 p.m.	21.8	19.9	1.9
	5 p.m. - 6 p.m.	25.2	21.9	3.3
	6 p.m. - 7 p.m.	18.4	17.8	0.6

Note: Travel time is measured between Stoneridge Drive and Treat Boulevard. HOV lane travel times include travel in the general purpose lanes where no HOV lanes exist.

Average travel speeds and HOV lane traffic volumes during the most congested hours in the northbound direction are shown in Figure 2-10 through Figure 2-12 As shown in Figure 2-10, congestion during the morning peak hour in the northbound direction causes speeds in the general purpose lanes to drop below 30 mph between Crow Canyon Road and El Cerro Boulevard. Congestion is more severe and widespread in the afternoon peak hour, as shown in Figure 2-11. Average speeds in the HOV lanes are maintained above 45 mph throughout the corridor during both peak periods. HOV lane traffic volumes, shown in Figure 2-12, do not go above 1400 vph indicating that excess capacity exists in the HOV lanes during the peak periods.

[1] MTC Express Lane Phase I Project – Weekday Data Collection Results for Interstate 680. Metropolitan Transportation Commission. September 28, 2012.

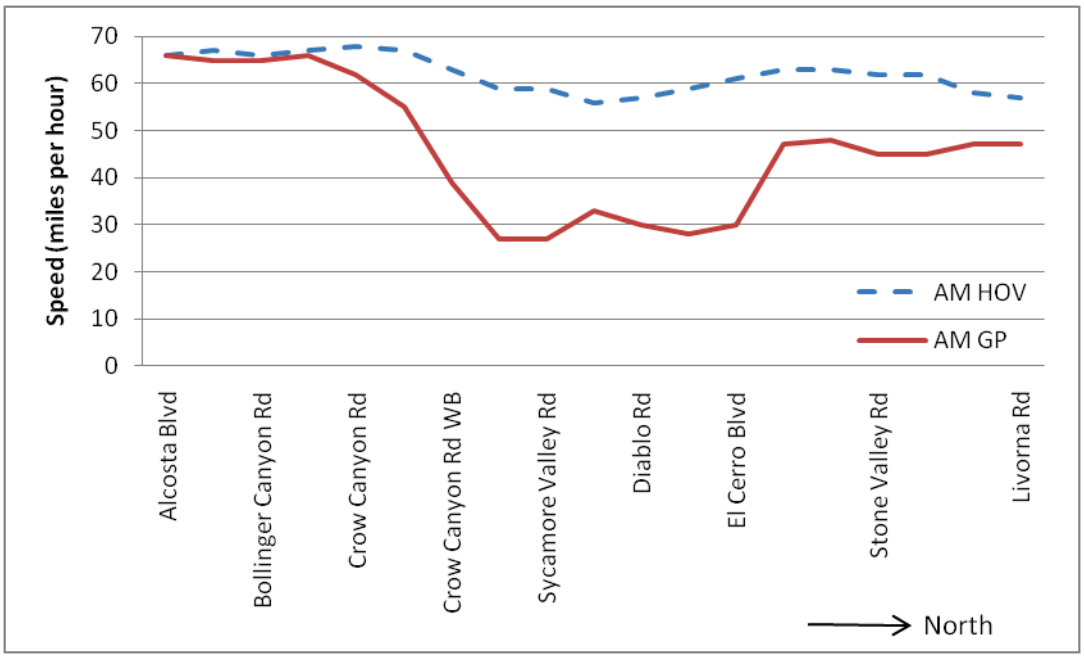


FIGURE 2-10: I-680 NORTHBOUND A.M. PEAK HOUR (8 A.M. TO 9 A.M.) AVERAGE SPEEDS[1]

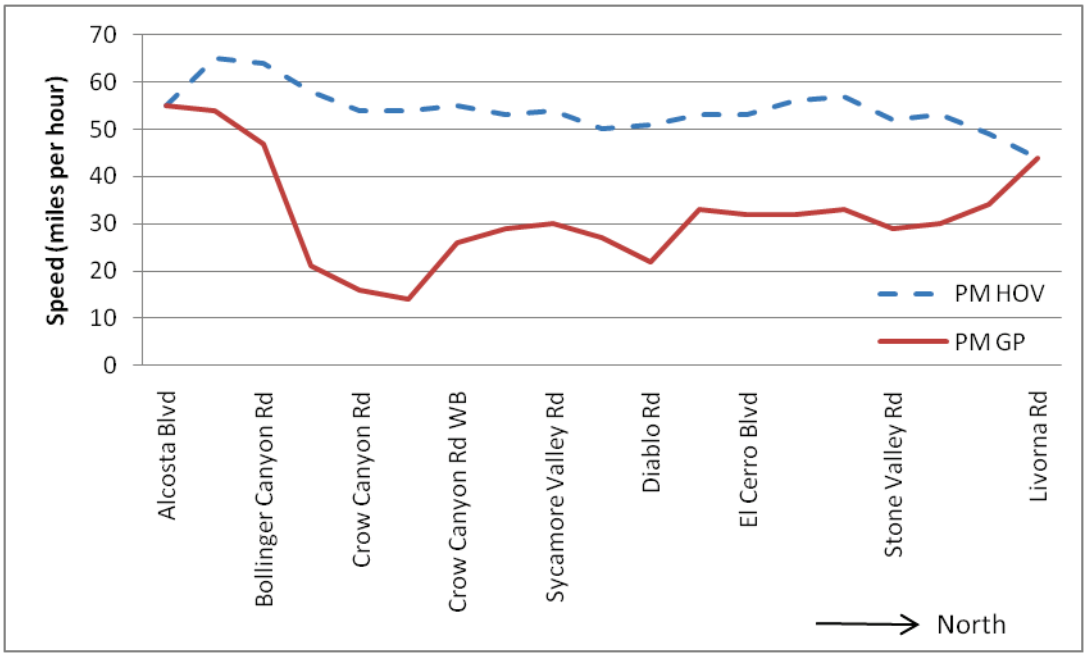
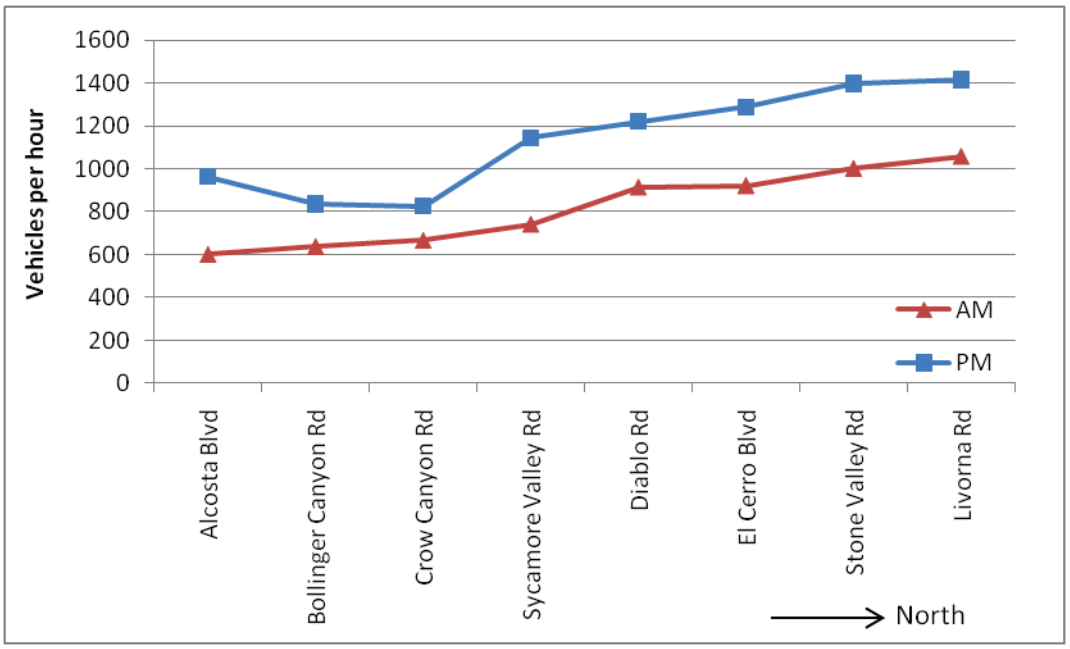


FIGURE 2-11: I-680 NORTHBOUND P.M. PEAK HOUR (5 P.M. TO 6 P.M.) AVERAGE SPEEDS[1]

[1] MTC Express Lane Phase I Project – Weekday Data Collection Results for Interstate 680. Metropolitan Transportation Commission. September 28, 2012.



Note: Volumes shown include all vehicles traveling in the HOV lane, including motorcycles, hybrid vehicles and single-occupant violators

FIGURE 2-12: I-680 NORTHBOUND A.M. PEAK HOUR (8 A.M. TO 9 A.M.) AND P.M. PEAK HOUR (5 P.M. TO 6 P.M.) AVERAGE HOV TRAFFIC VOLUMES[1]

Average travel speeds and HOV lane volumes for the southbound direction of I-680 are shown in Figure 2-14 through Figure 2-15. During the peak hour, average speeds in the general purpose lanes tend to be low (15-20 mph) around Rudgear Road and generally improve as drivers travel south along the corridor. Average speeds in the southbound HOV lane follow a similar trend of increasing from north to south, but speeds are maintained above 45 mph at all times. Average HOV volumes, shown in Figure 2-15, do not go above 1100 vph and are lowest south of Sycamore Valley Road.

[1] MTC Express Lane Phase I Project – Weekday Data Collection Results for Interstate 680. Metropolitan Transportation Commission. September 28, 2012.

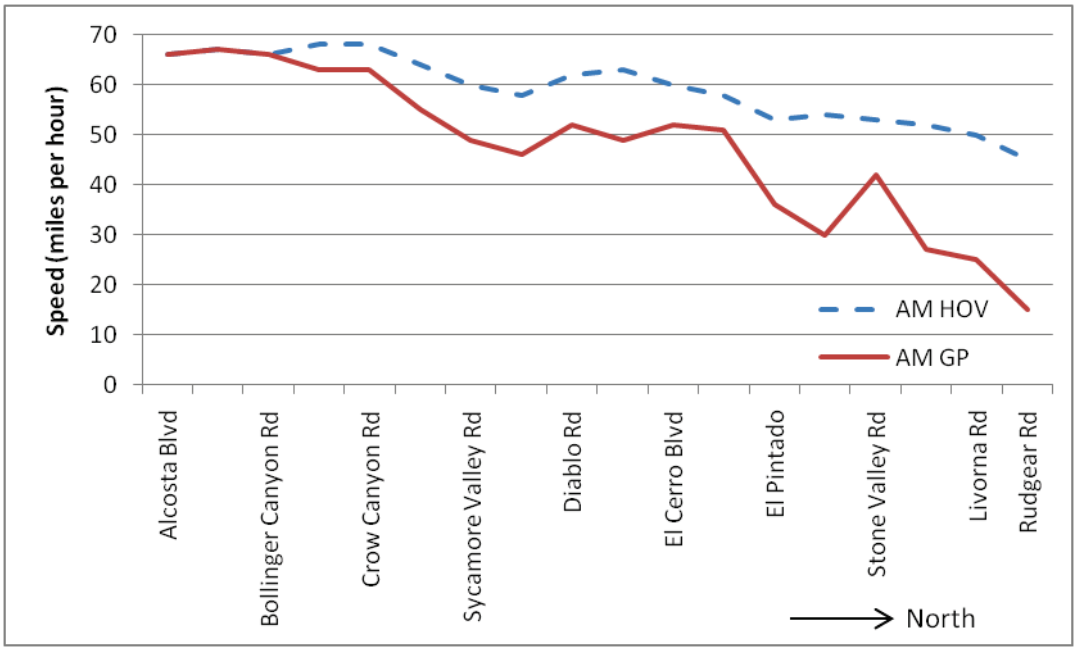


FIGURE 2-13: I-680 SOUTHBOUND A.M. PEAK HOUR (8 A.M. TO 9 A.M.) AVERAGE SPEEDS[1]

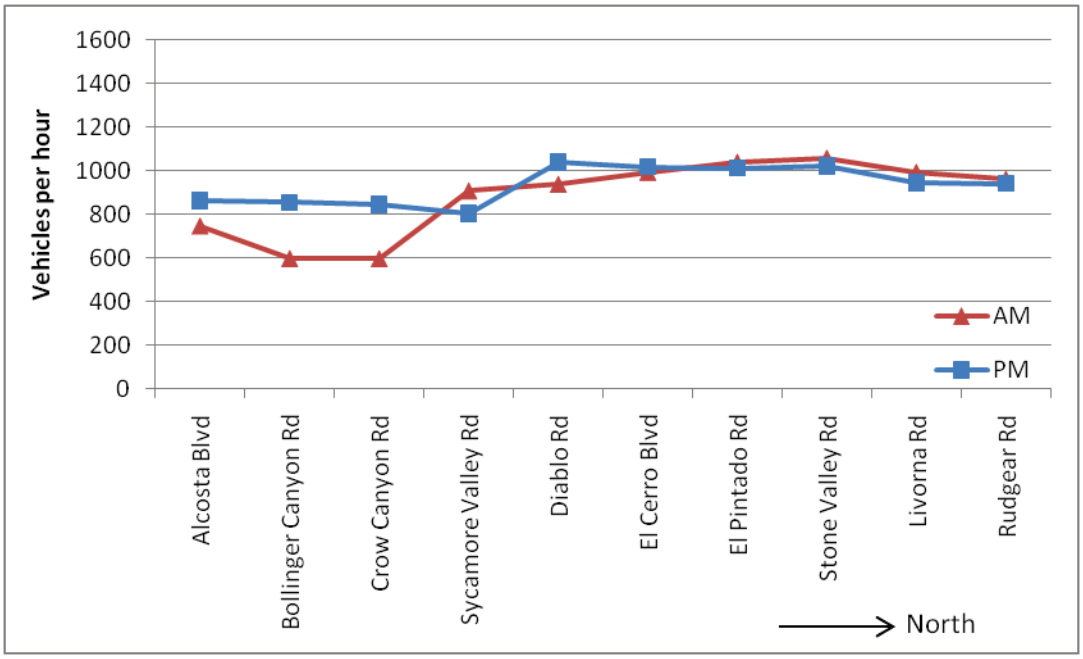
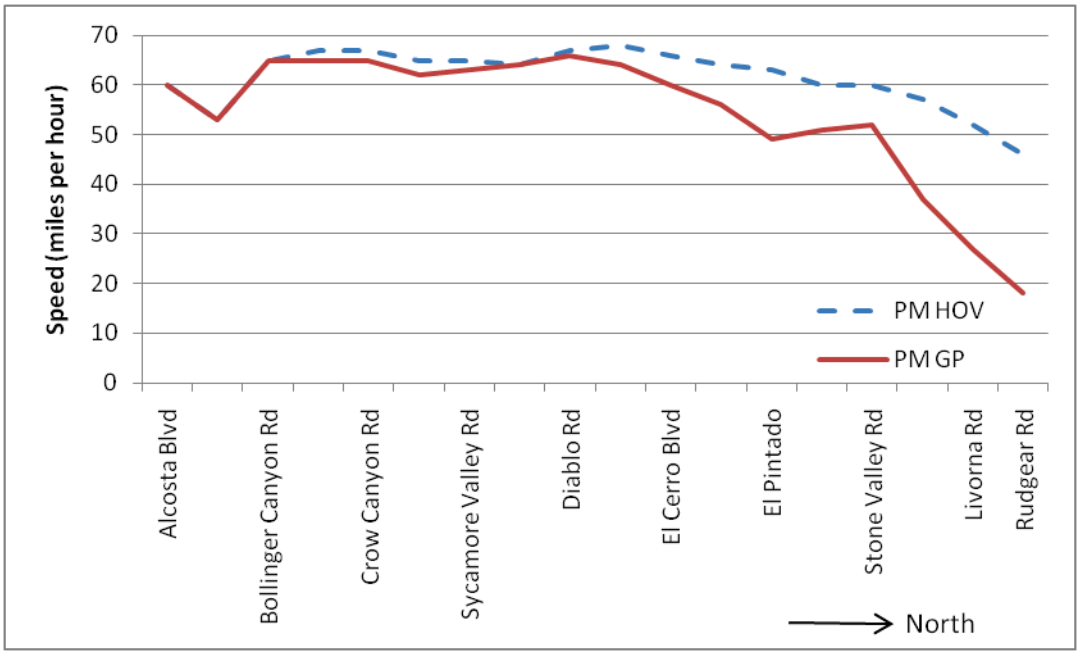


FIGURE 2-14: I-680 SOUTHBOUND P.M. PEAK HOUR (5 P.M. TO 6 P.M.) AVERAGE SPEEDS[1]

[1] MTC Express Lane Phase I Project – Weekday Data Collection Results for Interstate 680. Metropolitan Transportation Commission. September 28, 2012.



Note: Volumes shown include all vehicles traveling in the HOV lane, including motorcycles, hybrid vehicles and single-occupant violators

FIGURE 2-15: I-680 SOUTHBOUND A.M. PEAK HOUR (8 A.M. TO 9 A.M.) AND P.M. PEAK HOUR (5 P.M. TO 6 P.M.) AVERAGE HOV LANE TRAFFIC VOLUMES[1]

2.2.5 TRANSIT

A list of express bus routes utilizing the I-680 project segment are shown in Table 2-6. The main transit service provider on I-680 within the project limits is County Connection, operated by the Central Contra Costa Transit Authority (CCCTA). County Connection routes connect Dublin/Pleasanton with downtown Pleasant Hill as well as several locations in between. The Livermore Amador Valley Transit Authority (LAVTA) also operates an express bus service as part of WHEELS that uses the I-680 project segment and connects the Dublin BART station with the Pleasant Hill and Walnut Creek BART stations. The Bishop Ranch office park in San Ramon also provides express shuttle service to and from BART.

TABLE 2-6: TRANSIT SERVICE ON I-680 CORRIDOR

Transit Operator	Route
County Connection	92X: Walnut Creek to Pleasanton ACE Train Station
	95X: Walnut Creek BART to San Ramon Transit Center
	96X: Walnut Creek BART to San Ramon Transit Center
	97X: San Ramon Transit Center to Dublin BART
WHEELS	70X: Dublin BART to Pleasant Hill BART

[1] MTC Express Lane Phase I Project – Weekday Data Collection Results for Interstate 680. Metropolitan Transportation Commission. September 28, 2012.

2.2.6 PARK AND RIDE

Table 2-7 lists the four park and ride lots along I-680 within the project limits.

TABLE 2-7: I-680 PARK AND RIDE LOTS

Address	City
Sycamore Valley Road & Camino Ramon	Danville
Bollinger Canyon Road & I-680	San Ramon
Camino Ramon & Executive Parkway	San Ramon
Rudgear Road & I-680	Walnut Creek

2.3 BAY BRIDGE APPROACHES

2.3.1 GENERAL CHARACTERISTICS

There are four approaches to designated HOV lanes at the Bay Bridge Toll Plaza that are being evaluated for potential conversion to express lanes. The study limits for these approaches, including I-80, I-580, I-880 and West Grand Avenue, are shown in Figure 2-16. Each of these approaches feeds into one of the four lanes at the Bay Bridge toll plaza that operate as designated HOV lanes during peak periods that carry vehicles to the Bay Bridge metering lights. There are a total of 20 lanes that pass through the Bay Bridge toll plaza. The left-side HOV lanes are designated as Lanes 1 and 2 and the right-side HOV lanes are designated as Lanes 19 and 20 (see Figure 2-17 and Figure 2-18). All other lanes operate as cash/FasTrak® lanes, allowing vehicles to pay the bridge toll with cash or with a FasTrak® toll tag, or as FasTrak® only lanes. The lane designation is indicated using changeable message signs mounted at the toll plaza.

Metering lights, located downstream of the toll plaza, meter all vehicles in Lanes 3 through 18 when the bridge is approaching capacity. While meters are present in HOV lanes 1 and 2, they are not turned on during peak periods to prevent queuing in those lanes, as well as to provide an incentive for carpooling. The current metering algorithm uses the flow in the general purpose lanes and is adjusted based on the volume of vehicles being loaded onto the bridge through the HOV lanes. FasTrak® only lanes are metered at a faster rate than cash/FasTrak® lanes.

FIGURE 2-16: STUDY LIMITS FOR BAY BRIDGE HOV APPROACHES

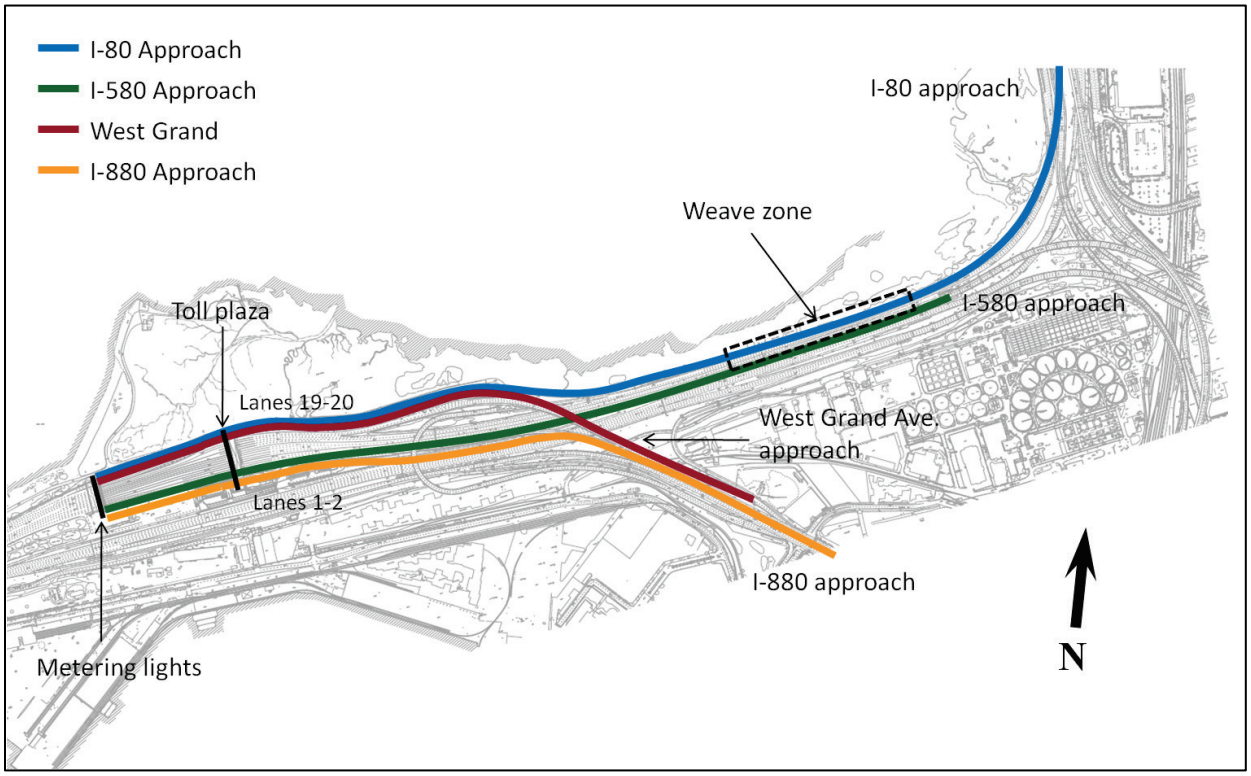


FIGURE 2-17: APPROACHES TO BAY BRIDGE TOLL PLAZA HOV LANES

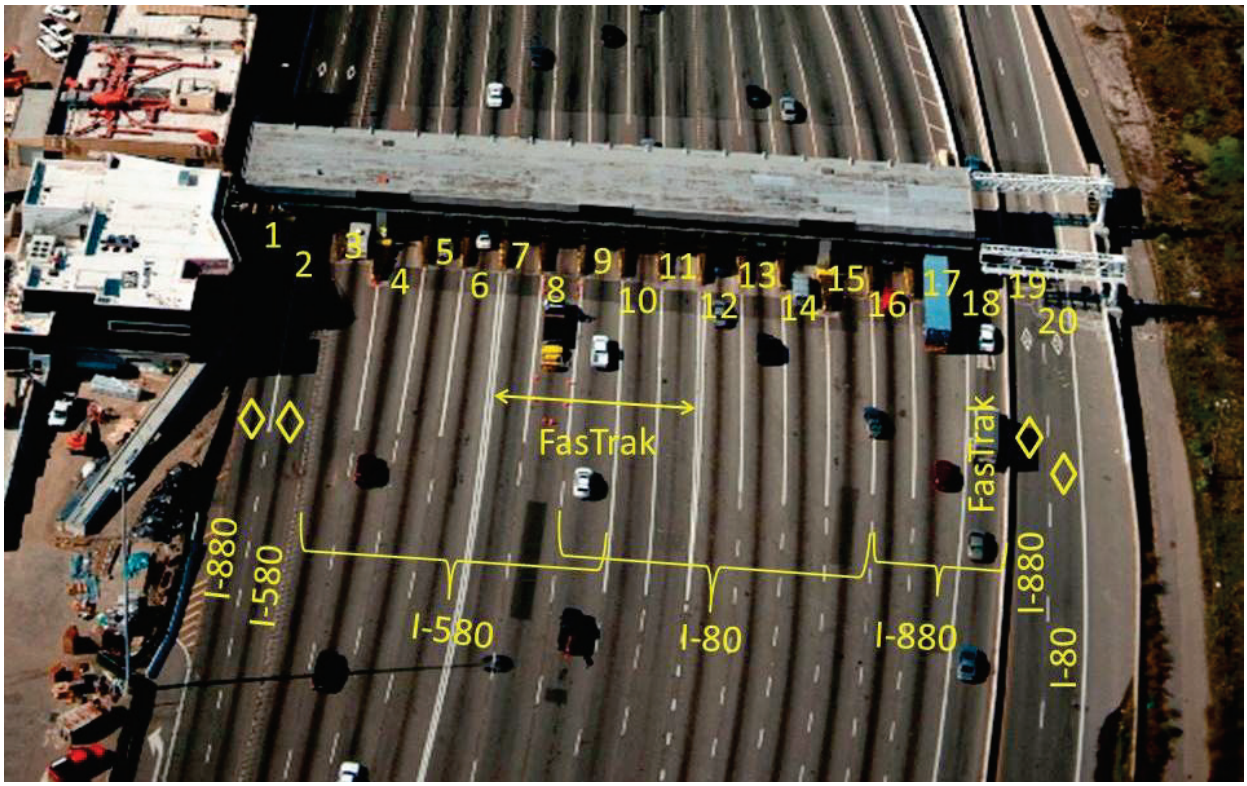


FIGURE 2-18: BAY BRIDGE TOLL PLAZA LANE DESIGNATION

2.3.2 CURRENT HOV OPERATING POLICY

When in operation during peak periods, defined as 5 a.m. to 10 a.m. and 3 p.m. to 7 p.m., the designated HOV lanes at the toll plaza charge vehicles a reduced bridge toll (see Table 2-8 for bridge toll rates) and allow vehicles to bypass the metering lights, providing a monetary and time-saving incentive. Vehicles eligible for the reduced bridge toll include 2-axle vehicles with three or more occupants, motorcycles, inherently low emission vehicles with DMV issued decals and 2-axle vehicles with two occupants in vehicles designated by the manufacturer to carry no more than two occupants. Eligible vehicles must use the designated HOV lanes at the toll plaza to be charged the reduced bridge toll and must carry a FasTrak® toll tag. Commute buses and vanpools are able to cross the bridge toll-free at all times in designated lanes. During off-peak periods, Lanes 1 and 2 operate as cash/FasTrak® lanes, and Lanes 19 and 20 operate as bus-only lanes. The approaches to these lanes are described in further detail below.

