METROPOLITAN
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Summary of I-680 Southern Segment Express Lane in Contra Costa County Environmental Technical Analyses: Greenhouse Gas Emissions, Vehicle Miles Traveled and Use by Low-Income Populations

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Section 1: Overview

This report, prepared solely by the Metropolitan Transportation Commission (MTC), summarizes technical analyses of greenhouse gas (GHG) emissions effects, vehicle miles traveled (VMT) effects, and use of express lanes by low-income populations of the I-680 Southern Segment Express Lane project from Alcosta Boulevard to Livorna Road in Contra Costa County (Project). The technical analyses were conducted for environmental review in accordance with the California Environmental Quality Act (CEQA) and National Environmental Policy Act (NEPA). Caltrans approved the technical analyses as the CEQA and NEPA lead agency. The analyses follow the formats and procedures outlined in Caltrans' Standard Environmental Reference. In this summary, the I-680 Southern Segment Express Lane project may be referred to as "I-680 Express Lanes,", "the Project", "I-680 Corridor Project" or "the Build Alternative", depending on the terminology used in the technical report being summarized.