TABLE 2-8: BAY BRIDGE TOLL RATES

	Day/Time	Toll Rate
2-axle vehicles	Mon-Fri 5 a.m. – 10 a.m. 3 p.m. – 7 p.m.	Three or more occupants*: $2.50
		Less than three occupants*: $6.00
	Mon-Fri 10 a.m. – 3 p.m. 7 p.m. – 5 a.m.	$4.00
	Saturday – Sunday	$5.00
Commute buses and vanpools	All times	Toll-free

*Inherently-low-emission vehicles (ILEVs) with DMV-issued decals, 2-axle vehicles carrying two persons that are designated by the manufacturer to be occupied by no more than two persons and motorcycles are also eligible for reduced rate of $2.50 during peak periods. Discounted passage for HOV users is recognized only in designated lanes at the toll plaza.

2.3.3 I-80 HOV APPROACH PHASE 1 PROJECT LIMITS

The I-80 approach is approximately 2 miles in length when measured from the entrance near Powell Street to the Bay Bridge metering lights. The approach connects the HOV lane on westbound I-80 to Lane 20 at the toll plaza (shown in blue in Figure 2-17). Part of the I-80 approach consists of a grade-separated flyover ramp that carries traffic traveling in the I-80 westbound HOV lane over the general purpose lanes to the rightmost lane approaching the toll plaza.

Access to the right-side HOV lane at the downstream end of the flyover is currently unrestricted. This allows eligible vehicles that enter I-80 at the Powell Street on-ramp, and are therefore unable to access the HOV flyover, to use Lanes 19 and 20. The configuration of the downstream end of the flyover allows vehicles that use the HOV flyover ramp during off-peak period to access the cash/FasTrak® lanes and for buses entering I-80 at Powell Street to access Lanes 19 and 20, which operate as bus-only lanes during off-peak periods.

2.3.3.1 I-80 INTEGRATED CORRIDOR MOBILITY (ICM) PROJECT

The I-80 ICM project will install ITS and Active Traffic Management (ATM) technologies along the I-80 corridor from the Carquinez Bridge to the I-80/I-580/I-880 interchange as well as improvements to San Pablo Avenue. The goal of the I-80 ICM project is to enhance freeway operations and safety along the corridor by maintaining optimum traffic flow. This will be accomplished via the use of strategies such as advisory speeds, lane control, adaptive ramp metering and vehicle detection. Advisory speeds, lane control signals and variable message signs will be installed on sign structures that span all lanes of traffic at approximately one-half mile intervals. The current schedule assumes that the I-80 ICM construction will be completed by June of 2014.

2.3.4 I-880 HOV APPROACH PHASE 1 PROJECT LIMITS

The I-880 HOV approach is approximately 1.8 miles when measured from its entrance near 14th Street to the metering lights. The approach provides a connection for HOVs traveling northbound on I-880 to access the left-side HOV lane at the toll plaza (Lane 1). Part of the approach consists of a grade-separated connector ramp that carries all I-880NB traffic destined for the Bay Bridge. The leftmost lane of this connector carries HOV vehicles into Lane 1 at the toll plaza.

During off-peak periods, the HOV approach is open to all vehicles and Lane 1 at the toll plaza serves as a cash/FasTrak® lane.

2.3.5 I-580 HOV APPROACH PHASE 1 PROJECT LIMITS

The I-580 HOV approach begins downstream of the direct connector ramp carrying westbound traffic on I-580 to the Bay Bridge. The approach is approximately 1.2 miles when measured from its start to the metering lights. Vehicles traveling westbound on I-580 are able to access the HOV lane, which immediately starts on the left hand side as vehicles come off of the connector ramp. Access to the lane is unrestricted for its entire length, although it is separated from the adjacent lane with a single solid white stripe. The I-880 approach meets the I-580 approach about ¼ mile before the toll plaza and the two lanes travel side by side and feed into Lanes 1 (I-880) and 2 (I-580) at the toll plaza. Approximately 450 feet upstream of the toll plaza, access to Lanes 1 and 2 are restricted by flexible pylons to prevent last minute weaving into and out of the faster moving HOV lanes.

2.3.6 WEST GRAND AVENUE HOV APPROACH PHASE 1 PROJECT LIMITS

The West Grand Avenue on-ramp connects with the I-880 ramp carrying vehicles traveling northbound on I-880 destined for the Bay Bridge. Vehicles entering at West Grand Avenue are placed into the rightmost lane of the ramp that provides access to Lane 19 at the toll plaza. This lane operates as a bus-only lane during off-peak periods.

2.3.7 TRAFFIC CHARACTERISTICS

Traffic volumes at the Bay Bridge Toll Plaza are typically highest during the morning weekday peak periods, although Friday afternoon peak periods and mid-day periods on weekends also regularly

experience high traffic volumes. Average weekday traffic volumes for HOV lanes at the Bay Bridge Toll Plaza reported for the month of March 2012 are shown below in Figure 2-19.

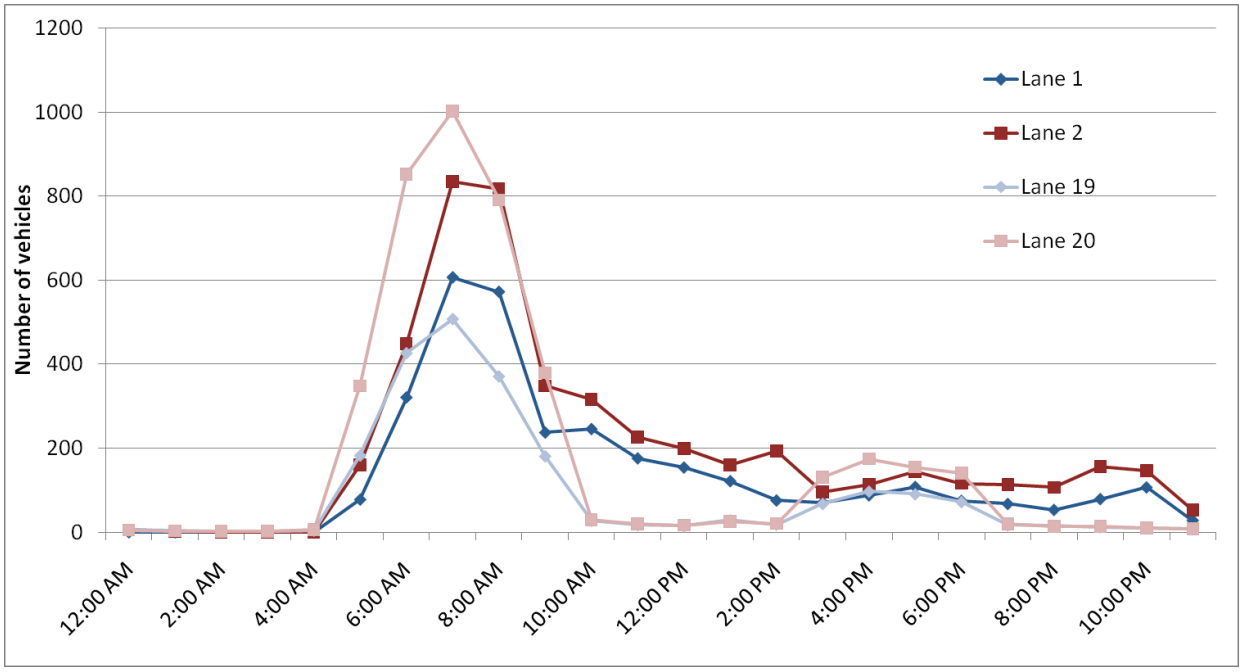


FIGURE 2-19: AVERAGE WEEKDAY (MON-THUR) TRAFFIC VOLUMES AT BAY BRIDGE TOLL PLAZA HOV LANES (AVERAGED FOR MARCH 2012)[1]

2.3.8 TRANSIT

Transbay transit routes utilizing the Bay Bridge are summarized below in Table 2-9. AC Transit currently operates 27 routes over the Bay Bridge that provide connections between downtown San Francisco and various locations in the East Bay. In addition, the Western Contra Costa Transit Authority (WestCAT) provides express transbay service between Hercules and San Francisco via its Lynx service. Amtrak also provides bus service between San Francisco and its Emeryville train station.

[1] Data provided by Bay Area Toll Authority. March 2012.

TABLE 2-9: TRANSBAY TRANSIT ROUTES OVER THE BAY BRIDGE

Transit Operator	Route: Origin	HOV Approach Used
AC-Transit	B: Oakland	I-580
	C: Piedmont	I-580
	CB: Oakland	I-580
	E: Oakland	I-580
	F: Berkeley	I-80
	FS: Berkeley	I-80
	G: El Cerrito	I-80
	H: Richmond	I-80
	J: Berkeley	I-80
	L: San Pablo	I-80
	LA: Richmond	I-80
	LC: Richmond	I-80
	NL: Oakland	West Grand
	NX: Oakland	I-580
	NX1: Oakland	I-580
	NX2: Oakland	I-580
	NX3: San Leandro	I-580
	NX4: Castro Valley	I-580
	O: Oakland	I-880
	OX: Alameda	I-880
	P: Piedmont	I-580
	S: Hayward	I-880
	SB: Newark	I-880
	V: Oakland	I-580
	W: Alameda	I-880
	Z: Albany	I-80
	800: Richmond	I-80
WestCAT	Lynx: Hercules	I-80
Amtrak	Thruway: Emeryville	I-80

2.3.9 PARK AND RIDE

There are no park and ride lots along the Bay Bridge approaches within the project limits. However, park and ride lots along the I-880, I-80, I-580 and Route 24 corridor serve travelers crossing the Bay Bridge.

2.4 SR-84 DUMBARTON BRIDGE APPROACH

2.4.1 GENERAL CHARACTERISTICS

The segment of westbound SR-84 from I-880 to the Dumbarton Bridge Toll Plaza consists of two general purpose lanes and one HOV lane. The HOV lane begins on the I-880 southbound off-ramp and extends approximately 2.8 miles to the toll plaza (see Figure 2-20 below). Vehicles exiting from southbound I-880 are directed into the HOV lane as they approach the intersection with SR-84.

The lane is separated by a solid white line for most of its length to indicate that it feeds into a designated HOV/FasTrak® lane at the toll plaza.

FIGURE 2-20: SR-84 DUMBARTON BRIDGE APPROACH

2.4.2 CURRENT HOV OPERATING POLICY

The Dumbarton Bridge HOV lane approach operates during weekday peak periods, defined as 5 a.m. to 10 a.m. and 3 p.m. to 7 p.m. The lane is open to FasTrak® only during all other times. Overhead changeable message signs indicate when the lane is open for HOV versus FasTrak® vehicles. The operating hours for the HOV lane on SR-84 differ from the operating hours on I-880 HOV lanes, which operate from 5 a.m. to 9 a.m. and 3 p.m. to 7 p.m.

HOV lane eligibility requirements on SR-84 require two or more passengers in a vehicle during peak periods. Other eligible vehicles include buses, motorcycles and SOVs that meet specified emissions standards with DMV issued decals. When in operation, the approach feeds into a designated HOV lane at the bridge toll plaza that charges vehicles a reduced bridge toll ($2.50 for eligible vehicles).

2.4.3 TRAFFIC CHARACTERISTICS

Westbound traffic volumes are heaviest on SR-84 approaching the Dumbarton Bridge during the AM peak period. Average annual daily traffic (AADT) volumes on both directions of SR-84 are shown below in Figure 2-21.

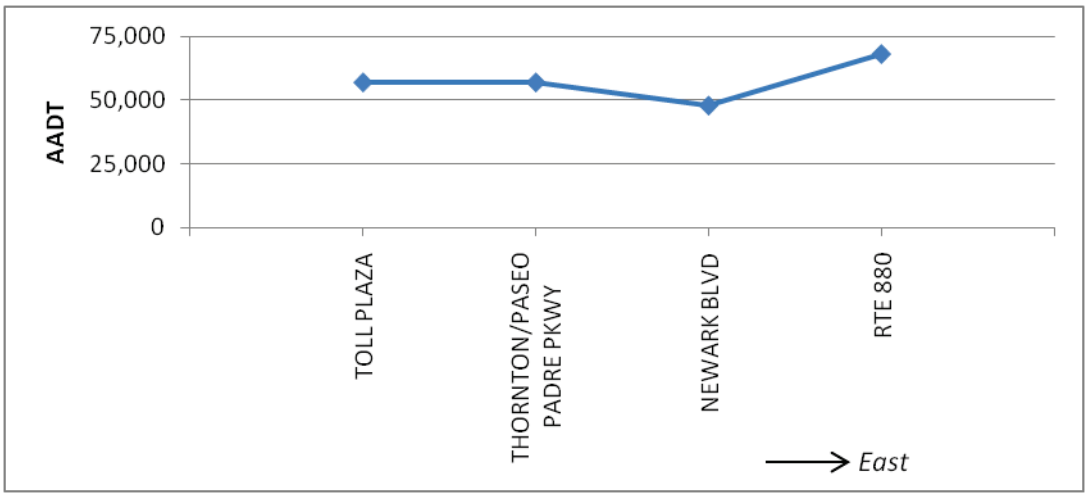


FIGURE 2-21: AADT ON SR-84[1]

Average peak hour HOV lane traffic volumes on westbound SR-84 from the Caltrans District 4 2010 Bay Area HOV Lanes report are reported as 944 vehicles in the AM peak period and 290 vehicles in PM peak period[2].

2.4.4 TRANSIT

The Dumbarton Express bus service is administered by AC Transit and offers transbay service via the Dumbarton Bridge serving the cities of Menlo Park, Newark, Palo Alto and Union City. Dumbarton Express operates two bus lines between the Union City BART station and the Palo Alto Caltrain Station. In addition to the Dumbarton Express, AC Transit operates two routes between the East Bay and San Mateo/Santa Clara Counties via the Dumbarton Bridge. All transbay bus routes across the Dumbarton Bridge are listed below in Table 2-10.

TABLE 2-10: TRANSBAY TRANSIT ROUTES OVER THE DUMBARTON BRIDGE

Transit Operator	Route
Dumbarton Express	DB: Union City BART to Palo Alto
	DB1: Union City BART to Palo Alto
AC Transit	DA: Newark to Redwood City
	U: Fremont BART to Stanford University

[1] Traffic and Vehicle Data Systems Unit, 2011 Traffic Volumes on California State Highway System. California Department of Transportation, Traffic Operations Division. http://www.dot.ca.gov/hq/traffops/saferesr/trafdata/2011all/index.html

[2] 2010 Bay Area HOV Lanes: Volumes, Occupancies and Violation Rates for Freeway High Occupancy Vehicle Lanes in the San Francisco Bay Area. California Department of Transportation, District 4, Office of Highway Operations.

2.4.5 PARK AND RIDE

There is one park and ride lot located along the SR-84 Dumbarton Bridge Approach, listed in Table 2-11. Park and ride lots in the I-880 corridor also serve travelers crossing the Dumbarton Bridge.

TABLE 2-11: SR-84 DUMBARTON BRIDGE APPROACH PARK AND RIDE LOT

Address	City
Ardenwood Boulevard & SR-84	Fremont

2.5 SR-92 SAN MATEO-HAYWARD BRIDGE APPROACH

2.5.1 GENERAL CHARACTERISTICS

The segment of westbound SR-92 from Hesperian Boulevard to the San Mateo-Hayward Bridge Toll Plaza consists of three general purpose lanes and one HOV lane. The HOV lane begins just downstream of the Hesperian Boulevard interchange and extends approximately 3.2 miles to the toll plaza (see Figure 2-22 below). The HOV lane on SR-92 is unrestricted along its entire length to allow vehicles entering SR-92 downstream of the Hesperian Boulevard interchange to access the lane.

FIGURE 2-22: SR-92 SAN MATEO-HAYWARD BRIDGE APPROACH

2.5.2 CURRENT HOV OPERATING POLICY

The San Mateo-Hayward Bridge HOV lane approach operates during weekday peak periods, defined as 5 a.m. - 10 a.m. and 3 p.m. – 7 p.m. The lane is open to all vehicles during all other times. Like the SR-84 HOV lane, the operating hours for the SR-92 HOV lane differ from the operating hours on I-880 HOV lanes, which operate from 5 a.m. - 9 a.m. and 3 p.m. - 7p.m.

HOV lane eligibility requirements on SR-92 require two or more passengers in a vehicle during peak periods. Other eligible vehicles include buses, motorcycles and SOVs that meet specified emissions standards with DMV issued decals. When in operation, the approach feeds into a designated HOV lane at the bridge toll plaza that charges vehicles a reduced bridge toll ($2.50 for eligible vehicles and $5.00 for other autos).

2.5.3 TRAFFIC CHARACTERISTICS

Like the approach to the Dumbarton Bridge, westbound traffic volumes are heaviest on SR-92 during the AM peak period. AADT volumes on both directions of SR-92 are shown below in Figure 2-23.

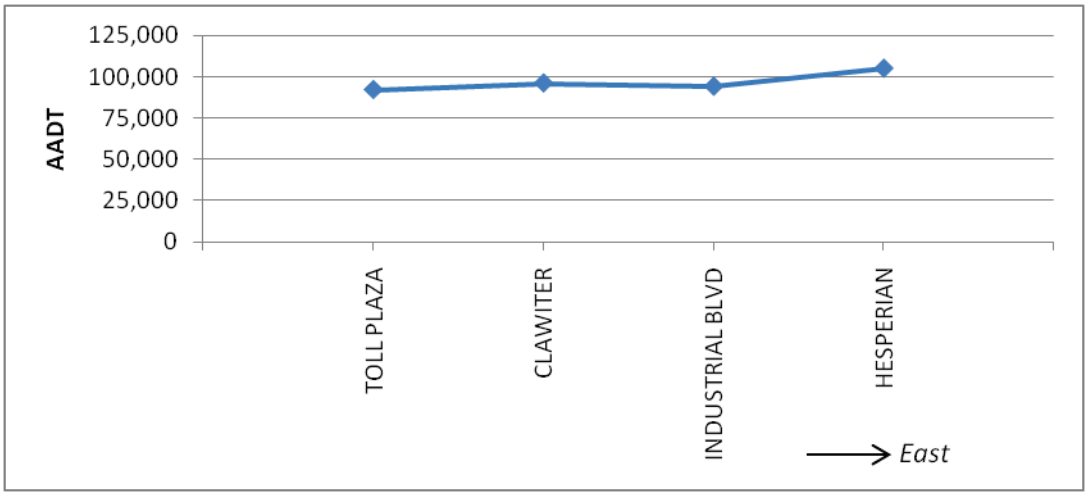


FIGURE 2-23: AADT ON SR-92[1]

Average peak hour HOV lane traffic volumes on westbound SR-92 from the 2010 Caltrans HOV Lane Report are reported as 1056 vehicles in the AM peak period and 422 vehicles in PM peak period[2].

[1] Traffic and Vehicle Data Systems Unit, 2011 Traffic Volumes on California State Highway System. California Department of Transportation, Traffic Operations Division. http://www.dot.ca.gov/hq/traffops/saferesr/trafdata/2011all/index.html

[2] 2010 Bay Area HOV Lanes: Volumes, Occupancies and Violation Rates for Freeway High Occupancy Vehicle Lanes in the San Francisco Bay Area. California Department of Transportation, District 4, Office of Highway Operations.

2.5.4 TRANSIT

AC Transit's Route M provides express transbay service from the Hayward BART station to the Hillsdale Shopping Center in the city of San Mateo via the San Mateo-Hayward Bridge.

2.5.5 PARK AND RIDE

There are no park and ride lots along the SR-92 San Mateo-Hayward Bridge approach. However, park and ride lots along the I-880 corridor serve travelers crossing the San Mateo-Hayward Bridge.

2.6 I-80

2.6.1 GENERAL CHARACTERISTICS

The I-80 corridor connects the Bay Area to the Central Valley, linking San Francisco and Sacramento and serving many suburban communities in-between. The corridor is heavily traveled by commuters on weekdays and on weekends serves as a recreational gateway to destinations outside of the Bay Area, including Lake Tahoe and Reno, Nevada.

2.6.2 PROJECT LIMITS FOR STA ENVIRONMENTAL STUDIES

Concurrently and in coordination with efforts on the MTC Phase 1 Project, the Solano Transportation Authority (STA) is undertaking environmental studies for an express lane on a portion of the I-80 corridor between Red Top Road in Fairfield and I-505 in Vacaville. This project, which is part of the MTC Program, is broken into two segments as described below:

- **Red Top Road to Airbase Parkway** – This segment is approximately eight miles long and serves a total of ten interchanges, making for an average interchange spacing of less than one mile. Within this segment, the I-80 typical cross-section consists of four general purpose lanes plus one HOV lane in each direction, with the exception of the portion between I-680 and SR-12 East which has five general purpose lanes and one HOV lane in each direction.
- **Airbase Parkway to I-505** – This segment is approximately ten miles long and serves a total of nine interchanges. The typical cross section within this segment consists of four general purpose lanes in each direction.

2.6.3 CURRENT HOV OPERATING POLICY

HOV lanes on the segment of I-80 between Red Top Road and Airbase parkway were opened to traffic in 2009. Operating hours for the HOV lanes are 5 a.m. to 10 a.m. and 3 p.m. to 7 p.m. During all other times, the lanes serve as general purpose lanes.

HOV lane eligibility requirements on I-80 require two or more passengers in a vehicle during peak periods. Other eligible vehicles include buses, motorcycles and SOVs that meet specified emissions standards.

2.6.4 TRAFFIC CHARACTERISTICS

The I-80 corridor through Vacaville and Fairfield is heavily traveled by commuters and freight traffic during weekdays. On weekends, the corridor serves as a gateway for recreational traffic traveling to the Sierra Nevada Mountains and other destinations outside of the Bay Area.

Traffic volume data collected for the Solano County I-80 Express Lane Project are shown in Figure 2-24 and Figure 2-25. Weekday traffic volumes are heaviest during the p.m. peak period in the eastbound direction and during the a.m. period in the westbound direction, reflecting the typical commute pattern representative of vehicles heading towards San Francisco in the morning and returning home in the afternoon. These figures also show that weekend traffic volumes are significant. In the westbound direction, Sunday peak period volumes are nearly as high as weekday peak volumes.

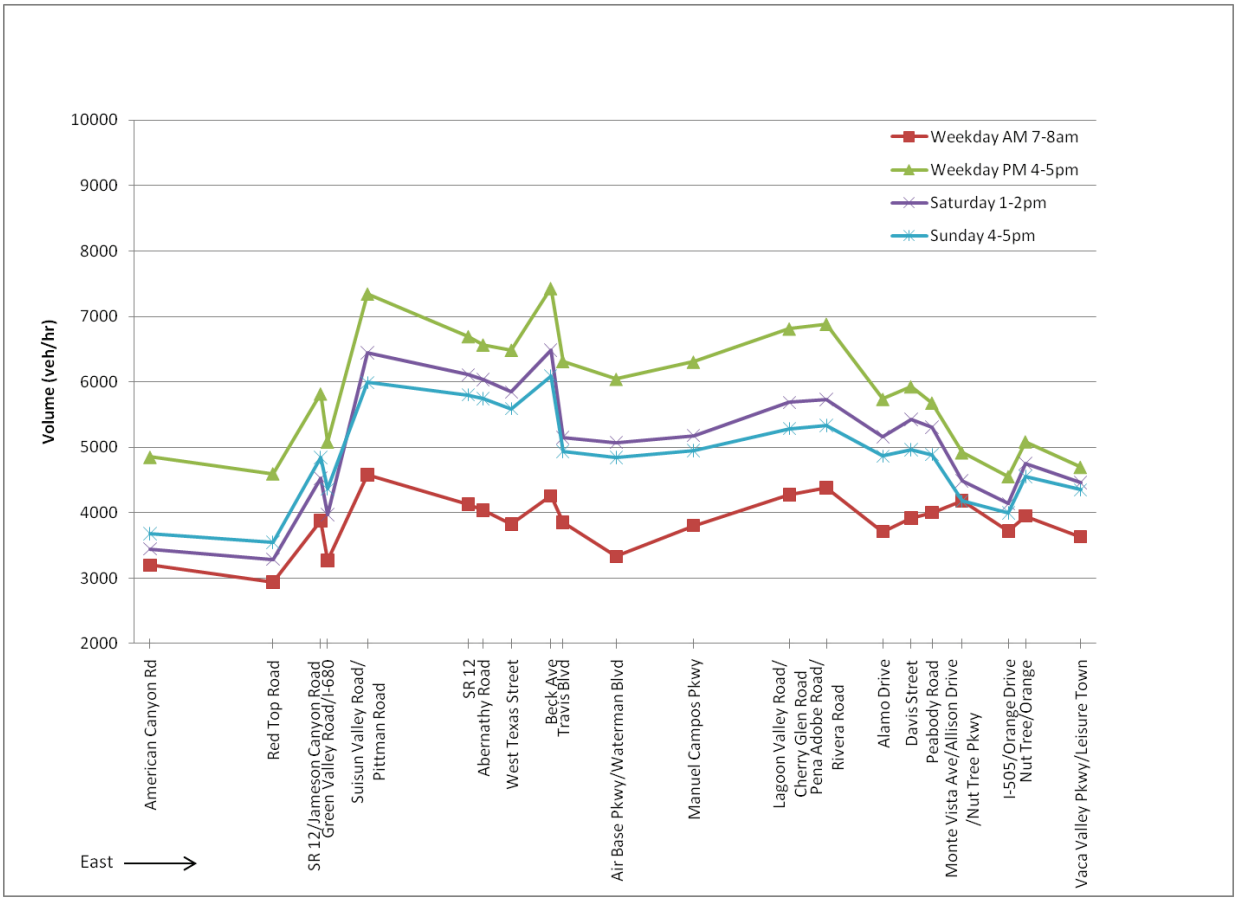


FIGURE 2-24: EASTBOUND I-80 WEEKDAY AND WEEKEND PEAK TRAFFIC VOLUMES[1]

[1] I-80 Express Lanes Project Existing Conditions Report. Solano Transportation Authority. September 28, 2012.

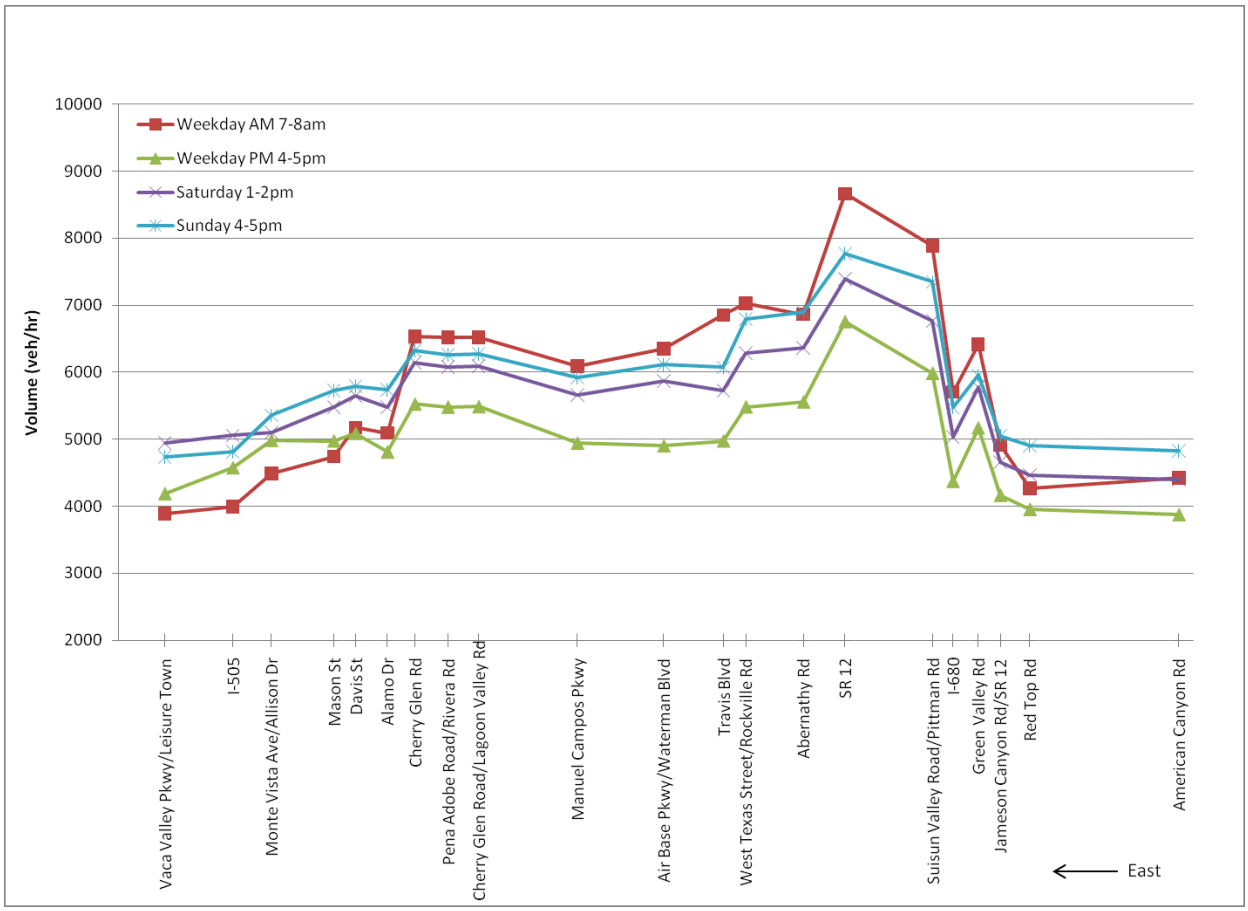


FIGURE 2-25: WESTBOUND I-80 WEEKDAY AND WEEKEND PEAK TRAFFIC VOLUMES[1]

Peak hour HOV volumes from the Caltrans District 4 2010 Bay Area HOV Lanes report indicate that substantial unutilized capacity exists in the HOV lanes, as shown in Table 2-12[2].

TABLE 2-12: PEAK HOUR HOV VOLUMES ON I-80 IN SOLANO COUNTY (2010)2

Direction	Segment	Average HOV Volumes (vph)	
		AM Peak	PM Peak
Westbound	Airbase Parkway to Red Top Road	347	235
Eastbound	Red Top Road to Airbase Parkway	191	495

Note: HOV Volumes include all vehicles in the HOV lane, including motorcycles, hybrids and violators.

2.6.5 TRANSIT

There are three transit operators providing intercity bus service on the I-80 corridor between Fairfield and Vacaville, as shown in Table 2-13. These include Fairfield/Suisun Transit (FAST), Yolobus and Soltrans.

[1] I-80 Express Lanes Project Existing Conditions Report. Solano Transportation Authority. September 28, 2012.

[2] 2010 Bay Area HOV Lanes: Volumes, Occupancies and Violation Rates for Freeway High Occupancy Vehicle Lanes in the San Francisco Bay Area. California Department of Transportation, District 4, Office of Highway Operations.

TABLE 2-13: TRANSIT SERVICE ON I-80 CORRIDOR BETWEEN VACAVILLE AND FAIRFIELD

Transit Operator	Route
FAST	20: Vacaville to Fairfield
	30: Fairfield to Sacramento
	40: Vacaville to Walnut Creek BART
	90: Fairfield to El Cerrito del Norte BART
YoloBus	220: UC Davis to Vacaville
Soltrans	85: Vallejo to Fairfield

2.6.6 PARK AND RIDE

There are seven park and ride lots located along the I-80 project limits, shown in Table 2-14.

TABLE 2-14: I-80 PARK AND RIDE LOTS

Address	City
Red Top Road & I-80	Fairfield
Green Valley Road & I-80	Fairfield
Fairfield Transportation Center Near West Texas & I-80	Fairfield
Cliffside Drive & I-80	Vacaville
Davis Street (north) & Hickory Ln	Vacaville
Davis Street (south) & I-80	Vacaville
Allison Drive & Ulatis	Vacaville

CHAPTER 3 FACILITY DESIGN

This chapter highlights preliminary geometric and signing standards that will be applied to the design of MTC express lanes. The concepts provided in this chapter do not represent final design decisions. Instead, they are intended to promote clarity and consistency for both users and operators throughout the MTC Program. As preliminary engineering for the MTC Phase 1 Project advances, there may be refinements or changes to the design.

3.1 CURRENT INVENTORY

The express lane corridors and bridge approaches included in this concept of operations are conversions of existing HOV lanes. These HOV lanes operate as concurrent flow lanes which are located on the inside freeway lane in the same direction of travel and not physically separated from the adjacent general purpose lanes. Overhead and median barrier-mounted signs and the diamond symbol pavement marking are used to designate the HOV lanes from the general purpose lanes. In addition, the corridors and bridge approaches have all the components of a freeway system, including existing signs and sign gantries and striping that will need to be evaluated during design of the express lanes.

3.2 EXPRESS LANE CORRIDORS

The following sections describe the preliminary design approach being applied to MTC express lane corridors including I-680 and I-880. The design approach for the bridge approaches is discussed separately in Section 3.3.

3.2.1 DESIGN STANDARDS

The express lanes will be implemented on Caltrans facilities and therefore will need to be designed in accordance with all applicable Caltrans standards. The final highway design will be approved by Caltrans and may also require FHWA approval. The following design standards and guidance documents will be referenced during the design process:

- Caltrans Highway Design Manual (HDM)
- Caltrans Standard Plans and Standard Specifications
- Caltrans High-Occupancy Vehicle Guidelines
- California Manual on Uniform Traffic Control Devices (MUTCD)
- Caltrans Traffic Operations Policy Directive (TOPD) 11-02
- Caltrans Headquarters is currently updating the state's existing HOV Guidelines and other general policies to include in the new HOV/Express Lane Policy Guidance. At the time this document was drafted, these guidelines were not yet published. However, efforts are ongoing to coordinate with headquarters staff to ensure this project is consistent with the proposed guidelines.
- Caltrans encroachment policies and guidance.
- All other current Caltrans standards, policies and procedures applicable to the project.

3.2.2 TYPICAL SECTION

The entire MTC Program consists of concurrent flow, single-lane express lanes. The existing condition provides limited ability to expand the freeway cross-section, and the ultimate design will be influenced by this limitation. Where reductions in the standards for cross-sectional elements are determined necessary and justified and approved by Caltrans, the HOV Guidelines provide a priority listing of where the reductions should be made. The ranges of widths for various elements of the freeway cross-section from the Caltrans Highway Design Manual and the HOV Guidelines are listed below in Table 3-1.

TABLE 3-1: FREEWAY CROSS-SECTION ELEMENTS

	Unrestricted Access	**Restricted Zone**
Left Side Offset	10 feet (standard) 2 feet *	10 feet (standard) 2 feet *
Lane Widths	14 feet (desirable) 12 feet (standard) 11 feet *	14 feet (desirable) 12 feet (standard) 11 feet *
Express Lane Buffer Width	0 feet	4 feet (desirable) 2 feet *
Right Side Shoulders	10 feet	10 feet

*Subject to Caltrans approval

3.2.3 ACCESS AND STRIPING

Current guidance specified in Caltrans' Traffic Operations Policy Directive (TOPD) 11-02 issued in April of 2011 suggests consideration of two types of access treatments for managed lanes as described below:

1. Limited access design – Access to/from the express lane is provided at designated locations, typically through at-grade access openings that can serve ingress, egress, or combined ingress and egress. Physical barriers or striping separates the express lane from the adjacent general purpose lanes between access locations.
2. Continuous access design – Access to/from the express lane is not restricted to designated locations. Instead, vehicles are able to enter and exit the express lane at any point.

The access configuration for MTC express lanes will most likely be a combination of the two access treatments specified above. The goal of the MTC express lane access configuration will be to preserve the flexibility inherent in the design of the existing continuous access HOV system to the extent possible, while at the same time ensuring that safety and operational considerations are addressed. The requirements related to weaving distance and minimum access openings specified in the TOPD for limited access design pose a challenge for implementation in settings with closely spaced interchanges, such as the I-880 corridor. Therefore, it is expected that MTC express lanes may have long stretches of unrestricted access where traffic and safety analyses do not reveal adverse impacts to operations or safety. In this document, the term "more open access" is used to recognize that the express lanes will likely allow ingress and egress at most locations but there will be some areas of restricted access.

The stretches of unrestricted access will be designated using a broken single white lane line in accordance with the MUTCD. The California MUTCD 2012 Edition includes a wider 8-inch lane line and a pavement marking consisting of the words "EXPRS LANE" to designate an express lane. Areas of restricted access will be designated using a solid double stripe pavement marking. The use of a diamond marking, as seen in HOV lanes, will not be used to designate express lanes.

In addition to operational and safety considerations, the placement of access restrictions must also consider transit routes. Buses require longer weaving distances to reach the express lane from a freeway on-ramp and to reach an off-ramp from the express lane. Locations of park and ride lots should also be considered when placing access restrictions.

3.2.4 SIGNING

Detailed signing plans for the express lanes have not yet been developed. The signing considerations discussed in this section are preliminary and subject to change.

The MUTCD provides prescriptive sign and lane marking requirements for limited access express lanes, including requirements for signing at the beginning and end of an express lane facility and for intermediate access locations. However, the MUTCD does not provide guidance with respect to the type and frequency of signs to employ for continuous access express lanes, although it does include signing practices for continuous access HOV lanes that are applicable to express lanes.

In order to develop a preliminary signing concept for a more open access design, a series of workshops was held with MTC, Caltrans (District 4 and Headquarters), the CMAs, CHP and FHWA. These workshops provided a forum to discuss assumptions related to the types and frequency of signs that may be necessary. Imposing an access restriction after a long stretch of unrestricted access was a main topic of discussion, since this transition to restricted access requires unique signing to ensure that users are alerted about upcoming access restrictions. These discussions are still ongoing.

The preliminary signing concept for MTC express lanes is discussed in the following sections. The proposed signing treatments are described separately for the start of an express lane, intermediate access (where ingress/egress is allowed between stretches of restricted access), areas of unrestricted access, transition from unrestricted to restricted access and vice versa, terminus of an express lane, and transition from an express lane to a HOV lane. The ultimate signing concept will need to take into account the existing inventory of signs within the express lane limits. Design of the express lane signage will take into account Caltrans sign mounting details and potential impacts to the median barrier.

The signs described in the following sections assume that all vehicles are required to have a registered Electronic Toll Collection (ETC) account. As described in Chapter 4, ETC accounts may include pay-by-plate accounts in addition to toll tag accounts. Eligible toll-free vehicles will be required to carry a switchable toll tag to travel in the express lanes toll-free. MTC may choose to brand the switchable toll tag with a modified name and market it separately from the legacy FasTrak® toll tags. The incorporation of pay-by-plate accounts and/or a separately branded switchable toll tag will have impacts to the signing concept described in the following sections.

3.2.4.1 SIGNS DESIGNATING THE BEGINNING OF AN EXPRESS LANE

Signing for the start of an express lane will include advance overhead signs to let drivers know that they are approaching an express lane, the price to travel in the express lane, the ETC account requirement and the hours of operation. The specific design of the signs in advance of the start of an express lane has not been finalized.

Overhead-mounted express lane advance signs will be used to inform drivers that they are approaching the start of an express lane (see Figure 3-1). These signs will also indicate that an ETC account is required for vehicles to use the lane.

FIGURE 3-1: EXAMPLE EXPRESS LANE ENTRANCE GUIDE SIGNS

Pricing signs will be overhead-mounted and display the toll to travel to downstream locations (see Figure 3-2). In accordance with the guidance provided in the MUTCD, pricing signs will display no more than two downstream locations. Changeable message elements will be used to display the toll amount in effect at any given time. As discussed in Chapter 4, the destinations shown on pricing signs will correspond to the termini of pricing zones. Pricing signs will include a third dynamic message display element below the destinations for the purpose of displaying express lane messages as appropriate. These signs will also indicate that an ETC account is required for vehicles to use the lane.

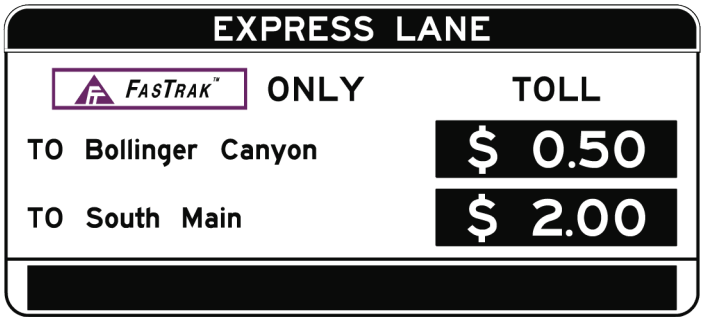


FIGURE 3-2: EXAMPLE EXPRESS LANE PRICING SIGN

3.2.4.2 SIGNS TO BE PLACED AT REGULAR INTERVALS WITHIN UNRESTRICTED ACCESS SEGMENTS

Along segments where there are few or no access restrictions, overhead regulatory signs will be located at regular intervals to clearly designate the express lane and display the HOV eligibility requirement, hours of operation and the ETC account requirement for all vehicles in the lane (see

Figure 3-3). These signs may need to allow for easy edits in the event that the HOV eligibility requirement or the hours of operation change in the future.

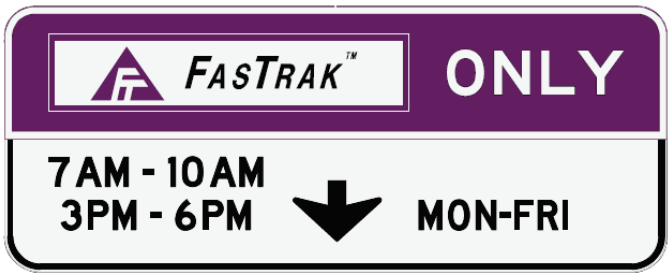


FIGURE 3-3: EXAMPLE OVERHEAD REGULATORY EXPRESS LANE SIGN

In addition to the overhead regulatory signs, pricing signs will be placed at an average spacing of 2 miles and will be strategically placed downstream of major interchanges and at locations with recurring congestion where drivers are likely to make a decision to enter the express lane.

3.2.4.3 SIGNS FOR INTERMEDIATE ACCESS WITHIN RESTRICTED SEGMENT

In locations where access to/from the express lane is provided following a long segment of restricted access, the same types of signs as those used to indicate the start of an express lane will be used to inform drivers in the general purpose lanes of the upcoming opportunity to enter the express lane.

If the break in the express lane access restriction is short (i.e., the express lane access restriction will begin again after satisfying the minimum requirements in the TOPD), then signs will be needed to inform drivers in the express lane of the local exits that are served by the express lane intermediate access. These local exit signs (see Figure 3-4) should list all downstream exits that are not directly accessible from the express lane due to access restrictions, thereby informing drivers wishing to access one of the locations shown that they need to exit the express lane.

FIGURE 3-4: EXAMPLE EXPRESS LANE LOCAL EXIT SIGNS FOR INTERMEDIATE ACCESS

3.2.4.4 SIGNS DESIGNATING BEGINNING OF A RESTRICTED SEGMENT

In locations where express lanes transition from long stretches of unrestricted access to a long stretch of restricted access, it will be necessary to inform drivers of the impending change in access type. In addition to the local exit signs shown in Figure 3-4, additional signs shown in Figure 3-5 will inform drivers that they will no longer be able to freely exit the express lane ahead. These signs will be installed at regular intervals within a restricted segment to reinforce the access restriction.

FIGURE 3-5: EXAMPLE SIGNS INDICATING UPCOMING EXPRESS LANE ACCESS RESTRICTION

There may be instances when drivers entering the freeway are able to access the express lane before a restricted access segment begins, but aren't able to see the sequence of signs advising of the upcoming restrictions and the interchanges they cannot access. In this instance, it may be necessary to locate signs along the freeway on-ramp to alert motorists of the restricted access. There may also be a need to install signs at freeway on-ramps and upstream connecting freeways.

3.2.4.5 SIGNS DESIGNATING THE END OF AN EXPRESS LANE

A sequence of signs beginning one-half mile upstream of the terminus of an express lane will be used in accordance with the MUTCD to indicate that the express lane is ending. For an express lane that transitions to an HOV lane, a sequence of post-mounted signs instructing all non-HOV vehicles to exit will be installed (see Figure 3-6). These signs will also indicate the HOV eligibility requirement and the hours of operation for the HOV lane.

FIGURE 3-6: EXAMPLE SIGNS INDICATING END OF EXPRESS LANE

3.2.5 TOLL ZONES

The location of the toll zones, including toll readers and LPR cameras, is important for operations as well as enforcement. There is a concern that toll evaders may try to weave in and out of the lane to avoid the readers in areas where access is not restricted. This concern can be minimized with careful consideration of both the frequency and placement of toll readers. Initial toll sites will be identified based on operational needs and areas of restriction. The assumption is that toll zones will be more frequent in areas of open access and less frequent in areas of restricted access. They will be strategically placed downstream of major interchanges and at locations where bottlenecks are known to occur regularly. The exact spacing of the readers will be determined in design, but it is assumed that the spacing will vary between one-half mile and two miles, with an average spacing of approximately one mile. This average spacing provides redundancy if a toll reader malfunctions and allows the toll system to function without all toll readers operational at all times.

3.2.6 OBSERVATION AREAS

Observation areas are wider median areas where CHP can observe express lane patrons to ensure compliance with express lane eligibility requirements. Observation areas differ from enforcement areas in that a vehicle cannot be pulled over into an observation area. Observation areas will be strategically located to allow CHP to easily view enforcement beacons, as described in Chapter 7.

In lessons learned from existing projects, CHP has noted that observation areas have been “fit in” to the express lane and are unusable by CHP. Observation areas should only be included in the layout if they meet the considerations specified in the Caltrans HOV Guidelines. These Guidelines are intended to maintain a perception of safe conditions to avoid non-use by CHP and include typical configurations for observation areas. In addition, CHP has expressed a preference for observation areas to be elevated because of the better viewing angle into the vehicle, and to have long, gradual run-offs to allow their cruisers to easily accelerate to full speed. Elevation of CHP observation areas is not in current Caltrans guidance. If observation areas are to be elevated, the run-off of the elevated area should not occur within the shoulder.

Discussions with CHP will continue to inform decisions related to the design of enforcement provisions for express lanes.

3.3 BRIDGE APPROACHES

The bridge approaches are configured differently than the express lane corridors. They are shorter in length and act more like "chutes" than corridors. Although the same design standards will be applied, it is anticipated that each bridge approach may have only one toll zone (or two maximum) and will be more restricted in terms of access. The bridge approaches will also have more existing signage that must be taken into account. As described in Chapter 4, signs at the bridge approaches will have to clearly distinguish the express lane toll from the bridge toll, or show a combined toll[1]. With the exception of the I-80 approach to the Bay Bridge discussed below, the other bridge approaches do not have unique design issues.

At the Bay Bridge, there is a weave zone where the I-80 general purpose lanes meet the HOV flyover ramp. This weave zone, shown in Figure 3-7, is currently needed to allow buses that are not able to access the HOV flyover ramp to access the right-side HOV approach lanes at the toll plaza, which allow commute buses and registered vanpools to travel toll-free over the bridge at all times. Buses that are not able to access the HOV flyover currently include AC Transit and Amtrak buses that enter the freeway at Powell Street. This access will need to be preserved for transit upon conversion to express lanes.

Lanes 19 and 20 historically did not have tolling equipment, requiring the lanes to revert to bus only operations during non HOV hours since there was no ability to collect a toll. Recently, tolling equipment was installed to collect tolls from HOVs.

[1] Currently, the CMSs on the Bay Bridge approaches do not show the toll rates. They only indicate what lane type it is (e.g., Carpool, FasTrak® Only, or Cash/FasTrak®).

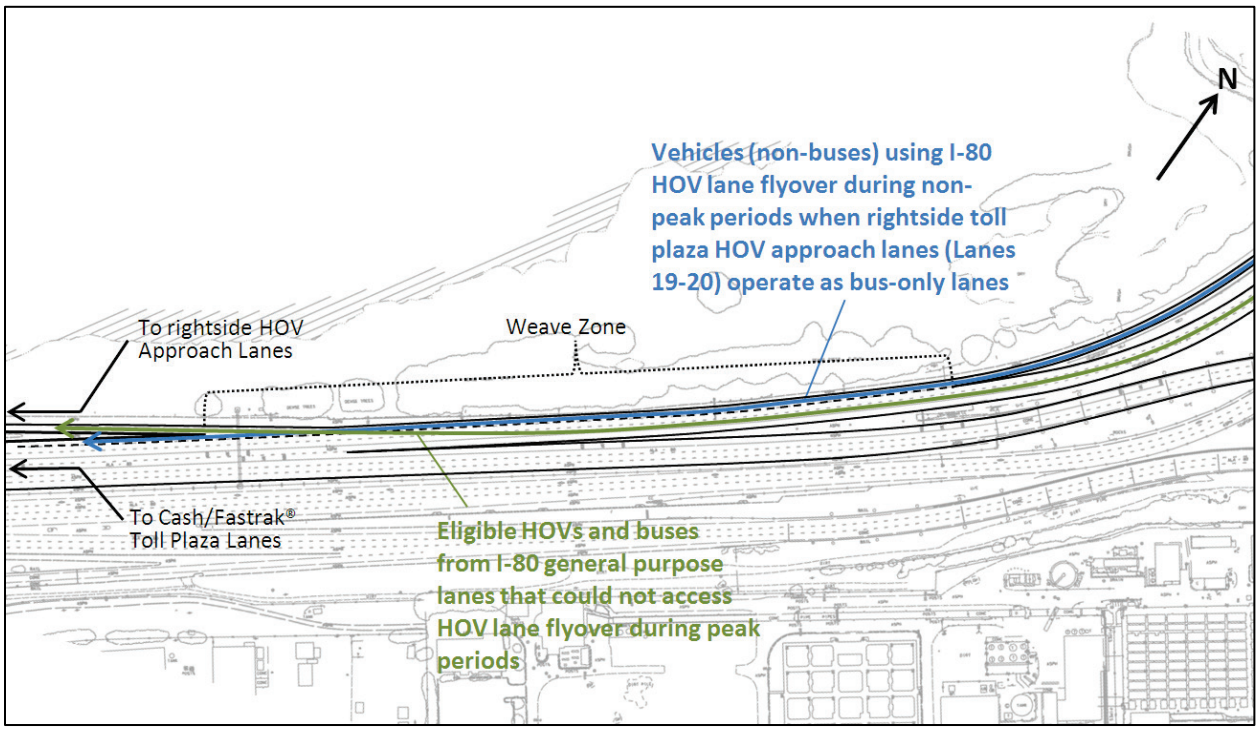


FIGURE 3-7: BAY BRIDGE APPROACH WEAVE ZONE WHERE I-80 HOV FLYOVER MEETS I-80 GENERAL PURPOSE LANES

CHAPTER 4 OPERATING CONCEPT

This chapter describes how MTC express lanes will operate. As defined in Chapter 1, express lanes allow vehicles that do not meet HOV lane eligibility requirements to use the lane when paying a variably priced toll. The following sections describe how HOVs and toll-paying vehicles will use the MTC express lanes and how the express lanes will be priced to ensure that traffic in the lanes is maintained at free-flowing conditions, in accordance with State and Federal law. This chapter also describes how the MTC express lanes will interface with other California express lane systems and with other operational projects such as ramp metering and ICM. The operational characteristics of the bridge approaches are inherently different than the express lane corridors; therefore, unique aspects of the bridge approaches are described separately within this chapter.

4.1 OPERATING SCENARIOS

There are different ways that express lanes can require toll-paying and toll-free vehicles to use the lanes. The scenarios that were evaluated for MTC express lanes are shown in Table 4-1. Pay-by-plate account scenarios were included in the evaluation due to the Golden Gate Bridge Highway and Transportation District's (GGBHTD) approval of license plate accounts for toll payment. For customer service and consistency reasons, BATA plans to honor GGBHTD pay-by-plate accounts on the state-owned bridges and may eventually offer pay-by-plate as an option for BATA customers. As such, it is important that MTC consider the possibility of pay-by-plate for express lanes.

These scenarios consider different permutations of toll payment options and methods for eligible toll-free vehicles to be recognized by the toll system, which are further described in the sections that follow. The detailed evaluations for each of the seven scenarios are provided in Appendix A, which shows how each scenario was evaluated against a set of criteria including cost, enforcement, policy, reliability, bandwidth requirements and revenue impacts.

TABLE 4-1: OPERATING SCENARIOS EVALUATED FOR MTC EXPRESS LANES

Scenario	Payment options for toll-paying vehicles			Payment options for toll-free vehicles			
	Standard FasTrak® transponder	Switchable FasTrak® transponder	Pay-by-plate account	Standard FasTrak® transponder with carpool registration	Switchable FasTrak® transponder	Pay-by-plate account	No transponder or account requirement
1 (Existing Bay Area Express Lanes)	✓						✓
2	✓			✓			
3	✓	✓			✓		
4	✓		✓	✓			
5	✓	✓	✓		✓		
6	✓		✓	✓		✓	
7	✓	✓	✓		✓	✓	

From a toll operations perspective, the preferred approach is to require all vehicles traveling in the express lanes during operational hours, including toll-free and toll-paying vehicles, to carry a FasTrak® toll tag and for eligible toll-free vehicles to declare their eligibility status using a self-declaration ("switchable") toll tag. This concept allows the toll system to automatically distinguish between toll-paying and toll-free vehicles and for license plate recognition (LPR) cameras to capture license plate images of any vehicle not carrying a toll tag for automatic toll violation processing. Given GGBHTD's approval of license plate accounts for toll payment, it is possible that MTC may allow pay-by-plate on express lanes. Therefore, pay-by-plate options were evaluated in Scenarios 4 through 7. Evaluation of these scenarios revealed a preference for Scenario 5, which requires toll-free eligible vehicles to carry a switchable toll tag and allows toll-paying vehicles to have the option of carrying a toll tag or establishing a pay-by-plate account. As the most preferred scenario that allows the possibility of pay-by-plate, Scenario 5 is assumed for the purposes of this document.

4.2 VEHICLE ELIGIBILITY FOR EXPRESS LANE USE

The MTC express lanes toll system will automatically distinguish between toll-free and toll-paying vehicles. Toll-free vehicles include two-axle vehicles that meet the requisite eligibility requirements or are otherwise allowed to use existing HOV lanes. Toll-paying vehicles include all other two-axle vehicles with a FasTrak® account. The distinction between these two types of vehicles is further described below.

4.2.1 TOLL-FREE VEHICLES

Vehicles eligible for toll-free travel on the express lanes include all vehicles that are currently eligible to travel in existing HOV lanes, including:

- Vehicles with the requisite number of occupants, as determined by Caltrans. For the initial project segments described in this Concept of Operations, current HOV lane occupancy requirements are:
    - I-680 in Contra Costa County: 2 or more occupants (HOV 2+)
    - I-880 in Alameda and Santa Clara counties: HOV 2+
    - I-80/I-580/I-880 westbound approaches to the San Francisco-Oakland Bay Bridge (I-80/I-580/I-880): 3 or more occupants (HOV 3+)
    - SR-84 westbound approach to the Dumbarton Bridge: HOV 2+
    - SR-92 westbound approach to the San Mateo-Hayward Bridge: HOV 2+
    - I-80 in Solano County: HOV 2+

- Other vehicles permitted by statute
    - Motorcycles
    - Vehicles that meet specified emission standards with Department of Motor Vehicles (DMV) issued decals
    - Emergency and other exempted vehicles
    - Two-seat vehicles with two persons on an HOV 3+ facility

4.2.1.1 ELIGIBILITY STATUS DECLARATION

The MTC express lane toll system will be able to recognize vehicles that are eligible for toll-free travel. Enforcement officers will be alerted to the presence of vehicles that self-declare as being eligible for toll-free travel as described in Chapter 7.

The preferred method for eligible toll-free vehicles to declare their toll-free eligibility status is via the use of a switchable toll tag. A feasibility study undertaken by BATA in 2010 found switchable toll tags to be feasible and cost effective. The Los Angeles County Metropolitan Transportation Authority (LA Metro) began distributing switchable toll tags for use on I-10 and I-110 express lanes in November of 2012. The I-495 express lanes outside of Washington DC also use a switchable tag, referred to as E-ZPass® Flex™. A switchable toll tag allows users to self-declare their eligibility status using a switching mechanism located on the face of the toll tag. Indicators and labeling on the switch correspond to the number of vehicle occupants (1, 2, or 3+). The switchable toll tag transmits a unique identification number to the toll reader corresponding to the switch setting, in accordance with procedures as established by the California Toll Operations Committee (CTOC). The toll system is then able to apply the appropriate facility toll (or lack of a toll) according to the declared eligibility status. Motorcycles, eligible low-emission vehicles with DMV-issued decals and two-seat vehicles with two occupants will need to be instructed to set their toll tag in a HOV setting when traveling without the requisite number of vehicle occupants in order to travel toll-free in the express lanes.

Enabling statute for the express lanes in the California Streets and Highways Code states that "unrestricted access to the lanes by high-occupancy vehicles shall be available at all times." MTC is researching whether the use of switchable toll tags is impacted by this language and how to address this issue if necessary.

MTC may choose to brand the switchable toll tag with a modified name and market it separately from the legacy FasTrak® toll tags. This is the approach that was taken for the I-495 express lanes where switchable E-ZPass® toll tags are referred to as E-ZPass® Flex™ and signage clearly indicates that HOVs are able to travel toll-free in the express lane with E-ZPass® Flex™.

The current legacy FasTrak® toll tags in use throughout California, including the external toll tags mounted on license plate frames, will still be able to be used by toll-paying vehicles on MTC express lanes, but these toll tags cannot be used to identify toll-free vehicles. Providing the ability for vehicles with external toll tags to declare as toll-free has yet to be decided. Switchable toll tags in the single occupancy setting will be recognized on all toll facilities in California.

Another method for eligible, toll-free vehicles to be recognized as such by the toll system without use of a switchable toll tag is to require these vehicles to carry a toll tag and to register prior to traveling in the express lanes. Eligible vehicles could be required to register by phone, internet or by using a smartphone application. If MTC decided not to proceed with switchable toll tags, the carpool registration option would need to be further evaluated to determine whether it can be used in conjunction with enforcement beacons as described in Chapter 7, or whether another enforcement strategy may be required.

4.2.2 TOLL-PAYING VEHICLES

Vehicles required to pay a toll on MTC express lanes include all two-axle vehicles that do not meet the requisite occupancy requirement in effect and are not one of the other vehicle types eligible to use HOV lanes without paying a toll. The method by which the toll is calculated and displayed to drivers is described in Section 4.5.

4.2.2.1 TOLL PAYMENT

Tolls on MTC express lanes will be collected electronically according to specifications detailed in California Code of Regulations, Title 21, or any other specification that may be adopted by the time that MTC express lanes are implemented, including a pay-by-plate account option. For vehicles that do not self-declare a toll-free eligibility status, the prevailing toll will automatically be debited from the prepaid account associated with the toll tag or license plate detected by the toll system. A license plate image is captured when no toll tag is detected. If the license plate image is successfully matched to an ETC account, then the toll amount will be applied to the user's account. If there is no account associated with the license plate then the license plate will be matched to the address of the vehicle's registered owner for collecting the toll payment. A toll violation penalty may also be assessed depending upon specific business rules established by MTC.

4.3 OCCUPANCY REQUIREMENT

In the future, as HOV demand increases and as the express lanes begin to connect corridors with different occupancy requirements, there may be a need to change the HOV occupancy requirements on some segments to maintain efficient operations and consistency throughout the network. It is expected that the growth in HOV 2 demand over time on existing Bay Area HOV lanes will cause operating conditions to fall below the minimum average operating speed of 45 mph specified in Section 166 of Title 23 of the United States Code[1]. This minimum average operating speed applies to any HOV facility that allows an exemption for vehicles that do not meet the occupancy requirement, including HOV lanes that allow low emission vehicles and HOT lanes. This standard applies to the Bay Area, since California allows low-emission vehicles in all HOV lanes and there are HOT lanes in the region. The current federal transportation bill, Moving Ahead for Progress in the 21st Century (MAP-21), identifies ways to bring a facility that falls below the minimum operating threshold into compliance, which include increasing the HOV occupancy requirement, varying tolls to reduce demand, discontinuing allowance for non-HOVs (California law that allows low emission vehicles to use the HOV lanes will sunset on January 1, 2015, although legislation to extend this date is under consideration), or increasing capacity by adding additional lanes. Reducing the number of violators using the facility with enhanced enforcement can also improve operating conditions.

The evolution of HOV demand on facilities operating at HOV 2+ is illustrated by the graphic in Figure 4-1. If the sunset date for low emission vehicles is extended and without adding additional capacity or changing state law to disallow low emission and other toll-free eligible vehicles from using the lane, it becomes necessary on some corridors to increase from a HOV 2+ to a HOV 3+ occupancy requirement as HOV demand grows over time to keep traffic volumes below the critical operating threshold. As described in Chapter 2, this critical operating threshold is typically

[1] Title 23 of the United State Code defines a "degraded facility" as one where vehicles fail to "maintain a minimum average operating speed 90 percent of the time over a consecutive 180-day period during morning or evening weekday peak hour periods (or both)."

assumed to be approximately 1650 vehicles per hour, which is considered to be the maximum traffic volume at which reliable free-flow travel can be maintained in the HOV lane. An increase in the HOV occupancy requirement would be warranted to maintain traffic volumes below the critical operating threshold as traffic demand grows in the HOV lane. Because there are typically far fewer vehicles with 3 or more occupants, this could result in significant underutilization. In addition, vehicles that were formerly able to use the lane may now have to travel in the congested general purpose lanes. The conversion of HOV lanes to express lanes allows the unutilized capacity in the HOV lanes to be occupied by toll paying vehicles (including HOV-2), as illustrated in Figure 4-2. As the express lanes continue to be built out and becomes more connected, it may be desirable to have a consistent HOV definition, which might also warrant the changing of HOV occupancy requirements on some segments.

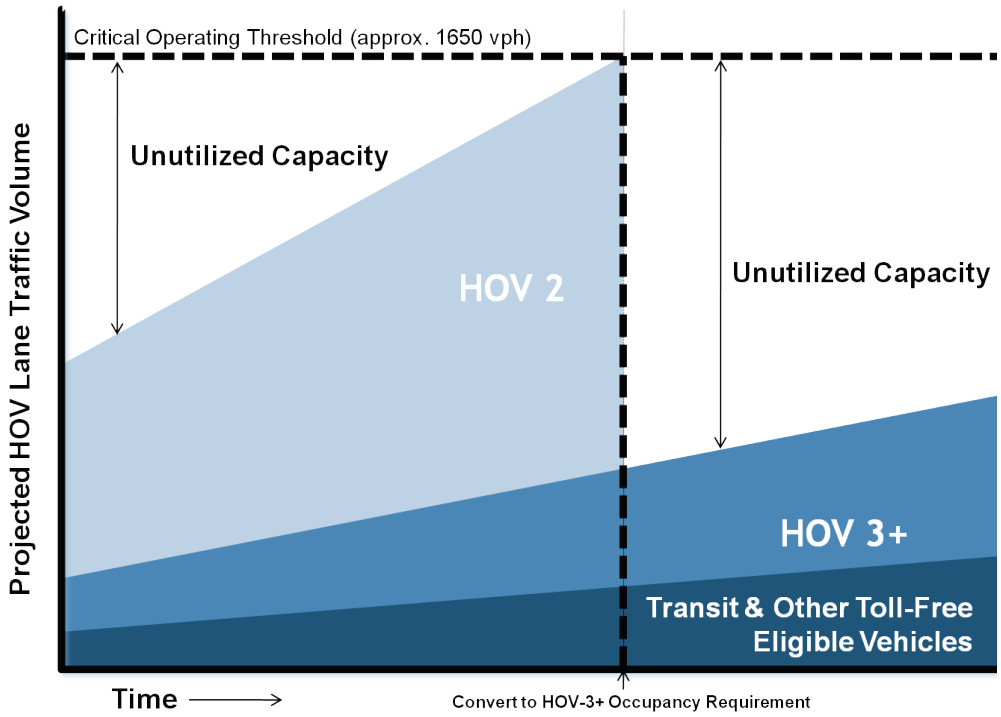
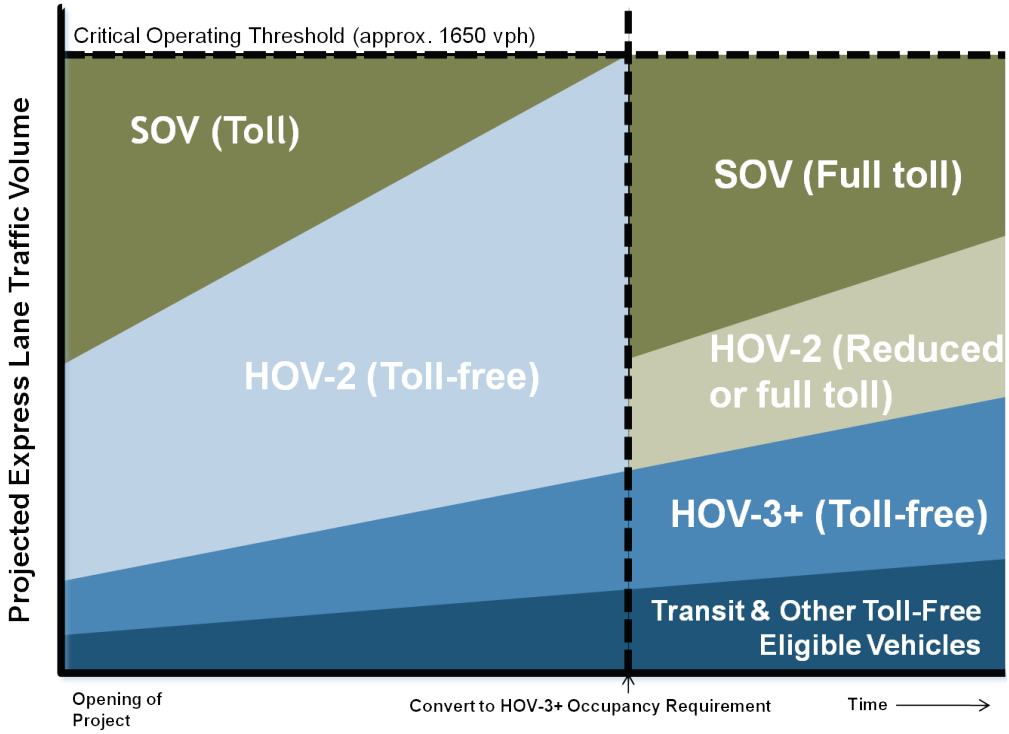


FIGURE 4-1: EVOLUTION OF HOV LANE

FIGURE 4-2:



EVOLUTION OF AN EXPRESS LANE

As described in Chapter 5, changes to the HOV occupancy requirement are evaluated by the HOV Committee, which is an informal committee chaired by Caltrans with representatives from MTC and CHP. Any increase in the occupancy requirement will need to be supported by an analysis of the operational impacts and consider the possibility of negative perception by the motoring public. With the implementation of express lanes, any operational impacts associated with an increase in the HOV occupancy requirement (i.e., shifting vehicles into the general purpose lanes) could be mitigated with pricing to ensure appropriate utilization of the express lane.

The toll system for the initial segments in the MTC Program must be able to recognize HOV occupancy requirements that will initially be different among segments and have the ability to change as warranted by increases in HOV demand and/or the desire to maintain consistency throughout the network. Depending on the nature of future HOV demand, it may be desirable to increase occupancy requirements to HOV 3+ during the peak of the peak periods only when HOV demand is highest, as is done on the I-10 corridor in Los Angeles. In this scenario, HOV 2 vehicles could be charged a reduced toll or the full toll depending on business rules implemented by MTC.

4.4 HOURS OF OPERATION

Express lane hours of operation define the time periods for which eligibility restrictions are in effect. Bay Area HOV lanes currently operate during the AM and PM peak periods only and serve as general purpose lanes during all other times. One exception is the existing I-680SB express lane which operates from 5 a.m. to 8 p.m. on weekdays and serves as a general purpose lane during all other times. Enabling statute specifies that Bay Area express lanes can only operate during hours that the lanes are restricted to use by HOVs. Therefore, express lane hours of operation must be

concurrent with the hours for which a HOV restriction is in effect unless there are changes to state law.

Figure 4-3 below shows existing HOV hours of operation for the initial segments in the MTC Program as well as VTA's SR-237/I-880 express lane. As shown, the operating hours differ by facility, responding to operational conditions for each corridor. The HOV operating hours for the AM peak period are longer by one hour on the westbound bridge approaches (5-10am) as compared to the I-680 and I-880 corridors (5-9am). Similarly, the existing SR-237/I-880 express lane direct connectors operate during an expanded AM peak period (5-10am) in the I-880SB-to-SR-237WB direction. It is likely that the initial express lanes will open with the same hours of operation as the existing HOV lanes. However, modifications to HOV hours of operation may be recommended in cases where there are significant operational or mobility benefits or where there is a desire for consistency among segments that directly interface, including the I-880 corridor, the San Mateo-Hayward and Dumbarton Bridge approaches and the existing SR-237/I-880 express lane direct connectors. Also, as the express lanes continue to be built out and becomes more connected, it may be desirable to have uniform hours of operation.

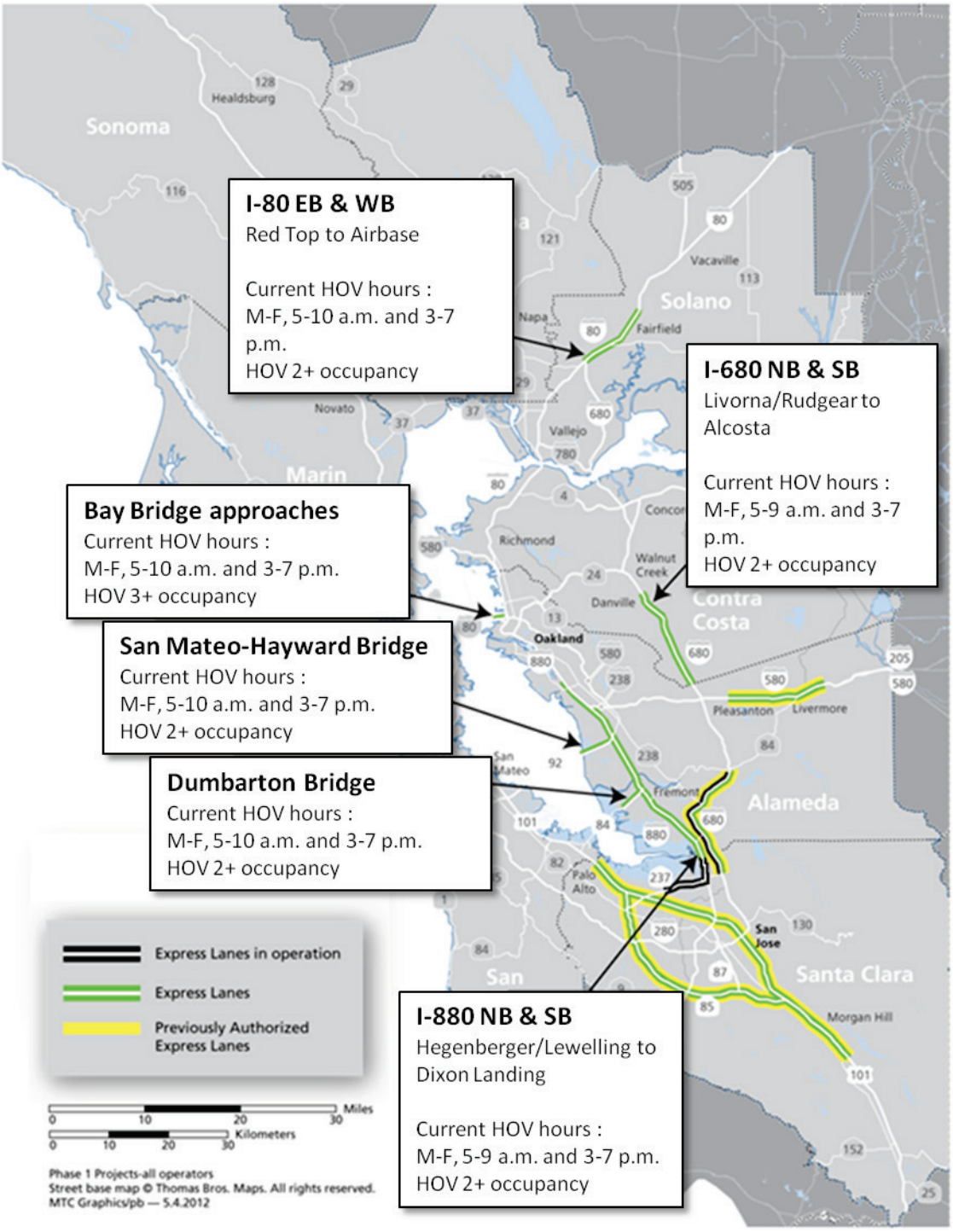


FIGURE 4-3: CURRENT HOV HOURS OF OPERATION ON INITIAL SEGMENTS

Operational conditions, traffic forecasts and the desire for consistency and efficiency will inform decisions related to hours of operation for subsequent phases of the MTC express lane buildout. The opening of the initial corridors in the MTC Program for part-time operations (i.e., operating during defined peak periods only) may be an interim condition as the express lanes are built out

and future conditions necessitate the need for expanded hours of operation. Therefore, the MTC toll system will need to be flexible and allow for hours of operation that may differ among segments in the near-term, and also allow for hours of operation to be extended in the future.

Like changes to the HOV occupancy requirement, changes to the HOV hours of operation are evaluated by the HOV Committee and will need to be supported by an analysis of the operational impacts. The decision to expand hours of operation should also consider the potential that the motoring public could view it as taking away a general purpose lane. The use of pricing, as described in the following section, can alleviate operational impacts by ensuring appropriate utilization of the express lanes during all hours for which they are in operation.

4.5 PRICING

Variable pricing will serve as the principal mechanism for regulating access to MTC express lanes for vehicles that do not meet toll-free eligibility requirements. The primary goal of pricing will be to ensure efficient operations and to meet the federally mandated requirement (Title 23, Section 166 of the U.S. Code) of maintaining a minimum average speed of 45 mph in the express lane. Tolls will be collected electronically using ETC accounts. The following subsections describe more specifically how pricing on MTC express lanes will work.

4.5.1 DYNAMIC PRICING

Dynamic pricing, which allows toll rates to vary according to real-time traffic conditions, is the preferred pricing strategy for MTC express lanes. Using vehicle detection equipment in the express lanes, with supplemental information provided by detection equipment in the general purpose lanes, the toll system is able to increase and decrease the toll rate to ensure that conditions in the express lane remain free-flowing and that any excess capacity in the express lane is appropriately utilized. When speeds in the express lane decrease, the toll rate increases to discourage additional vehicles from entering the lane. The toll rate decreases when speeds in the express lane increase to encourage general purpose lane vehicles to use the lane during periods of lower demand. Express lane operators will have the ability to override the dynamic pricing during incidents, lane closures or otherwise as appropriate.

4.5.1.1 MINIMUM AND MAXIMUM TOLL RATES

MTC may decide to implement a minimum and/or a maximum toll rate that would constrain the toll system from applying a toll rate that is deemed by policy to be too low or too high. Minimum toll rates are typically set to ensure that the value of the express lane is maintained at all times, even when demand is low, and to ensure that the cost to operate the lane during periods of low demand is justified by the amount of toll revenue collected. Maximum toll rates are set to cap the toll at a certain level. A dynamic pricing toll system without a maximum toll-rate would be free to assess any toll rate warranted by the prevailing traffic conditions. In instances when congestion is severe, this could cause toll rates to reach levels that could cause negative public reaction.

If the volume in the express lane continues to increase and approaches the critical operating threshold once the maximum toll rate is reached, the toll system will close the lane to new toll-paying vehicles. This is accomplished by displaying a message such as “HOV ONLY” on the pricing signs to indicate that only eligible toll-free vehicles are allowed to use the express lane. Business rules to be developed by MTC will include rules for toll-paying vehicles in the event that the express

lane reverts to HOV-only operations, including toll-paying vehicles that already happen to be in the express lane when it switches to HOV-only mode. Enforcement procedures during HOV-only operations will also be established.

If implemented, the minimum and maximum toll rates will need to be evaluated and adjusted periodically to ensure that speeds in the express lanes are being maintained above the minimum 45 mph threshold. They will also need to be revisited and adjusted as the buildout of the MTC Program provides longer distances of uninterrupted travel in the express lanes to ensure that the ability to effectively manage demand is not constrained by pre-determined minimum and maximum toll rates.

4.5.2 TIME-OF-DAY PRICING

Another type of variable pricing strategy is to set the toll rate according to a time-of-day schedule. This strategy does not require an interface between the toll system and vehicle detection equipment. Instead, the toll rate during different periods of the day is pre-programmed into the toll system. The amount of the toll is generally highest during periods when congestion is known to be most significant and is lower during shoulder hours when demand is lower. The toll on the San Francisco-Oakland Bay Bridge operates according to a time-of-day schedule, as discussed in Chapter 2.

With a time-of-day pricing strategy, the toll schedule will need to be evaluated regularly to ensure that free-flow conditions are being maintained in the express lane. A performance basis for changing the toll rates should be established to define operating thresholds that would trigger an increase or decrease in toll rates.

Time of day pricing may be implemented on an interim basis, so as to collect actuarial data for the dynamic pricing algorithm in advance of its operation. This, in turn, allows the dynamic pricing system to operate more consistently than adapting the algorithm within the initial weeks of opening.

4.5.3 ZONE-BASED PRICING

Due to the extensive length of the corridors within the MTC Program, it will be necessary to divide the corridors into smaller segments ("zones"), to ensure that the applied toll rate is able to effectively manage demand. A single toll rate applied over a long corridor will not be able to manage demand efficiently since varying traffic conditions over the length of the corridor could warrant lower or higher toll rates on some portions of the corridor, even though these rates may not be justified on other portions of the corridor. The concept of zone-based pricing applies a separate toll rate to each defined zone along the corridor according to traffic conditions within that zone. In this way, zones with higher levels of congestion could experience higher toll rates without causing toll rates to unnecessarily increase in other zones where demand does not justify such an increase.

The toll rate in effect for each defined zone will be charged to any vehicle entering the express lane within the limits of the zone regardless of how far the vehicle travels in the zone, or how many toll readers the vehicle passes under while in the zone. This type of pricing strategy is thought to be beneficial from a revenue leakage viewpoint since vehicles only need to be detected once within a

zone to be charged the full zone toll. This strategy may also be a potential disincentive to any drivers that would be otherwise tempted to weave in and out of the lane to avoid toll payment.

The beginning and end of pricing zones will be based on logical termini determined via analysis of traffic patterns along the corridor. Ideally, traffic volume characteristics within the limits of a zone should not vary drastically and bottleneck locations should be captured within a single zone. With these criteria applied, it is assumed that the length of zones will vary between approximately three and five miles, although specific conditions may warrant zones of different lengths. The length of a zone will also be constrained by the fact that the zone toll will need to effectively manage demand along the entire length of the zone.

Although the toll rate for a particular zone will be primarily determined based on traffic conditions within that zone, the toll system will have the ability to take into consideration the traffic conditions in adjacent zones when calculating the toll rate for a zone. This allows the toll system to increase the toll rate upstream of a zone experiencing heavy congestion to ensure that the express lane within the zone does not become over-utilized.

4.5.4 COMMUNICATING TOLL RATES TO DRIVERS

As described in Chapter 3, toll rates will be communicated to drivers using destination-based pricing signs incorporating changeable message elements as specified in the MUTCD. The destination(s) shown on these signs will correspond to the termini of zones and to designated major designations within the corridor. These major destinations will be based on an analysis of traffic patterns within the corridor and will form the basis of the pricing concept.

The concept for pricing to major destinations is illustrated in Figure 4-4. The graphic shows a portion of the I-880 corridor with three zones ending at SR-237, which serves as the designated major destination. The top price on the first sign shows the toll to travel in the orange zone, which terminates at SR-92, and the second price shows the cumulative toll to travel through the orange, blue and purple zones to the major destination, SR-237. Drivers entering the express lane upon seeing the first sign would be locked into both prices shown. Therefore, a driver traveling to SR-92 would pay $1.50 and a driver traveling to SR-237 would pay $4.50, even if the tolls were to increase while the driver was traveling in the lane. A driver entering the express lane upon seeing the first sign and traveling to SR-84 would know that the toll was somewhere between $1.50 and $4.50, but they would not know the exact price of their trip at the time the trip was made. The second sign shown in Figure 4-4 is similar in concept to the first sign as it shows the price to travel in the zone that it precedes and the cumulative price to travel to the major destination. The third sign precedes the zone terminating at the major destination and therefore only shows one price since the end of the zone and the major destination are the same.

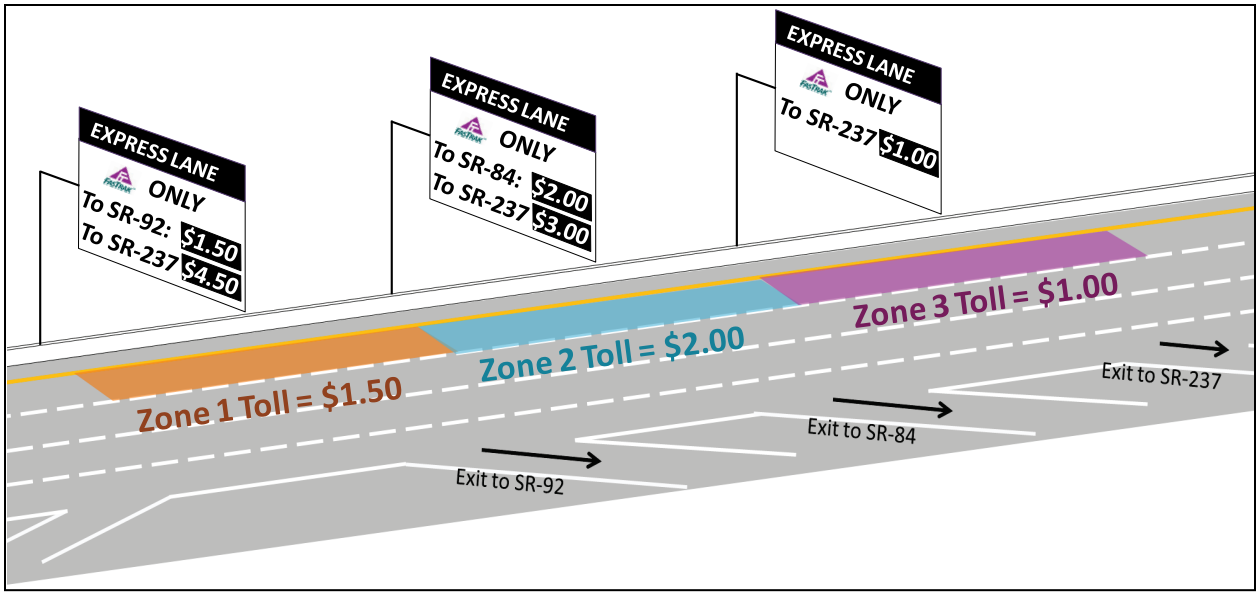


FIGURE 4-4: PRICING TO MAJOR DESTINATION EXAMPLE

Drivers using the express lanes will never be charged a toll greater than that which they see when entering the express lane, regardless of whether the price increases after the driver has entered the lane. MTC may decide to implement business rules to charge a lower toll than that which drivers see when entering the express lane if the toll happens to decrease while the vehicle is traveling in a zone. Depending on the destinations shown on the pricing signs, the following scenarios are possible:

Another option for destination-based pricing signs is to display the toll to travel to the end of the facility. However, this scenario is not advisable for longer corridors as it may become difficult to effectively manage demand along the corridor when locking vehicles into a static price early in their trip.

As described above in Section 4.5.1.1, the express lanes may close to toll-paying vehicles in the event that the maximum toll rate is reached but speeds continue to decrease in the express lane. This will be communicated to drivers by displaying a message such as "HOV ONLY" next to the destination on pricing signs, indicating that toll-free eligible vehicles are the only vehicles permitted to travel in the express lane.

Outside of the express lane hours of operation or during incidents, a message such as "OPEN TO ALL" or "NO TOLL" will be displayed next to the destinations on pricing signs. This will inform drivers that the express lanes are permitted to be used by all vehicles, toll-free.

4.5.5 CONSISTENCY IN PRICING AMONG CORRIDORS

In order to promote familiarity with express lane operations and to avoid driver confusion, a consistent pricing policy will be applied for all MTC express lanes. This will be accomplished by applying zone-based pricing to all MTC express lanes. This will simplify public outreach and allow education materials to focus on the following:

- Corridors are segmented into zones for the purposes of tolling.
- Each zone has its own toll rate that changes based on traffic conditions.
- Priced destination signs show toll rates to one or two downstream destinations.
- Tolls shown on the same priced destination signs are not additive (i.e., the price to the furthest downstream location is inclusive of the price to the end of the current zone).
- The price to travel within a zone is independent of the distance traveled in the zone, or where the driver enters the zone.

Although the existing express lanes on southbound I-680 and SR-237/I-880 are not described as employing zone-based pricing, the points made above are consistent with the user experience on either of these two projects.

4.6 PERFORMANCE MONITORING

A clearly defined set of operational goals will be established for the MTC express lanes and will form the basis for a performance monitoring program. The attainment of these goals will be quantified using various performance measures. The establishment of performance measures will ensure that express lane operations are ideally managed in response to varying traffic conditions. The performance measures will also drive the monitoring and associated data collection needs that are necessary to track adherence to goals. Example goals and performance measures that may be applied for express lane operations are shown in Table 4-2. These performance measures could be used to reflect conditions in the express lanes, general purpose lanes or across all lanes.

TABLE 4-2: EXAMPLES OF PERFORMANCE MEASURE TO ASSESS ACHIEVEMENT OF EXPRESS LANE GOALS

Goal	Possible Performance Measures
Improve Mobility	• Average speeds • Throughput • Average travel times • Rates of violation
Increase Reliability	• Speed or travel time variation • Transit "on time" performance
Improve Safety	• Number of incidents by type • Incident response times
Decrease Environmental Impacts	• Vehicle miles traveled (VMT) • Average vehicle occupancy • Fuel consumption • Quantities of exhaust pollutants
Improve Transit Performance	• Average bus speeds • Bus on-time performance

4.7 BUSINESS RULES

This chapter describes the foundational concepts for the express lanes to inform more detailed toll system requirements. Business rules that describe how various scenarios should be handled by the toll system and by the customer service center will need to be developed in order to translate the concepts in this document to system requirements and to carry out day-to-day operations of the express lanes. An example of a business rule is one that describes how to handle a customer that accidentally got in the express lane and was charged a toll. The business rule to be developed for this scenario may allow these customers one free accidental trip and all future trips the customer would be responsible for paying. The business rules will be a living document throughout the development of the toll system and will result in a set of agreed upon rules for the operation of the express lanes..

4.8 INTERFACES WITH OTHER PROJECTS AND SYSTEMS

There are several projects and Intelligent Transportation System (ITS) deployments with which MTC express lanes will need to interface. The technical requirements that need to be considered to achieve these interfaces are described in Chapter 6. The following sections describe how MTC express lanes will operate in combination with adjacent projects and systems.

4.8.1 OTHER BAY AREA EXPRESS LANES

MTC express lanes will interface with express lanes that are being developed and operated by other agencies. Within the MTC Phase 1 Project, express lanes on the I-880 corridor will directly connect to the SR-237/I-880 express lanes operated by VTA, and MTC express lanes on the I-680 corridor will operate in close proximity to the I-680SB express lane operated by ACTC. In addition, there are other express lane projects currently under development by VTA (SR-85 and US-101) and ACTC (I-

580 and I-680NB). Some of these projects are expected to be in operation by the time MTC Phase 1 is complete.

The goal is for all express lanes in the Bay Area to form a seamless network that allows users to travel seamlessly between express lanes operated by different agencies. This will require consistency in operating policies, the most important of which include:

- Use of toll tags and eligibility declaration: Legacy toll tags currently used throughout the Bay Area will be recognized by the MTC express lane toll system for toll-paying vehicles, but cannot be used by eligible vehicles for toll-free travel. Similarly, switchable toll tags used on MTC express lanes will be recognized on all toll facilities in California as long as they are set in the single occupancy position. All eligible toll-free vehicles traveling on MTC express lanes will be required to carry a switchable toll tag set in HOV mode to avoid being charged a toll. This is different than the current policy on SR-237/I-880 and I-680SB express lanes where users are required to shield their toll tags by placing them in Mylar bags when traveling in the express lanes as an eligible toll-free vehicle in order to avoid being charged a toll. Any vehicle traveling on MTC express lanes without a properly displayed toll tag will trigger an automated response by the toll system to take a picture of the vehicle's license plate to match to an ETC account or to issue a toll violation in the event that the license plate is not matched to an ETC account. Therefore, it is essential that the toll tag and eligibility declaration policy for all Bay Area express lanes be consistent to allow users to travel seamlessly. It is an action item for all stakeholders to work this out.
- Hours of operation: Although hours of operation on existing HOV lanes in the Bay Area differ, it may be desirable for the hours of operation to be consistent once express lanes start to become connected. For example, the hours of operation for the SR-237/I-880 express lanes operated by VTA and MTC express lanes on I-880 will need to be made consistent if users are expected to be able to make an uninterrupted trip along both facilities at all times of the day. As described previously, changes in hours of operation are dependent on analyses of traffic operational impacts.
- Eligibility requirement: Similar to hours of operation, consistency in the HOV eligibility requirements, including occupancy restrictions, is necessary to provide seamless travel when express lanes directly connect to one another.

It may also be necessary for the express lane toll systems to communicate with each other to ensure that the operating conditions on one express lane do not adversely impact conditions on another express lane. For example, an express lane that closes to non-HOV vehicles when demand approaches the critical operating threshold may warrant a response in an express lane upstream of the closure. The same is true if an express lane is closed to all vehicles during an incident. As discussed in Chapter 6, there may also be a need for the express lane pricing algorithms to be coordinated to ensure that demand is managed efficiently.

There are other functional areas where consistency of practice is desired to promote a seamless express lane network in the Bay Area, including signage and other design treatments, business rules and customer service.

4.8.2 TRANSITION FROM EXPRESS LANE TO HOV LANE

Another interface that will occur at the SR-237/I-880 interchange, and will occur at other locations throughout the MTC network as future phases of express lanes are implemented, is the transition from express lanes to HOV lanes. The I-880SB express lane will transition to an HOV lane south of the interchange when the HOV lane extension to US-101 is completed by the end of 2013. Appropriate signage will be deployed to direct non-eligible HOV vehicles out of the lane as the express lane transitions to a HOV lane, as is currently done on the northern and western segments of the SR-237/I-880 express lanes. Traffic operational analysis will inform decisions about the location and length of the transition area to ensure that exiting express lane vehicles do not adversely impact general purpose lane traffic.

4.8.3 RAMP METERING

Experience has shown that ramp metering in combination with express lanes can result in a noticeable improvement to freeway operations. The ability for ramp metering to reduce the rate of freeway incidents is not only beneficial for general purpose lane operations, but also reduces the likelihood that express lane operations are interrupted during an incident.

Ramp metering is currently deployed or planned along the I-880 and I-680 corridors where MTC Phase 1 express lanes will be implemented. In addition, the FPI plans to add additional ramp meters to the I-880, SR-84 and SR-92 corridors. The HOV bypass lanes at ramp meters will continue to operate only for eligible HOV vehicles after the implementation of express lanes. Implementation of adaptive ramp metering is planned as part of the I-880 & I-80 ICM projects described below.

4.8.4 INTEGRATED CORRIDOR MANAGEMENT (ICM)

As described in Chapter 2, ICM projects will be implemented on I-80 and I-880. The operations of these projects will need to be consistent with express lane operations and vice versa. For the I-80 ICM project, which includes the installation of advisory speed signs and lane control signals on overhead gantries, some of these operational consistencies include:

- Operating speed: Advisory speeds should not adversely impact the minimum operating speed of express lanes.
- Lane closures: Dynamic message signs deployed as part of the I-80 ICM project and express lane signage need to display consistent messages when there is an express lane closure.
- Lane designation: Overhead signs deployed as part of the I-80 ICM project to designate lane operations should properly reflect the current operation of the express lane (i.e., refer to the lane as express lane when tolling is in effect or as HOV when the lane is at capacity.)
- Alternate routing: When traffic is routed from San Pablo Avenue to the I-80 corridor, the express lanes operator should be notified.
- Incident detection: When incidents are detected by the express lanes or the I-80 ICM project, the other system should be alerted.

4.9 UNIQUE ASPECTS OF BRIDGE APPROACH OPERATIONS

There are several operational considerations which are unique to the three HOV approaches at the Bay Bridge (I-80/I-580/I-880), San Mateo-Hayward Bridge (SR-92) and Dumbarton Bridge (SR-84). Although the policies related to express lane eligibility and hours of operation described in Sections 4.1, 4.2 and 4.3 of this chapter are generally the same for the bridge approaches and the express lane corridors, there are other operational considerations associated with the bridge approaches, which are described below.

4.9.1 OVERVIEW OF EXPRESS LANE OPERATIONS AT THE BRIDGE APPROACHES

The Phase 1 project will convert the existing HOV approaches at the three bridges, described in Chapter 2, to express lanes. These approaches currently allow eligible vehicles to pay a reduced toll rate to cross the bridges and, during HOV hours, to bypass queues that form in the general purpose lanes at the bridge toll plazas. Upon conversion to express lanes, an additional toll (i.e., express lane charge) would be applied to vehicles not meeting the HOV eligibility requirements. Vehicles meeting HOV eligibility requirements will only be charged the effective carpool bridge toll. Commute buses and vanpools will continue to be able to cross the bridge toll-free. These vehicles that are eligible to cross toll-free will need to carry non-revenue FasTrak® toll tag as is done currently.

Dynamic message signs will inform drivers of the toll to use the express lane bridge approaches. The signs could convey the combined toll (including the bridge toll and the express lane toll as a consolidated toll) or just the express lane toll (not including the bridge toll). The unique configuration of the various approaches to the Bay Bridge may require multiple pricing signs to inform drivers of the express lane toll. The pricing signs for the I-80 and I-880 approaches to the Bay Bridge will be located along the I-80 and I-880 corridors in advance of the grade-separated HOV flyover ramp. There will also be signing as appropriate for the I-580 and West Grand Avenue approaches to the Bay Bridge. Pricing signs for the San Mateo-Hayward and Dumbarton bridge approaches will be located along the SR-92 and SR-84 corridors, respectively, in advance of the HOV lane at the toll plaza. Alternatively, the express lane tolls for SR-92 and SR-84 could be displayed on pricing signs on the I-880 corridor in advance of the SR-92 and SR-84 exits. The express lane toll applied may vary dynamically based on real-time traffic conditions or may vary according to a fixed time-of-day schedule. There may be a desire to operate all three of the bridge approach express lanes in a consistent fashion, which would necessitate the express lane pricing scheme to be consistent among the bridge approaches.

4.9.2 METERING LIGHTS

Metering lights at the Bay Bridge are intended to regulate traffic flow onto the bridge when the bridge is at or near operating capacity. The current algorithm for the metering rate is adjusted based on the volume of vehicles being loaded onto the bridge through the HOV approach lanes, which are not metered. FasTrak® only lanes are metered at a faster rate than cash/FasTrak® lanes. Increasing the volume of vehicles using the HOV approach lanes and bypassing the metering lights would cause the algorithm to meter the other lanes at a slower rate. This could potentially result in longer queue formations in these other lanes at the bridge approach. These impacts, along with the constraints set by the capacity of the bridge and the operation of the metering lights, will affect operation of the express lanes. Express lane tolls at the bridge approaches will be set to ensure that

the downstream capacity of the bridges is not exceeded as a result of increased traffic volume through the HOV approach lanes at the toll plazas.

Metering lights are installed at the Dumbarton and San Mateo-Hayward bridges, but are currently not used. Results of future traffic analyses will inform whether activation of the metering lights at these bridges will be needed upon conversion to express lanes.

4.9.3 REVENUE CONSIDERATIONS

If express lanes at the bridge approaches are to operate outside of the currently defined peak periods, then the hours during which HOV bridge toll rates are offered will need to also be expanded so that the HOV hours are concurrent with the express lane hours, provided that such expansion does not adversely impact bridge operations as described in the previous section. As described in Chapter 2, the HOV approach lanes at the bridge approaches allow eligible vehicles to pay a reduced bridge toll rate during the AM and PM peak periods when the lanes are in operation. An expansion of the hours for which the HOV approaches are in operation could result in reduced bridge toll revenue collected by BATA since eligible vehicles would qualify for a reduced bridge toll rate during longer periods of the day. This loss of bridge toll revenue would have to be quantified and offset by an equal portion of the amount collected from express lane operations. In the end, any express lane strategy operated at the bridge approaches would be implemented so as not to negatively affect BATA bridge toll revenue.

Another option to allow express lanes at the bridge approaches to operate outside of the currently defined peak periods without permitting eligible vehicles to qualify for a reduced bridge toll is to operate the express lanes without the HOV exemption outside of the peak periods. This option may require changes to state law, which currently specifies that express lanes must operate during the hours that the HOV eligibility requirement is in effect.

CHAPTER 5 ROLES AND RESPONSIBILITIES

5.1 ROLES AND RESPONSIBILITIES OVERVIEW

The implementation, operation and maintenance of MTC express lanes will require collaboration by multiple public agencies. This chapter describes the stakeholder agencies and their roles as they relate to the express lanes to be operated by MTC. State law requires MTC to contract with BATA, CHP and Caltrans for certain services and pay for those services with toll revenue. This Concept of Operations does not draw any conclusions or make recommendations on financial responsibilities beyond those required in state law.

5.2 METROPOLITAN TRANSPORTATION COMMISSION (MTC)

MTC is the transportation planning, coordinating and financing agency for the nine-county San Francisco Bay Area. MTC's work is guided by a 19-member policy board and performed by a staff of some 210 persons headquartered at the Joseph P. Bort MetroCenter in Oakland. MTC is currently planning a move to a new facility at 390 Main Street in San Francisco in 2014.

MTC is eligible to develop and operate 270 lane-miles of express lanes, based on action by the CTC in 2011. As the agency that sought express lane authority from the CTC, MTC's express lane roles include:

- Design, implement, operate and own the toll system.
- Oversee daily operations of the express lanes.
- Establish toll policy.
- Operate and administer the MTC Program.
- Maintain toll equipment.
- Monitor and report on express lane performance.
- Provide enforcement tools to the CHP.
- Perform marketing and public outreach for the express lanes.
- Protect personal identifiable information (PII).

In addition, MTC performs other roles that support express lane deployment and operation:

- In partnership with Caltrans and CHP, operates the regional traveler information system, 511, including:
    - Data collection and dissemination; and,
    - Operation of the Traveler Information Center (511 Operations Center).
- Operates the Regional Rideshare Program to support carpool and vanpool formation and perform employer outreach.
- Works in collaboration with Caltrans on the Freeway Performance Initiative (FPI) to design, install and implement ramp metering and traffic operations systems.
- Coordinates the Regional Traffic Incident Management Program with Caltrans, CHP, and incident response personnel to enhance traffic incident detection, verification, mitigation, response and clearance.

- Works with Caltrans, CHP and local agencies to implement ICM strategies to actively manage freeway, arterial, transit and parking systems within a corridor and optimize operations under various scenarios.
- Administers the Service Authority for Freeways and Expressways (SAFE). MTC SAFE works in conjunction with CHP and Caltrans to implement various motorist aid programs, which include:
    - Freeway Service Patrol (FSP): The FSP is a fleet of roving tow trucks that operate Monday through Friday during peak commute hours and all day in pre-designated freeway construction zones. FSP drivers clear accidents, assist motorists and remove debris from freeways.
    - Call Box Program (CBP): The CBP provides approximately 2,200 yellow roadside call boxes for motorists in need and operates a 24-hour call answering center.
- Prepares and approves the Regional Transportation Plan (RTP) and Transportation Improvement Program (TIP), which reflect express lane phasing and funding.
- Coordinates with other express lane operators in the region to provide a complete express lane network that is seamless to users.
- Conducts air quality planning and conformity analysis.
- Manages federal, state and regional matching funds for HOV and express lanes.

As discussed in Section 5.4, MTC delegated express lane authority to BAIFA in April of 2013.

5.3 BAY AREA TOLL AUTHORITY (BATA)

BATA was created by the California Legislature in 1997 to administer the bridge tolls on the San Francisco Bay Area's seven state-owned toll bridges. On January 1, 1998, BATA assumed toll operations from the State Department of Transportation. In August 2005, the California Legislature expanded BATA's responsibilities to include administration of all toll revenue and joint oversight of the toll bridge construction program with Caltrans and the CTC. Caltrans owns and operates the state-owned bridges.

BATA's express lane roles include:

- Operate the Regional Customer Service Center (RCSC) including:
    - Manage FasTrak® customer accounts, protect PII, and provide general customer service.
    - Collect express lane tolls from FasTrak® customer accounts based upon trip transaction records from express lane operators.
    - Reverse tolls in the event that express lane operating conditions are impacted during an incident.
    - Issue toll violation notices.
    - Track, inventory, and distribute FasTrak® toll tags to customer service outlets.
    - Operate, support and maintain FasTrak® back office operations (e.g., trip records, revenue and account information).
    - Provide marketing of the express lanes along with other FasTrak® marketing.
    - Distribute toll revenue to the express lanes agencies.
    - Establish interface with credit and debit card processing and banking services.
    - Establish interface with DMV for processing license plate reads and matching with registered vehicle owner.

In addition, BATA performs other roles that support express lane deployment and operation:

- Implement and maintain toll systems at the bridges.
- Operate and maintain changeable message signs at the bridges.
- Administer toll revenue generated by the region's seven state-owned toll bridges, including any express lane operations at the bridge approaches and toll plazas.

5.4 BAY AREA INFRASTRUCTURE FINANCING AUTHORITY (BAIFA)

BAIFA is a joint exercise of powers agency formed by MTC and BATA to plan, develop, operate and finance transportation and related projects, including express lanes. On April 24, 2013 MTC entered into a cooperative agreement with BAIFA through which MTC delegated authority to BAIFA to develop and operate the 270-mile Bay Area Express Lanes. In addition to assuming MTC's responsibilities shown in Section 5.2, BAIFA's express lane responsibilities also include financing of the express lanes.

5.5 CALTRANS

Caltrans manages more than 50,000 miles of California's highway and freeway lanes, provides inter-city rail services, permits more than 400 public-use airports and special-use hospital heliports, and works with local agencies to implement transportation projects. As owner of the state highway system, Caltrans has a large role in express lane development and implementation.

Caltrans' express lane roles include:

- Review and approve all design and operation plans, including construction and maintenance activities within state right-of-way.
- Monitor the operation of the freeway and initiate corrective actions when needed to ensure motorist safety.
- Operate the Transportation Management Center (TMC). Through the TMC, request override of the express lane toll display messages by the toll system operator when an event occurs that warrants an override.
- Control regional Advanced Transportation Management System (ATMS).
- Maintain all roadway elements of the express lanes, other than the toll collection equipment, unless MTC hires a contractor for this purpose. If MTC contracts with Caltrans for a higher level of maintenance (e.g., more frequent sweeping), MTC will reimburse Caltrans for these services. A Maintenance Agreement with Caltrans will be executed prior to approval for construction.
- Monitor the performance of HOV lanes.
- Own and maintain the Freeway Performance Monitoring System (PeMS).
- Maintain the Title 21 requirements consistent with statutory instructions.
- Support CHP in incident management.

5.6 CALIFORNIA HIGHWAY PATROL (CHP)

CHP is the law enforcement agency that has patrol jurisdiction over all California highways and serves as the state police. CHP's express lane roles include:

- Perform on-site enforcement of express lane eligibility (i.e., HOV and low emission vehicle) requirements with MTC-provided tools.
- Enforce buffer crossing violations in express lanes.
- Lead coordination and implementation of response functions related to incidents or other disruptions on the express lanes and general purpose lanes. CHP will communicate to the toll system operator and to the RCSC when incidents require the use of express lanes to divert traffic.
- Provide lane closure enforcement for installation and maintenance activities when required by policy, contract or agreement.
- Enforce motor vehicle violations.

5.7 CONGESTION MANAGEMENT AGENCIES (CMAs)

CMAs were formed in 1990 with the passage of Proposition 111, which doubled the state gas tax and specified among other things that each county designate a county-wide body to put programs in place to keep traffic levels manageable. The Regional Express Lane Network spans four counties: Alameda, Contra Costa, Solano and Santa Clara counties; however, the MTC Program is predominantly located in three of them: Alameda, Contra Costa and Solano counties. Alameda and Santa Clara counties have separate statutory authority to implement and operate express lanes on certain corridors within their counties. It is the desire of all stakeholders to have a network of express lanes that functions seamlessly for the customer throughout the Bay Area. An operations-focused staff-level Technical Working Group (TWG) and Executive Steering Committee (ESC, consisting of chief executive officers of each organization), including members of the CMAs discussed below, were instituted to promote collaboration and information sharing. These groups have been the main source for feedback on the recommendations in this concept of operations.

CMA express lane roles include:

- Participate in the TWG and the ESC.
- Participate jointly with MTC, CHP and Caltrans in the planning and delivery of express lane improvements for the MTC Program within their respective counties. The CMA may act as the lead for one or more phases of delivery (environmental, design, advertise and award or construction) for the civil component of the express lanes. Except where noted below, the leads for specific phases have yet to be determined.
- For express lanes that are owned and operated by a CMA, coordinate operations with those of the MTC express lanes.

5.7.1 ALAMEDA COUNTY TRANSPORTATION COMMISSION (ACTC)

ACTC is the CMA for Alameda County and coordinates countywide transportation planning efforts; programs local, regional, state and federal funding; and delivers projects and programs including those approved by voters in Alameda County transportation expenditure plans. ACTC is a joint powers authority governed by a 22-member Board of Directors comprised of elected officials from each of the 14 cities in Alameda County, all five members of the Alameda County Board of Supervisors, and elected representatives from AC Transit and BART.

ACTC is the administering agency for the I-580 express lanes, which are currently under development. ACTC is a member of the I-680 Sunol Smart Carpool Lane Joint Powers Authority (I-

680 Sunol JPA), which is the owner and operator for the I-680SB express lane, which is currently in operation, and the I-680NB express lane, which is under development. ACTC staff provides day-to-day staffing for the I-680 express lane projects.

5.7.2 CONTRA COSTA TRANSPORTATION AUTHORITY (CCTA)

CCTA is a public agency formed by Contra Costa voters in 1988 to manage the county's transportation sales tax program and to do countywide transportation planning. CCTA is also the county's designated CMA, responsible for putting programs in place to keep traffic levels manageable.

5.7.3 SOLANO TRANSPORTATION AUTHORITY (STA)

STA is the CMA for Solano County and is responsible for countywide transportation planning, programming transportation funds, managing and providing transportation programs and services, delivering transportation projects, and setting transportation priorities. STA is the sponsor and implementing agency responsible for preparing project approval, environmental and engineering documentation for civil construction of the Solano I-80 express lanes between Red Top Road and I-505, which are a part of the MTC Program. MTC will be the owner-operator of the I-80 express lanes.

5.7.4 SANTA CLARA VALLEY TRANSPORTATION AUTHORITY (VTA)

VTA is a special purpose district that provides transit service and serves as the CMA for Santa Clara County. VTA provides bus, light rail, and paratransit services, as well as participates as a funding partner in regional rail service including Caltrain, Capital Corridor, and the Altamont Corridor Express. As the county's congestion management agency, VTA is responsible for countywide transportation planning, including congestion management, design and construction of specific highway, pedestrian, and bicycle improvement projects, as well as promotion of transit oriented development.

VTA is the administering agency of an existing express lane on the SR-237/I-880 direct connector, which opened on March 20, 2012. Other express lane projects being implemented by VTA include an extension of the express lane on SR-237 as well as express lanes on SR-85 and US-101. VTA is a member of the I-680 Sunol JPA, which is the owner and operator for the I-680SB express lane.

5.8 FEDERAL HIGHWAY ADMINISTRATION (FHWA)

FHWA is the agency within the U.S. Department of Transportation that supports State and local governments in the planning, design and construction of the National Highway System via the Federal Aid Highway Program and provides financial resources and technical assistance for a coordinated program of public roads that service the transportation needs of Federal and Indian lands via the Federal Lands Highway Program. FHWA maintains project level approval for projects that are deemed as High Profile projects, which include major ITS projects. FHWA has designated all express lane projects as High Profile projects.

FHWA's express lane roles include:

- Review and approve improvements and lane operations on Federal Aid Highway Routes.

- Provide lessons learned and recommended best practices
- Provide oversight and review of the project as outlined in the agreement among FHWA, Caltrans and MTC.
- Approve Concept of Operations and Systems Engineering Management Plan (SEMP).

5.9 TRANSIT

There are numerous transit agencies as noted in Chapter 2 that are currently operating along the existing corridors. They will continue to operate transit in the express lane and therefore will provide input on bus operations and access needs.

5.10 CALIFORNIA TOLL OPERATORS COMMITTEE (CTOC)

CTOC is a collaborative organization composed of California's toll facility operators/owners. CTOC is the primary resource for interoperability and coordination among tolling facilities, and education and advocacy regarding tolling in California. CTOC members communicate regularly on issues of interoperability, technology, operating policies, customer service, the legislative, administrative and regulatory framework for tolling, and other issues affecting tolling in California.

CTOC's express lane role includes:

- Responsible for setting interoperability guidelines for California toll operators consistent with Title 21. One of the requirements set forth in the most recent Federal Surface Transportation Authorization, titled Moving Ahead for Progress in the 21st Century (MAP-21), calls for national interoperability among toll systems. It is envisioned that CTOC will be the body to discuss and implement changes to conform to this requirement.

5.11 SYSTEM INTEGRATOR

The system integrator will be contracted by MTC to implement and maintain the toll collection system. MTC may contract with the integrator to operate the express lane toll collection system for a period of time.

5.12 OTHER

5.12.1 CALIFORNIA TRANSPORTATION FINANCE AUTHORITY (CTFA)

CTFA is authorized to issue revenue bonds to finance transportation projects and to grant approval to a project sponsor to issue revenue bonds for a specific project. The CTFA may also grant approval to a project sponsor to collect tolls as part of the financing plans to repay revenue bonds for a specific project.

CTFA's express lane role includes:

- Assist with financing mechanisms, in the event MTC seeks CTFA approval of MTC's issuance authority for the MTC Program. This is not anticipated for the Phase 1 corridors.

5.12.2 CALIFORNIA TRANSPORTATION COMMISSION (CTC)

CTC is responsible for the programming and allocation of funds for the construction of highway, passenger rail and transit improvements throughout California. The CTC also advises and assists the Secretary of the Business, Transportation and Housing Agency or successor agency and the Legislature in formulating and evaluating state policies and plans for California's transportation programs. The CTC is also an active participant in the initiation and development of State and Federal legislation that seeks to secure financial stability for the State's transportation needs.

CTC's express lane roles include:

- Found MTC eligible to implement and operate the MTC Program in 2011.
- Review and approve public-private partnerships involving any aspect of the Regional Express Lane Network (per Senate Bill No. 4 passed in 2009).
- Approve programming of state funds, if used to fund the MTC Program.

5.12.3 HOV COMMITTEE

The HOV Committee is a mutually agreed upon group of three representatives from MTC, Caltrans and CHP to enable better coordination and communication between the partnering agencies involved with the aspects of implementing and operating HOV lanes. The California Vehicle Code (CVC) Section 21655.5 gives Caltrans the authority to designate exclusive or preferential use of a lane by HOV's based on a competent engineering estimate of the safety, congestion and highway capacity. Additionally, CVC 21655.6 requires that Caltrans obtain the approval of the transportation planning agency (i.e., MTC) before implementing preferential lanes. The function of the HOV Committee is to review any requests to modify the hours of operation and eligibility requirements on HOV lanes in the Bay Area. Any request made must be accompanied by justification showing that the change will not have adverse operational impacts.

5.12.4 BAY AREA INCIDENT MANAGEMENT TASK FORCE (IMTF)

The Bay Area IMTF is an interagency committee formed in 2002 and comprised of chaired by Caltrans with cooperation from CHP, MTC and first responder agencies. The goal of the IMTF is to improve responder safety and to promote safe and quick clearance of freeway incidents. The IMTF meets monthly to discuss challenges and solutions for responding to traffic incidents.

5.13 EXISTING AGREEMENTS

The stakeholders and groups referenced above have been working together on a variety of projects throughout the region, including the express lanes. Existing agreements between stakeholders, which are pertinent to express lanes, include:

- Standard operating procedures for incident management on the State Highway System between CHP and Caltrans
- Enforcement agreements between I-680 Sunol JPA and CHP and between VTA and CHP
- Toll collection and RCSC operations between ACTC and BATA and between VTA and BATA
- Express lane agreements between I-680 Sunol JPA and Caltrans and between VTA and Caltrans

- Toll agreements between Caltrans and FHWA for the I-680 and SR-237/I-880 express lanes and Bay Area toll bridges, including the Dumbarton and San Mateo-Hayward bridges.
- Cooperative Agreement between Caltrans and MTC for preliminary design.
- Cooperative Agreements between Caltrans and STA on preliminary design.

Future express lane agreements needed for the initial segments in the MTC Program:

- Enforcement agreement between MTC and CHP
- Toll collection and RCSC operations between MTC and BATA
- Express lane maintenance agreements between MTC and Caltrans
- Possible agreement between MTC and BAIFA assigning certain express lane responsibilities from MTC to BAIFA.
- Possible agreements among or between MTC, Caltrans and CMAs addressing project responsibilities for delivery of civil projects.
- Potential Memorandums of Understanding (MOUs) with VTA and ACTC on business rules and interoperability.
- Possible agreements between MTC and CMAs on the use of express lane toll revenue.

CHAPTER 6 TECHNICAL REQUIREMENTS

6.1 SYSTEM ARCHITECTURE

MTC express lanes will require a system of equipment, software and communication links to control the facility. The base of all these components come from the traditional tolling industry and either replicate the infrastructure used for single point tolling or have slight modifications to function in an open road tolling (ORT) scenario. Similar systems have already been deployed in the Bay Area and a similar architecture will be used for this project with adjustments made based on lessons learned and/or advances in technology.

MTC has a Regional ITS Architecture that includes express lanes as shown below in Figure 6-1. The conceptual system architecture is depicted in Figure 6-2 and includes the lane equipment, the central systems and the interfacing systems. The architecture is meant to be descriptive and does not dictate final design; rather, it is intended to provide a conceptual operating idea. A description of these components follows.

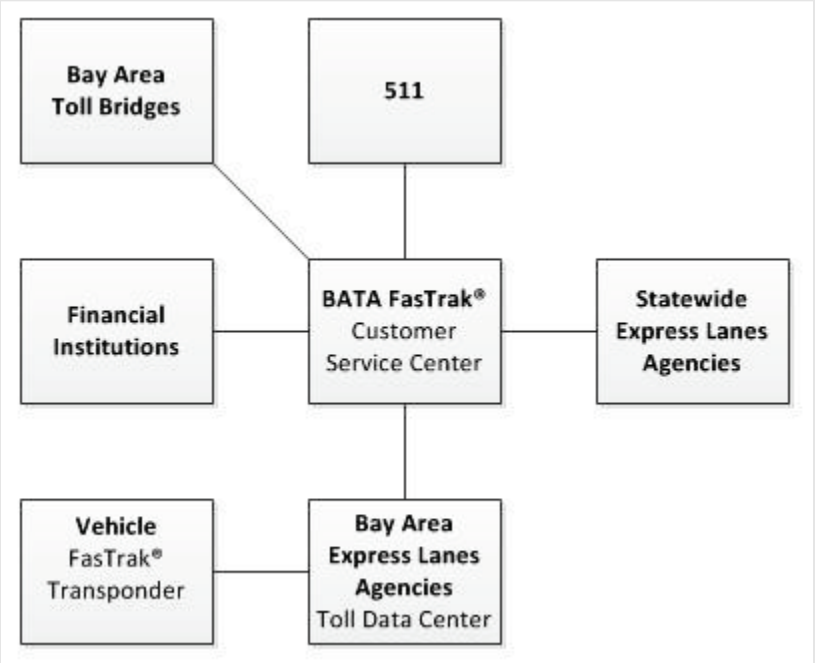


FIGURE 6-1: REGIONAL ARCHITECTURE[1]

[1] Bay Area ITS Architecture 2011 Update. Metropolitan Transportation Commission. April 23, 2012

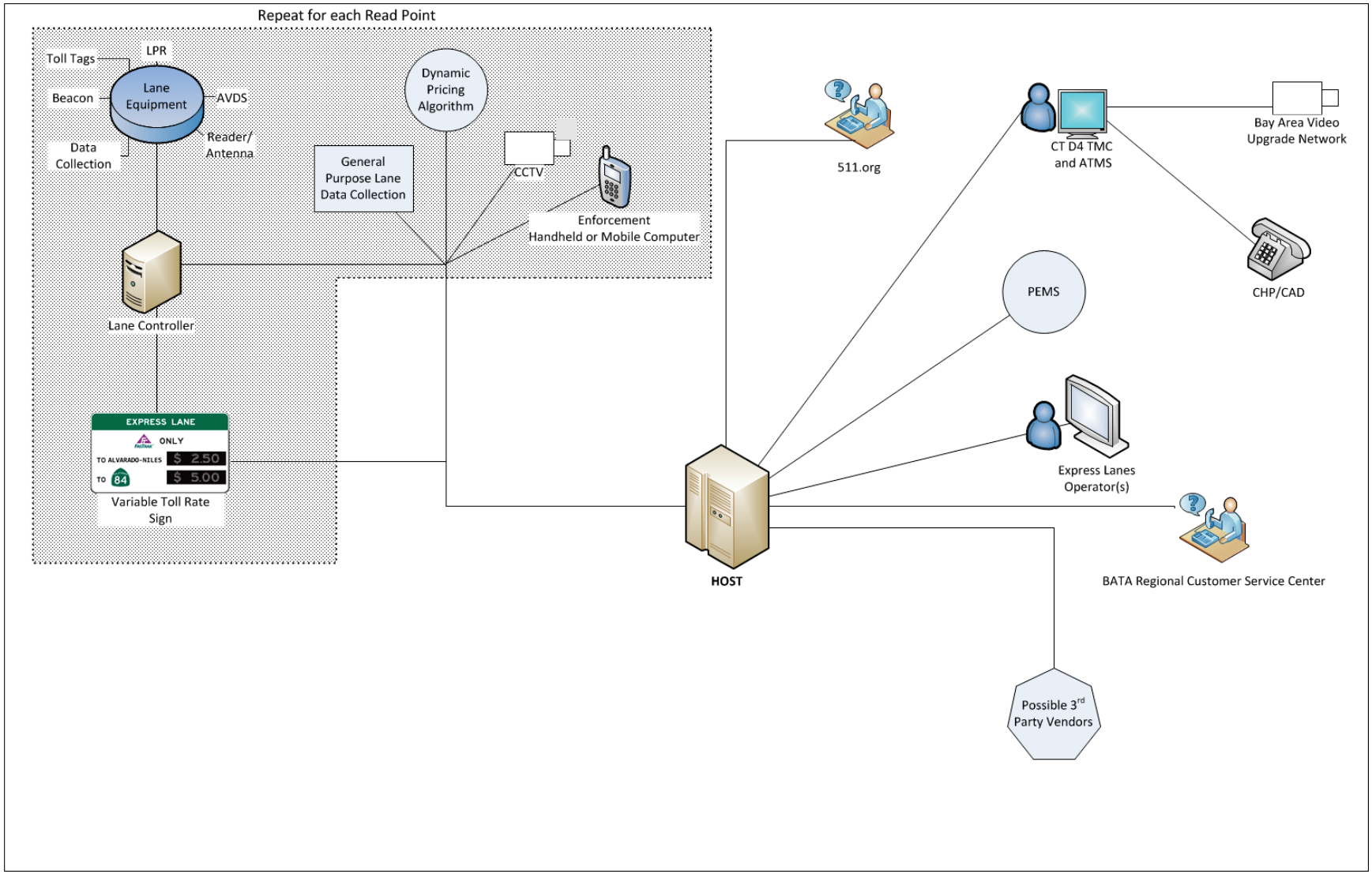


FIGURE 6-2: EXPRESS LANE SYSTEM CONCEPTUAL ARCHITECTURE

6.1.1 AUTOMATED VEHICHLE IDENTIFICATION (AVI)

The AVI equipment is the physical equipment used to identify an individual vehicle for tolling. At the heart of the AVI system is the antenna, reader and toll tag.

6.1.1.1 FASTRAK® READER/ANTENNA

The antenna typically will be mounted on an overhead gantry or mast arm and connected to the reader mounted on the sign post. The antenna will emit a radio signal forming a read zone beneath the gantry. As a vehicle enters the read zone, the toll tag in the vehicle will reflect back the unique toll tag ID, identifying the vehicle. A sample read zone is depicted below in Figure 6-3.

The reader and toll tag are based on Radio Frequency Identification (RFID) technology. In California, the RFID is mandated by Title 21 Specification to communicate using a frequency of 915 megahertz (MHz). Title 21 legislation was established to ensure that electronic toll collection (ETC) systems implemented in the State of California are interoperable with current and future ETC systems in the State. Across the United States there are a variety of different protocols for tolling, including ISO 18000-6C sticker tags. For this reason a dual reader capable of reading both Title 21 and 6C may be desirable for deployment to assist in interoperability and be ready if there were to be a change in Title 21.

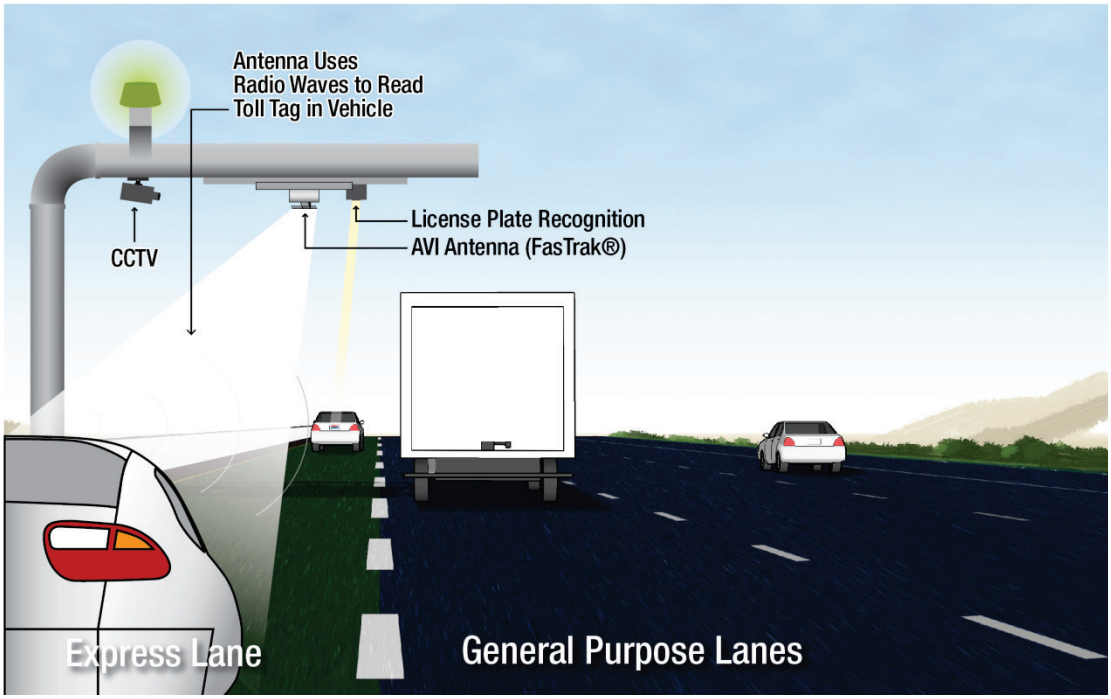


FIGURE 6-3: EXAMPLE TOLL READ ZONE

6.1.1.2 AUTOMATED VEHICLE DETECTION SYSTEM

The Automatic Vehicle Detection System (AVDS) is placed in conjunction with the AVI systems and serves to trigger a message to the AVI system when a vehicle enters the Read Point. The AVDS can consist of inductive loops in the pavement, a light curtain, a microwave sensor, an overhead laser or a treadle.

6.1.1.3 TOLL TAGS

The express lane toll tags will be Title 21 compliant and are commonly referred to as a FasTrak® tag in the San Francisco Bay Area. FasTrak® tags are battery operated and user installed on the inside front windshield of the vehicle behind the rear view mirror. They communicate a unique tag identification number to the reader via the antenna. The existing inventory of tags will work on MTC express lanes, but a switchable toll tag will be required for eligible toll-free vehicles. In the Bay Area, it has become common to keep the tag elsewhere in the car (glove compartment, center console, inside Mylar bag) and pull it out as the driver passes through the tolling facility. To improve the accuracy of the system, it is much better to have the tags mounted on the windshield and provide a method of declaring toll-free eligibility.

There is a subset of high-end vehicles with windshields that interfere with the ability of tag readers to read a traditional toll tag. These vehicles are issued a toll tag to be mounted on their license plate. There are a number of issues with the license plate mounted toll tags that need to be addressed, including a lower read rate than windshield mounted tags. As described in Chapter 4, these externally mounted toll tags cannot be used to travel as an eligible toll-free vehicle. A mechanism to allow these vehicles to declare as an eligible toll-free vehicle needs to be determined.

The system can be set to cause the toll tag to emit a beep when being read at a Read Point. The beep is a way of communicating a successful transaction to the driver. This is helpful since open road tolling does not have the traditional status signs that toll booths have which indicate toll paid, low balance, or no toll paid. The system can also be set to not emit a beep, if desired. This could be helpful if the desire is to obscure the location of toll readers from the traveling public, making it more difficult to intentionally avoid readers or if reader density is so high that frequent beeping might be an irritation to drivers.

The Los Angeles express lanes implemented and operated by LA Metro employ switchable or self-declaration toll tags, shown in Figure 6-4 below. These tags have a sliding switch to allow drivers to self-declare their occupancy status as one of the following: SOV, HOV 2, or HOV 3+. This allows the toll system to charge the appropriate toll according to the declared occupancy. Other toll-free eligible vehicles are instructed to set their toll tag in a HOV setting to be recognized as a toll-free vehicle. The switchable toll tag offers an advantage for drivers who sometimes use the express lanes as a tolled SOV and other times as a toll-free HOV. The I-495 express lanes in Virginia are also using a switchable toll tag called E-ZPass® Flex™.

In addition to providing the ability for users to self-declare their vehicle eligibility status, the switchable toll tag can be a useful tool in monitoring and tracking vehicle occupancy in the express lanes.

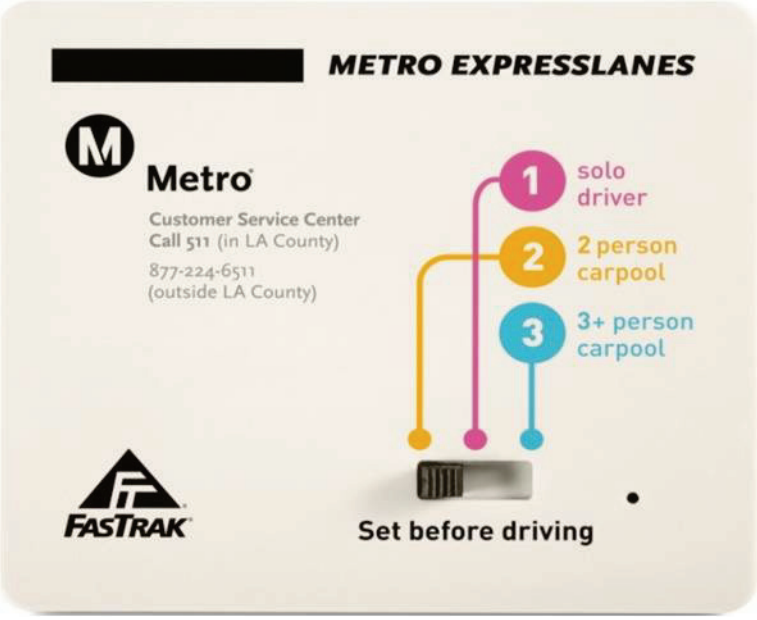


FIGURE 6-4: LA METRO SWITCHABLE TOLL TAG

6.1.2 LANE CONTROLLERS

The lane controller is the component of the toll collection system that manages and automates the real-time control of lane equipment and receives data from in-lane equipment, systems and sub-systems. They will be housed in roadside cabinets and will store updated tag status files, communicate to all devices in the field and the corridor hosts, and record transactions. To provide the level of performance needed for a tolling system, there will be two zone controllers provided at each toll zone for redundancy. An uninterruptable power supply (UPS) should be located at each toll zone controller to ensure performance.

6.1.3 HOST

The Host is the central database and processor for the express lanes toll system. It will communicate with all the individual lane, sign, CCTV, and TMS controllers. It houses all the business rules, Lane Transaction and Trip Transaction data, dynamic pricing algorithm, trip building, file storage, revenue and operational reporting for the express lane toll system.

6.1.4 VARIABLE TOLL MESSAGE SIGN

The Variable Toll Message Sign (VTMS) will be located throughout the express lane corridors to communicate the toll to drivers. The pricing sign will be an integrated Changeable Message Sign (CMS) with a static portion. The CMS signs include a series of LED lights capable of displaying alphanumeric characters. The CMS signs will be sized to display the needed character height and message size according to the standards and guidelines in the MUTCD. Typically, these signs display the toll to travel to specific destinations, but they could also display messages on the status of the lane. Example messages include “HOV ONLY,” “CLOSED,” or “ACCESS ¼ MILE.” The messages will be automatically controlled by the Host. They will also be capable of manual overrides for incident management or other operational reasons. In order to visibly ensure the price shown on

the sign is accurate, there may be a fixed camera with a view of the sign. These cameras can take an image capture every time the pricing changes to give the RCSC verification if a customer disputes a price. An example pricing sign is shown in Figure 6-5 below.

FIGURE 6-5: EXAMPLE I-680SB EXPRESS LANE PRICING SIGN

6.1.5 BEACONS

Beacons will be strategically placed in the proximity of selected toll zones and will alert officers to the presence of vehicles self-declaring as an eligible toll-free user. The beacon will be linked to the Lane Controller and will illuminate when a self-declared toll-free vehicle passes through the Read Point. The color of the beacons should not be red or amber, as those colors tend to be used to alert drivers to stop or slow down. Beacons that are visible upstream and downstream can be used to allow CHP to do roaming enforcement, as described in Chapter 7. These beacons have not been used in the region yet and could present some driver distraction issues, which should be tested before full deployment in the region.

6.1.6 DATA COLLECTION

There is a need for data collection (aka Traffic Monitoring Sensors) of vehicle speed and traffic volumes in both the express lane and the general purpose lanes. This is needed for input into the dynamic pricing algorithm as well as monitoring the overall performance of the corridor. The express lanes may require more frequent spacing of data collection infrastructure than the general purpose lanes. Data collection can be achieved through multiple technologies including in-pavement loops, side-fire microwave sensors, or in-pavement magnetic sensors.

6.1.7 ENFORCEMENT TOOLS

CHP needs tools to enforce HOV occupancy requirements in the field. Handheld FasTrak® readers are mobile devices that query a toll tag for an account number and confirm the declaration status for the last transaction recorded from the toll zone. These readers are currently used on the I-680 and SR-237/I-880 express lanes. They are mobile and wireless, allowing them to be used by motorcycle CHP officers as well as to be easily moved between standard patrol vehicles. Despite these features, handhelds are not a preferred tool for enforcement by CHP because they are bulky and require officers to hold them which is viewed as a safety issue when approaching a vehicle, especially in the dark. An alternate enforcement tool preferred by CHP would be a web portal that

allows officers to access toll tag transaction information through their on-board mobile computers or via central dispatch. Enforcement tools are further described in Chapter 7.

6.1.8 LICENSE PLATE RECOGNITION (LPR)

LPR cameras will be used to capture images of vehicle license plates for any vehicle passing through a toll zone without a toll tag. Optical character recognition (OCR) software is then used to automatically distinguish the actual plate characters. LPR is not 100% accurate and typically some portion of the license plate images will have to be manually read by an operator. OCR can be used in combination with the emerging "fingerprinting" technology to enhance the accuracy of the system. Vehicle fingerprinting technology attempts to match various characteristics in the captured images, including the license plate and the image of the vehicle itself.

6.1.9 CLOSED CIRCUIT TELEVISION (CCTV) CAMERAS

CCTV cameras will be strategically placed in the corridor to monitor the express lanes, the toll equipment, and the general purpose lanes. The cameras deployed as part of the express lanes will be primarily used for express lane operations, but should be integrated with the Caltrans video distribution system. Operator priority can be set so express lane operators always have the highest status for operation of the express lane cameras. There is currently no plan to record the video feeds.

In particular, Caltrans typically places cameras to allow for viewing of messages on the VMS signs. The cameras will be placed on roadside poles and are sometimes placed on mast arms attached to the gantries. The cameras will have pan, tilt and zoom capabilities to allow the express lane operators and the TMC to monitor the freeway and incidents.

6.1.10 MAINTENANCE ONLINE MANAGEMENT SYSTEM (MOMS)

The express lanes will have multiple components integrated to make one complete system. It will be important to monitor all the hardware and software components for errors, failures or any inconsistencies. The industry uses a Maintenance Online Management System (MOMS) to monitor all the components and to send an alert when there is an error. MOMS can be set up to send emails, texts or pages to IT staff, the system integrator or whoever is responsible for repairing the problem.

6.1.11 EXPRESS LANE OPERATIONS

The express lanes will have operators to monitor the system and to coordinate with Caltrans, CHP and other agencies. The operators will have workstations that interface with the toll system and provide the ability to monitor the operations of the express lanes and override the dynamic pricing algorithm if conditions warrant. The location of the express lane operations is yet to be determined.

6.1.12 REGIONAL CUSTOMER SERVICE CENTER (RCSC)

The RCSC is a one-stop shop for the seven Bay Area State-owned bridges, the Golden Gate Bridge and the express lanes to maintain FasTrak® accounts and provide customer service. The RCSC is operated by BATA and will be responsible for the following express lanes tasks:

- Toll tag distribution
- Sending tag status file to the Central Processing System
- Receiving trip-based data from the Central Processing System
- Receiving images from the Central Processing System for violation processing
- Account Management
- Customer Service

There is an existing Interface Control Document which specifies the communication protocol for the express lanes to send and receive data to/from the RCSC. This document will need to be verified for the MTC express lanes and updated as needed to accommodate switchable toll tags.

6.2 OTHER INTERFACES

There are multiple other systems with which the express lanes may interface for improved operations. Descriptions of some of these potential system interfaces are below.

6.2.1 ADVANCED TRANSPORTATION MANAGEMENT SYSTEM (ATMS)

Caltrans District 4 owns and operates the ATMS which is an integrated ITS platform for monitoring and managing the transportation network from the TMC. Currently, express lane operators on I-680 and SR-237/I-880 manually notify the Caltrans District 4 TMC of an incident over the phone. Caltrans then enters the incident into their ATMS. There is the ability to automate this process for MTC express lanes through an interface to the ATMS from the express lane system. The ATMS is also the software used to manage the I-80 ICM project described in Chapter 4.

6.2.2 PERFORMANCE MEASUREMENT SYSTEM (PeMS)

PeMS is the data fusion system for all traffic monitoring in the state, owned and maintained by Caltrans. It takes in data from over 25,000 detectors to provide real time and historical traffic information on both the general purpose and HOV lanes in the State. The existing inventory of roadway sensors in the corridors is part of the PeMS system and can be used for monitoring the express lanes and general purpose lanes. In addition, any detection equipment deployed for MTC express lanes should be integrated into PeMS. Data from PeMS will not be used for the speed input into the dynamic pricing algorithm due to latency and downtime issues within the PeMS system.

6.2.3 511.ORG

The Bay Area traveler information website (www.511.org) and phone service is the regional source for information on transit, traffic, ridesharing and bicycling, owned and operated by MTC. Currently, 511 does not display information on the status of existing express lanes, but may in the future. There is a desire by MTC for 511 to take advantage of any CCTV feeds and traffic data collection deployed for express lanes for inclusion in their system. Additionally, 511 currently disseminates travel times and could in the future provide travel times in both the express lanes and the general purpose lanes as well as display the current price to travel on express lanes. Provision should be made for 511 to have direct access to camera feeds, pricing, and all traffic data including speeds, travel times and incident data.

6.2.4 EXPRESS LANE WEBSITE

The express lanes will need a website for public access to project-related information. This website could either be the same as the RCSC website, included in 511.org, or a stand-alone website. In addition, there could be a mobile application (maybe as part of 511 apps) or other forms of social media (e.g., twitter, Facebook) to communicate information.

6.2.5 COMPUTER AIDED DISPATCH (CAD)

CHP owns and operates the CAD system to track incidents and officer response. There is currently an interface between CAD and Caltrans' ATMS, which is not being used. If there is a desire to automate and interface between the CHP CAD and the express lanes operators, an interface would need to be developed between the express lanes and either the CAD or the ATMS at a minimum.

6.2.6 NEW ADVANCED TOLL COLLECTION AND ACCOUNTING SYSTEM (ATCAS II)

It is possible that conversion of the HOV approach lanes at the three bridge approaches to express lanes will be achieved by building off of the existing bridge toll system, referred to as ATCAS II. This possibility will be explored further when system requirements are developed.

6.3 COMMUNICATIONS

The communication design will realistically utilize a combination of existing fiber, new fiber, leased lines and wireless. The network will be Ethernet-based and utilize field equipment cabinets and communications hubs to support the entirety of the express lane project. The network should be designed and installed with physical redundancy in mind. If physical redundancy is not available, redundancy using leased telecommunications infrastructure should be evaluated. The design needs to take into account all the data needs for the current and planned usage of the express lane program.

There is currently no existing agency-owned field-to-center communications infrastructure in the express lanes project area. The field-to-center and system-to-system communications should be designed and implemented to fully support communications to the field devices and between physically separate systems using leased infrastructure. These communications links should be properly sized and have redundant links to prevent or minimize system downtime. The leased infrastructure should be implemented such that the communications network is private and does not traverse the open internet. The communication infrastructure should be designed to handle all of MTC's ITS projects.

6.4 DYNAMIC PRICING ALGORITHM

As described in Chapter 4, there will be zone-based pricing that will be dynamically set to manage the demand of traffic in the express lanes. An algorithm will be developed to determine the price in each zone at any given time. The pricing algorithm will have the capability to set a minimum toll and a maximum toll. The algorithm will use current speeds on the express lanes to calculate the price and can take into account the speed of the general purpose lanes. The price will be updated on a reasonable interval so travelers are not seeing a constantly changing price and the price will

only vary by a designated amount. Although the algorithm will be automated, it will need to be monitored to ensure it is effectively responding to operating conditions. After a period of performance, the algorithm and the designated interval of pricing change may need to be refined. The toll algorithm will need to provide for the ability for operators to manually override when conditions warrant (e.g., for incident management and routine maintenance). The system will need to adjust for the time it takes a vehicle to travel from a pricing sign to a reader to ensure each customer is charged the price shown on the sign when that vehicle entered the express lane. For example, a vehicle may drive under a pricing sign, but the toll may change by the time the vehicle reaches a downstream toll zone. In this case, the toll system would need to apply the toll that the driver saw on the pricing sign.

6.5 AUTOMATED OCCUPANCY

There are two emerging technologies to detect and communicate the number of occupants in a vehicle. The first is infrared cameras capable of detecting the number of people in a vehicle. The second is interrogation to the vehicle on-board unit (OBU) to get occupancy based on seat detectors in the vehicle. OBU's are used in newer vehicles to control airbag operations, seat belt warnings and other functions.

Fully automated enforcement has not been deployed to date in any express lanes and there are a number of obstacles that must be overcome, including validity in court, privacy concerns and accuracy. Even though automated occupancy detection may not be used for violations, it may be helpful information for CHP to have even if not entirely accurate.

Automated occupancy is an experimental market and, in order to determine its applicability and reliability, a technology demonstration from multiple vendors could be set up to see the latest in the industry. SANDAG and some other express lane operators are also looking at automated occupancy detection, and this project can learn from their findings.

6.6 RADIO FREQUENCY INTERFERENCE

The AVI system relies on radio frequency (RF) communication at a frequency of 915 megahertz. Radio frequency is notorious for bouncing, reflecting and causing general interference issues. The Federal Communications Commission (FCC) requires a license for anybody operating RF in this band to help control interference issues. Prior to any deployment, a radio frequency survey should be performed, along each corridor at the toll zones, to determine any potential conflicts. Periodic radio frequency interference surveys may also need to be performed once the lane is operational to maintain toll system integrity. Conflicts can affect the physical placement of readers and can influence the selection of the ultimate communications technology to be employed.

6.7 PRESERVE FLEXIBILITY FOR FUTURE TECHNOLOGIES

In order to design and build a system ready for traffic in 2015, the technologies will need to be determined shortly after the adoption of this Concept of Operations. It can be assumed that Title 21 technology will be used, as a change in technology will be difficult in the short term. To the extent possible, the system should be built with flexibility in mind to allow for use of emerging technologies, including 5.9 gigahertz RFID, ISO 18000-6C windshield sticker tag and Global

Positioning System (GPS) technologies. Under new federal requirements, national interoperability will be required by 2016. The standards for national interoperability have yet to be determined, and each tolling agency will have to make adjustments as details emerge. Caltrans is responsible for maintaining the California Title 21 specification for electronic toll collection. Any changes to Title 21 would have an effect statewide and require support from CTOC.

6.8 NATIONAL TRANSPORTATION COMMUNICATIONS FOR ITS PROTOCOL (NTCIP)

The National Transportation Communications for ITS Protocol (NTCIP) is a family of standards being jointly developed by the American Association of State Highway and Transportation Officials (AASHTO), the Institute of Transportation Engineers (ITE), and the National Electrical Manufacturers Association (NEMA). These standards should be used in the selection of hardware, infrastructure and software to ensure greater interoperability and adherence to national standards.

6.9 SYSTEM REDUNDANCY, BACKUP AND SECURITY

It is important that there be redundancy with critical pieces of equipment and that all data is backed up on a routine basis to minimize revenue loss in the event of equipment failures, communications losses, theft or destruction from an accident. An Uninterruptible Power Supply (UPS) should be deployed for battery back up in the case of power failure. In order to prevent theft, lockable pullboxes and cabinets should be utilized. The system and network also need to be designed to protect against hacking and to keep personal identifiable information secure. Reliability of the revenue stream is important to maintain the financial integrity of the express lanes to cover operations and maintenance costs and to meet obligations to bondholders, if any.

6.10 INTEROPERABILITY WITH ALAMEDA AND SANTA CLARA PROJECTS

Currently, there are two operational express lanes in the Bay Area, SR-237/I-880 (VTA) and I-680 SB (ACTC). Although there is no plan to operate these express lanes from the same software platform, there will be a need in the future for these systems to be more closely integrated with the MTC express lanes. For instance, there may need to be a coordinated pricing algorithm for express lanes on I-680 in Contra Costa County and I-680 in Alameda County to manage demand more efficiently along the entire corridor. It will also be necessary for toll systems to communicate in the event of express lane closures.

The ability for switchable toll tags to be properly read and processed by the existing express lanes toll systems must be resolved.

6.11 EQUIPMENT LIFECYCLE AND SPARES

All equipment has a natural lifecycle that will need to be planned for, typically assumed to be 10 years in the tolling industry. There are components that can have a shorter lifecycle (e.g. network switch, monitors) and will need to be replaced more frequently. There is also a technology lifecycle that should be accounted for in the 5-10 year range. Routine maintenance and preventative replacements will help to ensure unplanned outages. The lifecycle of all equipment should be

planned for and properly financed ahead of time. Spare parts should be acquired and on hand to keep the system running in case of a failure. Ten percent is a typical spare parts quantity used.

6.12 FAILURE SCENARIOS

The express lane system will be designed with all potential failure scenarios planned for with redundancy, failover plans, or other mechanisms to minimize downtime. Potential failures include loss of power to a reader, physical damage to a roadside cabinet or interruptions in third party communication service. There will be physical redundancies, battery backup and duplication of storage to ensure transactions are never lost. The maintainer of the systems will have pre-designated response times to failures and alert systems to notify of outages.

CHAPTER 7 ENFORCEMENT & INCIDENT MANAGEMENT

To maintain an acceptable level of operational performance and system integrity, adequate enforcement on MTC express lanes is critical. Enforcement efforts will be a combination of visual enforcement by CHP officers along with automated toll system enforcement strategies to ensure that vehicles using the express lanes follow adopted toll policies and pertinent vehicle codes regarding payment of tolls, eligibility and legal ingress/egress of the express lanes.

7.1 TYPES OF VIOLATIONS

For the purposes of express lane enforcement, violations are classified into three types: (1) toll violations, (2) eligibility violations and (3) buffer crossing violations. As described in Chapter 4, the requirement for eligible toll-free vehicles to declare their eligibility status will allow the toll system to automate the toll violation process. The CHP will enforce eligibility violations, including violation of the occupancy requirements for toll-free travel, and buffer-crossing violations. Toll violations will be automatically enforced through the LPR system. The flowchart shown in Figure 7-1 illustrates how automated toll system enforcement will work in conjunction with manual enforcement by CHP officers. As shown, CHP officers would only be expected to visually observe vehicles when alerted by an enforcement beacon, which is triggered when a self-declared toll-free vehicle passes through a toll zone. Vehicles without a valid toll tag read will be handled via LPR for matching the transaction to an account or for issuance of a toll violation. Business rules for the issuance of toll violations are to be determined by MTC.

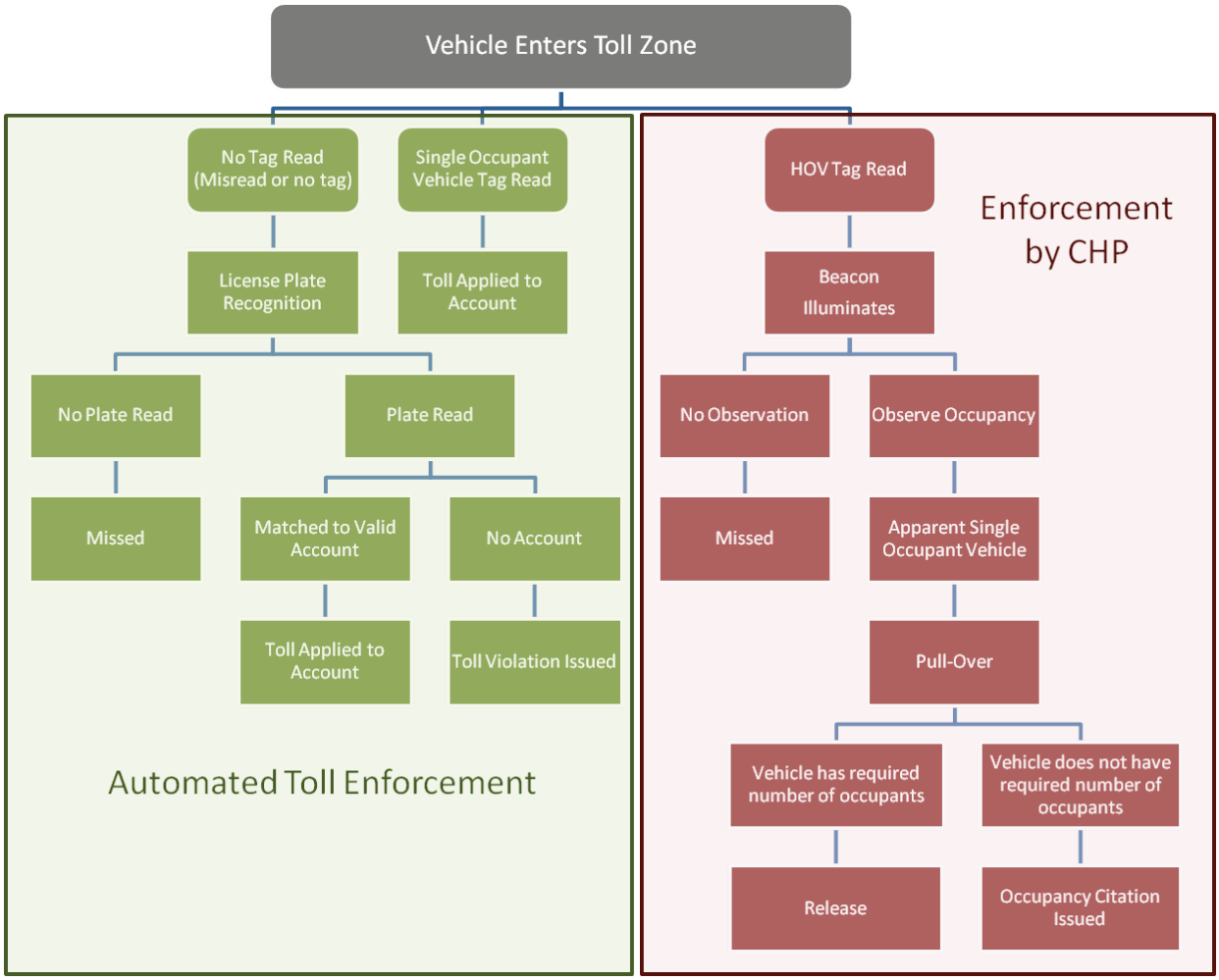


FIGURE 7-1: EXPRESS LANE ENFORCEMENT PROTOCOL

7.1.1 ELIGIBILITY VIOLATIONS

The CHP will be responsible for enforcing the eligibility requirement for the express lanes. Eligible toll-free vehicles will be required to declare their eligibility status using a switchable toll tag, as described in Chapter 4. CHP have expressed concern that switchable toll tags could be a driver distraction. To alleviate some of these concerns, drivers will be instructed to set their switchable toll tag before making their trip. Once the toll tag is set, a driver would have no need to change the switch setting. Enforcement tools described in the following sections will allow CHP officers to determine whether a driver has changed the switch setting on the toll tag while driving on the express lanes.

Enforcement beacons will be installed at tolling zones and in close proximity to CHP observation areas throughout the corridor. The beacons will be located to allow CHP officers to clearly associate vehicles with the beacon. As described in Chapter 3, observation areas provide a location for CHP officers to park and observe vehicles in the express lane. The enforcement beacons will ideally be visible to patrolling officers and officers parked either upstream or downstream of the beacon, but not be visible from the other direction of travel or otherwise cause distraction to motorists. However, to preserve the ability to disguise toll zones that are not operable, it may not

be advisable to design all beacons to be visible to vehicles upstream of toll zones. The beacons will display a distinct light color to indicate that a self-declared toll-free eligible vehicle has passed through the toll zone. The CHP will monitor the beacons, and when alerted, will visually inspect the vehicle to ensure that it meets eligibility requirements (i.e., whether the vehicle has the required number of vehicle occupants or has a DMV-issued clean air vehicle sticker). Users who commit a violation will be issued a citation by the CHP for violating the HOV policy for the facility.

The following sections describe CHP enforcement tools that may be deployed to aid enforcement of eligibility violations. Selecting specific enforcement tools for the MTC express lanes will require further analysis (technical feasibility, cost, etc.).

7.1.1.1 HANDHELD FASTRAK® READER

Handheld FasTrak® readers are wireless devices that can assist CHP officers in verifying the declaration status of vehicles that are pulled over by providing officers information about the last transaction recorded. Handheld readers that have been provided to CHP officers for enforcement of the two existing Bay Area express lanes are underutilized. This is due to the lack of interoperability between facilities, the size of the readers which makes them cumbersome to carry, and the need for officers to keep their hands free when approaching a vehicle for safety reasons. Any deployment of handheld readers for MTC express lanes will require interoperability between all facilities. Also, the readers will need to be small enough to be easily attached to the officer's utility belt or carried in a pocket. The reader will be designed to read the account number from the toll tags and determine the declaration status of the toll tag for the last transaction recorded at a toll zone. The reader will need to provide current data and documentation for CHP of eligibility violations so that citations hold up in a court of law. To protect officer safety and minimize the duration of a pullover, the handheld readers should provide quick access to toll tag information.

7.1.1.2 WEB PORTAL FOR CHP ON-BOARD COMPUTERS OR DISPATCH

An alternative to the handheld readers is to provide CHP with a web portal to the express lane customer service center to access the declaration status of a toll tag when a vehicle is pulled over. Web portal access could be integrated into CHP vehicle on-board computers or could be provided to CHP dispatch. If integrated into the on-board computers, CHP officers could query the toll tag declaration status by typing in the toll tag identification number affixed to the toll tag. Alternatively, web portal access could reside at CHP dispatch. In this scenario, officers in the field would relay a toll tag identification number to CHP dispatch over their radios to query the declaration status. As with the handheld readers, this alternative would need to provide documentation for CHP to use in a court of law.

7.1.1.3 OTHER POSSIBLE ENFORCEMENT TOOLS

While space constraints in the current CHP vehicles preclude the installation of additional equipment, the use of additional tools listed below may be considered in the future if vehicle space limitations are addressed and enforcement needs warrant their use. Specific enforcement protocols would have to be developed and coordination with CHP's Fleet Operations Section would be required if any of these tools are to be used. Requiring an officer to perform any task while driving may be considered to be a potential safety issue and must be discussed with CHP.

- Mobile License Plate Readers: These are progressive scan cameras that are mounted to patrol vehicles to capture license plate images of traveling vehicles. This equipment is most

useful in eligibility enforcement if license plate data is included in carpool declaration, either by linking license plates to FasTrak® accounts, which BATA presently does not require, or through a carpool registration system that identifies carpool vehicles by license plate. The license plate reader system would include a triggering mechanism for an officer to use to initiate capture of a configurable number of images. OCR is then used to process and extract the license plate characters. The extracted license plate characters can be cross-referenced to a toll tag-to-plate list by making a data inquiry to the RCSC to determine the toll tag declaration status. The officer can use this information to verify visual observations to determine if an eligibility violation has occurred. Mobile license plate readers could serve as an additional tool for the CHP enforcement effort and could be considered if FasTrak® business rules were changed. CHP currently has a LPR program and vehicles equipped with LPR cameras, although CHP has indicated that they can't dedicate these vehicles for express lane patrol. Further discussions with CHP would be necessary if mobile license plate readers are to be used for express lane enforcement.

- Mobile Enforcement Readers (MERs): The use of a MER permits express lane enforcement activities by officers while traveling at highway speeds (see Figure 7-2). The MER is mounted on and within a patrol vehicle and consists of an ETC reader, control/display unit and an antenna. The control/display unit is designed to be used while safely driving the patrol car and is mounted in the front seat of the vehicle within easy reach of the officer. A directional antenna is mounted on the vehicle, allowing the MER to determine the toll tag declaration status of a vehicle traveling alongside the enforcement vehicle in the express lane. The MER subsystem will then make a data inquiry to the RCSC database to determine the declaration status of the toll tag, which is then displayed to the CHP officer.

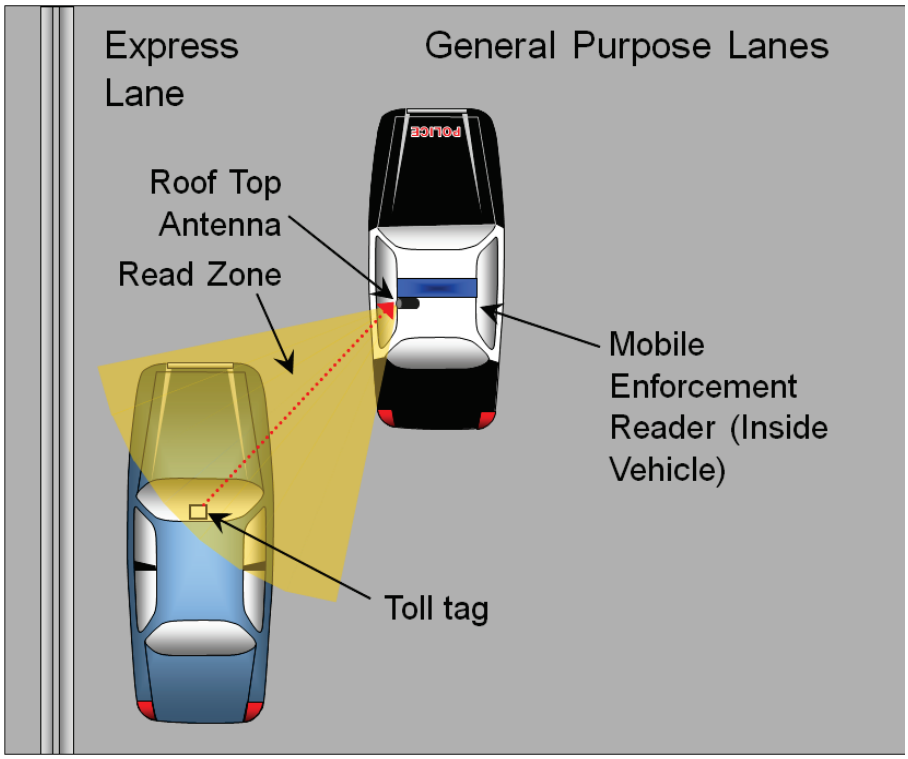


FIGURE 7-2: MOBILE ENFORCEMENT READER (MER) DIAGRAM

7.1.2 TOLL VIOLATIONS

Toll violation enforcement will be accomplished through the use of LPR. The LPR cameras will take a picture of the license plate of any vehicle that passes through a toll zone without a properly mounted toll tag. The license plate image will then be used to associate the transaction(s) with a valid account or to issue a toll violation to users without an established account. Business rules will be implemented to define protocol for first-time violators and vehicles with malfunctioning toll tags.

Secondary enforcement of vehicle eligibility will be accomplished with CHP resources deployed in the corridor. Enforcement beacons will provide an indication of whether a vehicle has a valid toll tag allowing CHP to cite vehicles for eligibility violations while the automated system would cite vehicles for a toll violation.

7.1.2.1 LICENSE PLATE RECOGNITION SYSTEM

LPR cameras will be installed at every toll zone. The primary components of the LPR subsystem are a camera, a light source, and an image processor. Cameras and lights will be mounted to the toll zone structure above the express lane to capture the rear license plate for each vehicle that fails to record a valid toll tag read. When a toll tag ID is not read and recorded, a vehicle detector installed at the toll zone will trigger an attempt to capture the vehicle license plate. The transaction record will be transmitted to the central processing system for handling. All images, including those that cannot successfully be processed by OCR, will be indexed to the corresponding transaction record built by the toll zone controller. The image processor will periodically transmit images to the central processing system. The system will protect PII.

The use of full color cameras would allow the subsystem to recognize vanity and specialty plates currently used that are not standard seven character license plates. A feature on these plates and its color (emblem, a shape, etc.) can be used as a starting point in recognizing the characters position on the plate.

7.1.3 BUFFER CROSSING VIOLATIONS

The CHP will be responsible for enforcing the ingress and egress restrictions for the express lanes. As described in Chapter 3, portions of the express lanes will be separated from the general purpose lanes by a solid double-striped pavement marking. Legal access into and out of the lane in these areas will be restricted to designated access points. Vehicles that illegally enter or exit the facility will be subject to a vehicle code violation citation from the CHP.

7.1.4 OFFICER OBSERVATION

CHP enforcement on MTC express lanes will be primarily on a contracted overtime basis and can be categorized as stationary enforcement from a designated observation area or as a moving patrol. Enforcement may be targeted during peak periods when violations are most problematic.

For stationary enforcement, the officers park on the shoulder or in designated observation areas where they can observe an enforcement beacon and have a clear view of the vehicles to determine eligibility. As noted in Section 3.2.6, observation areas are to be designed according to the Caltrans HOV Guidelines to provide a high level of officer safety as well as ease of access and ability to

accelerate. Stationary enforcement is the most practical way for officers to enforce adherence to eligibility requirements, but this strategy severely limits the area that an officer can see to enforce ingress/egress violations.

Patrols that are moving with the flow of traffic provide a higher visual presence of officers throughout the corridor which can serve as a deterrent to violators. These patrols are also the more practical method for enforcing illegal weaving in and out of the express lane as the officers will have a greater view of the corridor than what can be seen from the stationary observation points.

The periodic deployment of a high presence of CHP officers (2-3 times the normal amount of officers patrolling a corridor) has proven successful on existing Bay Area express lane facilities. This strategy provides several advantages:

- Able to provide higher level of CHP coverage and presence throughout the corridor.
- Provides more flexibility to move officers between stationary and moving patrols as needed
- Allows officers to work in teams where one officer identifies a violator and radios to a partner who writes the citation
- High profile presence acts as a deterrent

Due to costs and other difficulties associated with deploying additional officers on overtime, it is not practical to make use of these high presence days more than 2 -3 three times a month. This strategy can be more effectively employed when targeted during time periods and in locations where violations are most problematic. It may also be desirable to have a high presence of CHP enforcement when express lanes are first opened to establish compliance.

7.2 INCIDENT MANAGEMENT

The partnering agencies involved in the operations of the express lanes, including BATA, MTC, CMAs, Caltrans and the CHP, should have a clear understanding of roles and responsibilities regarding incident management to maintain express lane operations. Procedures for clearing of the incident and operations of the express lane during the incident should be documented in an incident management plan prior to the opening of the facility. It is assumed that the current process in place for the management of incidents by the CHP and Caltrans will continue per the existing CHP-Caltrans Joint Operational Policy Statement.

Incident management will be coordinated between the Transportation Management Center, the CHP and the FSP. The Bay Area Incident Management Task Force, which includes each of these agencies as members, can serve as a forum to facilitate coordination. In the event that express lanes are used to divert traffic during an incident, or if an incident causes conditions in the express lanes to deteriorate, the express lane operator and RCSC must be notified. The express lanes pricing signs will display a message such as “NO TOLL” and no toll will be charged when there is an incident affecting the express lane, but there may be instances when the RCSC is required to reverse any transactions that are recorded during the time of the incident.

7.2.1 EXPRESS LANE OPERATIONS

The express lane may be operated from a leased facility, MTC's offices, the Caltrans TMC or another location. There will be operators during the hours of operations to monitor the lanes, coordinate with Caltrans and CHP during an incident and work with the Regional Customer Service center partially for transaction reversal during an incident. The operators will need access to information from CHP CAD, the ICM projects, 511.org and the express lane systems.

7.2.2 TRANSPORTATION MANAGEMENT CENTER (TMC)

The Caltrans TMC is staffed by Caltrans operations staff as well as representatives from the CHP. The TMC includes the District Communications Center (i.e., the radio room), which is staffed by Caltrans maintenance. The TMC serves as the command center for traffic operations and coordination of activities associated with incident management. The TMC will coordinate with CHP officers on the scene of the incident and assist in the dispatch of Caltrans maintenance resources, emergency vehicle response and FSP as required.

7.2.3 CALIFORNIA HIGHWAY PATROL (CHP)

During an incident, the highest-ranking CHP officer is the on-scene incident commander. The CHP incident commander is responsible for traffic control and coordination of the incident. Information about the incident is relayed via CHP's Computer Aided Dispatch (CAD). In addition to the incident commander, a CHP officer assigned to manage the CHP's TMC staff is responsible for the CHP procedures for incident communications between CHP dispatch, officers at the scene of the incident and the TMC.

The CAD is a computerized listing of all incidents within California. The CAD is maintained by the CHP and provides real-time information regarding incidents. The public CAD is a package of the primary CAD with elements eliminated for safety and/or privacy considerations. The public CAD is utilized by transportation information organizations including 511 and TV and radio stations. The public CAD is a subset of the media CAD and is distributed at http://cad.chp.ca.gov.

7.2.4 FREEWAY SERVICE PATROL (FSP)

As described in Chapter 5, FSP drivers patrol the Bay Area freeways during hours of peak congestion, providing response to incidents including clearing of debris, towing and minor auto repairs. Each of the major freeways in the Bay Area has a predetermined schedule and allocation of FSP resources based on historical data regarding the average number of incidents for the corridor. The existing FSP resources for each of the express lane corridors should be reviewed on a case-by-case basis to determine the adequacy to address the operational needs of the express lanes. Additional FSP resources should be contracted if necessary.

CHAPTER 8 MOTORIST PERSPECTIVE

8.1 INTRODUCTION

This chapter describes users' perspectives through operational scenarios for MTC express lanes. The operational scenarios fall into three categories with 2 scenarios in each category. The categories and scenarios are listed below.

Customer focused scenarios:

- Becoming a customer and managing my account
- Using the express lanes

Customer service center scenarios

- Account activity
- Violation processing

Field-based Scenarios

- Enforcement
- Incident response

8.2 CUSTOMER FOCUSED SCENARIOS

8.2.1 BECOMING A CUSTOMER/MANAGING ACCOUNT

Becoming a customer of the MTC express lanes is essentially the same as becoming a FasTrak® customer. Only electronic toll collection will be in place for the express lanes as opposed to the toll bridges where cash payment is still accepted. A person purchases a toll tag, registers the tag, and then mounts the tag on his or her vehicle, usually on the windshield. Alternatively, if pay-by-plate is permitted, the customer can register their license plate for a pay-by-plate account if the customer will be using the express lanes as a toll-paying vehicle. As discussed in Chapter 4, the preferred method to declare being a carpool is via the use of a switchable toll tag. To be recognized as a toll-free HOV, drivers will be required to carry a switchable toll tag set in an HOV setting. Part of the purchase of the toll tag price becomes the initial balance available for tolls. As part of the registration process, a customer can link a credit card to his or her FasTrak® tag or can opt to pay cash to replenish the account.

The RCSC is responsible for toll tag distribution and account initiation and management. The RCSC is the primary contact between the customer and toll system. Once an account is established, customers can securely manage their accounts to:

- Update their user account information (such as credit card information and password).
- Track account activity.
- Update account type.
- Link one or more license plate numbers to the account. (If a tag is not read when a vehicle passes through a toll zone, a camera image of the vehicle's license plate is captured. If the

license plate is linked to a valid account, the toll is deducted from the account and no violation is issued.)

Once an account has been established, the customer can use the express lane system, as described in the next section.

8.2.2 USING THE EXPRESS LANES

There are two ways to use the express lane system, either as a carpool with the requisite number of occupants or as a toll payer. For both sets of customers, using the express lanes will be somewhat different from using the existing HOV lanes or toll bridge facilities in the Bay Area. Before making a trip, carpoolers will need to "declare" that they meet the carpool definition. As discussed in Chapter 4, the preferred method to declare being a carpool is via the use of a switchable toll tag. The switchable tag allows the user to indicate status (toll payer or carpool) by flipping a switch on the device. That means that a driver wanting to travel in the express lanes as a carpool will be required to acquire a switchable toll tag. If a driver will never travel in the express lanes as a carpool, a standard FasTrak® toll tag can be used and his or her account will always be debited the prevailing toll amount whenever traveling in the express lanes. Prior to starting their trip, the driver will simply select the position of the switch on the switchable toll tag that corresponds to the total number of people in the car. The system will recognize the declaration and handle the account as follows:

- If the switch is set to indicate that there are enough people in the vehicle to qualify as a carpool, no toll will be charged to the account.
- If the switch is set to indicate that there are not enough people in the car to qualify as a carpool, or the FasTrak® tag is not a declarable tag, the prevailing toll will be charged if the vehicle enters an express lane. The toll will be charged based on the number of toll "zones" a motorist passes through and how congested the facility is. The express lane facilities will be broken into toll zones with logical termini to effectively manage the demand. It is estimated that the toll zones will be approximately 3-5 miles in length. In order to dissuade motorists from weaving in and out of the express lanes, motorists will be charged a toll for each express lane zone they travel into or through, regardless of the distance they travel within that zone.

Overhead signs will display the toll amount to given destinations. The destination(s) will correspond to the termini of toll zones and will be based on an analysis of traffic patterns within the corridor. The driver will not be charged more than the toll that is displayed for the current zone and the major destination as displayed on the pricing sign upon entering the lane, even if the price increases after entering the lane. Generally speaking, either one or two destinations will be displayed on a given sign. A driver could choose to not enter the express lane in the first zone and then enter further downstream. Or, a driver could enter the first zone and then exit the express lane before entering the second zone. In either case, the driver would only be charged for the zone(s) traveled in and for the toll(s) displayed when first entering.

The toll prices will generally be set to maintain near free-flow speeds. The primary benefit that the express lanes provide is a reliable, quick trip for carpools or for people who wish to pay for the benefit. It is critical that the pricing is set to assure that reliable, quick trip. In the event that the speed drops below 45 mph in the express lane, the lane would revert to HOV-only mode and the

pricing signs would display "HOV ONLY". SOVs would no longer be permitted to enter the lane. Business rules to be developed by MTC will establish policies for toll-paying vehicles that are already in the express lane when it reverts to HOV-only mode.

Based on the price displayed on the toll signs, motorists will decide whether to enter the express lane or not. Drivers can enter/exit the express lanes at any location except those where the express lane is separated from the general purpose lanes by a double solid line. If the choice is to enter, the FasTrak® toll tag or license plate is read by field equipment (toll tag reader or camera). Information to identify the account is transmitted to a zone controller, then the corridor host and eventually the central processing system for eventual submission of a trip transaction to the customer service center where the tolls are charged to the appropriate accounts.

As discussed in Chapter 4, the express lanes will likely initially operate during the same hours as the HOV lanes operate currently (generally Monday through Friday, 5 a.m. to 9 a.m. and 3 p.m. to 7 p.m.) unless modified hours are recommended to improve traffic flow or for consistency among corridors. During other times of day, motorists will be able to use the lanes without paying a toll or being in a carpool.

8.3 CUSTOMER SERVICE CENTER SCENARIOS

8.3.1 ACCOUNT ACTIVITY

Staff at the RCSC manage ETC customer accounts and provide general customer service. They provide this service to all toll tag and pay-by-plate accounts, not just those that use the express lanes. The RCSC collects express lane tolls from customer accounts based on trip transaction records from individual express lane systems. The RCSC also maintains account records for each ETC account. The records at the RCSC allow customers to track their account activity.

The systems and staff at the RCSC also monitor account activity. As the balance in the account drops below a certain threshold, the system either automatically charges a set amount to the account holder's credit card to replenish the account or sends a notice to the account holder indicating that it is time to replenish funds using cash or a check.

8.3.2 TOLL VIOLATIONS PROCESSING

A toll violation occurs when a vehicle passes through a toll zone but does not have a valid ETC account. Toll violation enforcement is primarily an automated task. When the field detection system senses a vehicle without a tag read associated with it, an image of the vehicle's license plate is captured. The image processor will run the image through an optical character recognition routine. The image, the results of the OCR read and a complete transaction record is sent to the RCSC for processing. At the RCSC, the license number will be cross checked against valid accounts. If the plate is associated with a valid account, the account is charged the toll at the time of the transaction. If the plate is not associated with a valid account, the license number will be associated with the owner of the vehicle. A toll violation will be issued to the registered owner of the vehicle.

The violation will be processed in the same manner as any FasTrak® toll violation. A violation notice is sent to the vehicle's registered owner within 21 days of the toll violation. The first notice requests payment for the toll amount and an additional $25 penalty. Depending on business rules

to be developed by MTC, the penalty may be waived for first time violators that sign up for an ETC account, as is currently done for first time violators at the bridges. Violation history will be kept on record. If the registered owner fails to respond to the instructions on the first notice, a second notice will be sent for the toll amount plus a $70 penalty ($25 penalty plus $45 late penalty). Failure to respond to the second notice will result in additional penalties and fees and could lead to withholding the vehicle registration.

8.4 FIELD PERSONNEL SCENARIOS

8.4.1 ENFORCEMENT & CHP-ISSUED VIOLATIONS

An eligibility violation occurs when the driver of a vehicle declares that there is the requisite number of people in the vehicle, but there is not. Eligibility violations cannot be automated cost-effectively with today's technology. CHP officers in the field will be required to enforce vehicle eligibility requirements. When a vehicle passes through a toll zone or past an enforcement observation area in the express lane with a toll tag switched to the carpool position, a beacon will be triggered. The beacons will be lights that display a specific color to indicate that a tag switched to the carpool designation has passed through the toll zone. The beacon will ideally be visible to officers upstream and downstream of the toll zone. A stationary or roving officer that sees the beacon activated can observe the vehicle to determine if it meets the eligibility requirements. If it does not, the officer can stop the vehicle and issue a citation.

Another type of express lane violation is violating the ingress and egress restrictions of the express lane. These restrictions will also be enforced in the field by CHP officers. The majority of the express lanes will be separated from the general purpose lanes by a single dashed line, indicating that vehicles can freely enter or exit the express lane. However, some portions of the express lanes will be separated from the general purpose lanes by a solid striped buffer. Vehicles are not permitted to cross into or out of the express lane when they are separated from the general purpose lanes by a solid striped buffer. If a vehicle crosses the solid buffer, it is a violation and CHP can cite the driver.

8.4.2 INCIDENT RESPONSE

Incidents in the express lane jeopardize the performance of the lane and need to be cleared as quickly as possible. When a major incident occurs in the general purpose lanes, the express lane may be the only viable alternative to get around the scene. In either case, responding to and managing the incident becomes key in the overall operation of the express lanes.

After an incident occurs and is reported, action can be taken. Coordination among the agencies with capabilities and authority is key to effective incident management in general and is even more important when dealing with incidents involving express lanes because of the additional agencies involved and the potential revenue implications. Incident management in a corridor with express lanes will likely be handled in much the same way as incidents in these corridors today. The freeway corridors with express lanes are critical transportation lifelines and responding to incidents is given a very high priority. The primary difference with the express lanes is that the express lanes can be dynamically managed. Toll rates can be revised or eliminated (opening up the express lanes to all traffic). In addition to the pricing signs, the variable message signs can be used

to provide incident related messages. The express lanes may even be able to be used to rush incident response vehicles and first responders to the scene more quickly. Incident management will be coordinated through the express lane operations, TMC, the CHP and the FSP. The highest ranking CHP officer is the on-scene incident commander who is responsible for traffic control. The incident commander will make the ultimate on-site decisions about how to respond to and manage the incident. All decisions affecting the operation of the express lanes will be communicated to the express lane operator.

FSP is key to quick and effective incident management and clearance. In the Bay area, FSP is implemented and managed by the MTC SAFE, Caltrans and the CHP. FSP drivers patrol the Bay Area freeways during hours of peak congestion, providing response to incidents including clearing of debris, towing and minor auto repairs. The roving patrols will respond to incidents and help to clear a majority of the incidents that might affect the express lanes.

When an incident occurs in the express lane so the performance of the express lane degrades below a threshold, the tolls paid by those caught behind the incident will be reversed and tolls will not be collected. The RCSC will be notified of the incident by the express lane operator and RCSC staff will take the steps necessary to reverse the tolls on the account.

APPENDIX A – OPERATING SCENARIOS

MTC Express Lanes - Scenario comparison for Pay-by-plate

		Current Bay Area Express Lanes	No Pay-by-Plate Option		Pay-by-Plate Option for SOVs Only - HOV to Carry Tag		Pay-by-Plate Option for All	
		Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6	Scenario 7
Payment method/ Declaration	SOV	Regular Tag	Regular Tag	Regular Tag or Switchable Tag	Regular Tag or Pay-by-Plate	Regular Tag, Switchable Tag or Pay-by-Plate	Regular Tag or Pay-by-Plate	Regular Tag, Switchable Tag or Pay-by-Plate
	HOV	No tag needed	Regular Tag - Carpool Registration	Switchable Tag	Regular Tag - Carpool Registration	Switchable Tag	Regular Tag - Carpool Registration, or Pay-by-Plate - Carpool Registration	Switchable Tag, or Pay-by-Plate - Carpool Registration
Capital Cost		Low - No LPR	Medium - LPR cost	High - LPR cost + switchable tags	Medium - LPR cost	High - LPR cost + switchable tags	Medium - LPR cost	High - LPR cost + switchable tags
Operating Cost		Low - No license plate image processing	Medium - License plate image processing when no or malfunctioning tag.	Medium - License plate image processing when no or malfunctioning tag.	High - Requires plate reads of SOVs and violators. Possible surcharge to pay by plate accounts to offset operating cost.	High - Requires plate reads of SOVs and violators. Possible surcharge to pay by plate accounts to offset operating cost.	Highest - Requires plate reads of SOVs, HOVs and violators. Possible surcharge to pay by plate accounts to offset operating cost.	Highest - Requires plate reads of SOVs, HOVs and violators. Possible surcharge to pay by plate accounts to offset operating cost.
Impact to HOVs		Carpools shield tag if in vehicle. For the bridge approached Carpoolers would need to shield for the EL, and then unshield for the toll plaza.	Carpools must carry a tag and register.	Carpools must carry a switchable tag.	Carpools must carry a tag and register tag number.	Carpools must carry switchable tag.	Carpools must register tag number (if they have one) or license plate.	If not using switchable tag, carpools must register license plate.
Enforcement		No ability for automated toll enforcement since no LPR. Beacon alerts CHP to vehicles with no tag read. CHP performs visual check to confirm HOV occupancy status.	LPR to capture tagless vehicles who will receive violation in the mail. Beacon to identify HOVs for CHP visual confirmation of occupancy. (see Reliability)	LPR to capture tagless vehicles who will violation I the mail. Beacon to identify HOVs for CHP visual confirmation of occupancy.	LPR to capture tagless vehicles or vehicles without a Pay-by-Plate account who will receive bill by mail for payment. Beacon to identify HOVs for CHP visual confirmation of occupancy. (see Reliability)	LPR to capture tagless vehicles or vehicles without a Pay-by-Plate account who will receive bill by mail for payment. Beacon to identify HOVs for CHP visual confirmation of occupancy.	LPR to capture vehicles without a tag. For HOVs with a tag, a beacon will identify HOVs for CHP visual confirmation of occupancy. For HOVs with no tag, a beacon will not work [insufficient time for the system to process the LP number, confirm carpool registration and illuminate the beacon]. Instead, CHP will use mobile LPRs to identify HOVs for visual confirmation of occupancy.	LPR to capture vehicles without a tag. For HOVs with a tag, a beacon will identify HOVs for CHP visual confirmation of occupancy. For HOVs with no tag, a beacon will not work [insufficient time for the system to process the LP number, confirm carpool registration and illuminate the beacon]. Instead, CHP will use mobile LPRs to identify HOVs for visual confirmation of occupancy.
Policy/Statutory Change Needed		No	Yes - State law requires HOV to have unrestricted access.	Yes - State law requires HOV to have unrestricted access.	Yes - State law requires HOV to have unrestricted access. BATA/BAIFA has to allow Pay-by-Plate accounts.	Yes - State law requires HOV to have unrestricted access. BATA/BAIFA has to allow Pay-by-Plate accounts.	Yes - State law requires HOV to have unrestricted access. BATA/BAIFA has to allow Pay-by-Plate accounts.	Yes - State law requires HOV to have unrestricted access. BATA/BAIFA has to allow Pay-by-Plate accounts.
System Reliability		Medium-Low -The beacons are used to indicate when a valid transponder read does not occur. This causes vehicles to be pulled over unnecessarily by CHP.	Medium - Potential issues because field devices would have to get updates from the system continuously to reflect carpool registration in real-time and show HOV status on beacons.	High - No reliance on HOV occupancy status data being pushed to field devices since switchable tags are used.	Medium - Potential issues with carpool registration because field devices would have to get updates from the system continuously to reflect carpool registration in real-time and show HOV status on beacons.	High - No reliance on HOV occupancy status data being pushed to field devices since switchable tags are used.	Low - Potential issues with carpool registration, especially by license plate, and the use of a beacon for enforcement. The field (beacons/mobile LPRs) would have to get updates from the system continuously, then match with license plate instantly to show HOV status via beacon.	Low - Potential issues with license plate carpool registration and the use of a beacon for enforcement. The field (beacons/mobile LPRs) would have to get updates from the system continuously then match with license plate instantly to show HOV status via beacon.
Bandwidth Requirements		Low	Medium - License plate image captured for all vehicles without a tag	Medium - License plate image captured for all vehicles without a tag	Medium/High - Increased number of license plate images associated with SOVs with Pay-by-Plate accounts	Medium/High - Increased number of license plate images associated with SOVs with Pay-by-Plate accounts	High - Potential for large number of license plate images associated with SOV and HOV Pay-by-Plate accounts	High - Potential for large number of license plate images associated with SOV and HOV Pay-by-Plate accounts
Revenue Loss		High - No LPR for automated toll violation enforcement	Minimal - LPR allows automated toll violation enforcement of cars without a tag.	Minimal - LPR allows automated toll violation enforcement of cars without a tag.	Medium - Leakage associated with plate accounts (misreads, out of state)	Medium - Leakage associated with plate accounts (misreads, out of state)	Medium - Leakage associated with plate accounts (misreads, out of state)	Medium - Leakage associated with plate accounts (misreads, out of state)
Examples		-I-680SB & SR-237/I-880 (Bay Area) -I-15 (Utah), -I-15 (San Diego), -I-10 (Houston), -I-394 and I-35W (Minneapolis) -SR-167 (Washington)	-I-95 (Miami) - HOVs receive a decal when they register and must shield their toll tag. -I-85 (Atlanta) - HOVs must obtain a PeachPass tag and register 15 minutes prior to using lanes.	-I-10 and I-110 (Los Angeles) -I-495 (Virginia)	-I-25 (Denver) - HOVs not required to carry a tag and use designated lanes at toll zones	-Proposed for future express lanes in Seattle		
Overall Rank (1 is preferred, 4 is least preferred)		The analysis concluded that it is prudent to include pay by plate capabilities within our system design. However, when/if pay-by-plate is available to express lane users will depend on the outcome of the new Golden Gate Bridge program. As such, it does not make sense to rank scenarios that do not allow pay-by-plate.			2	1	4	3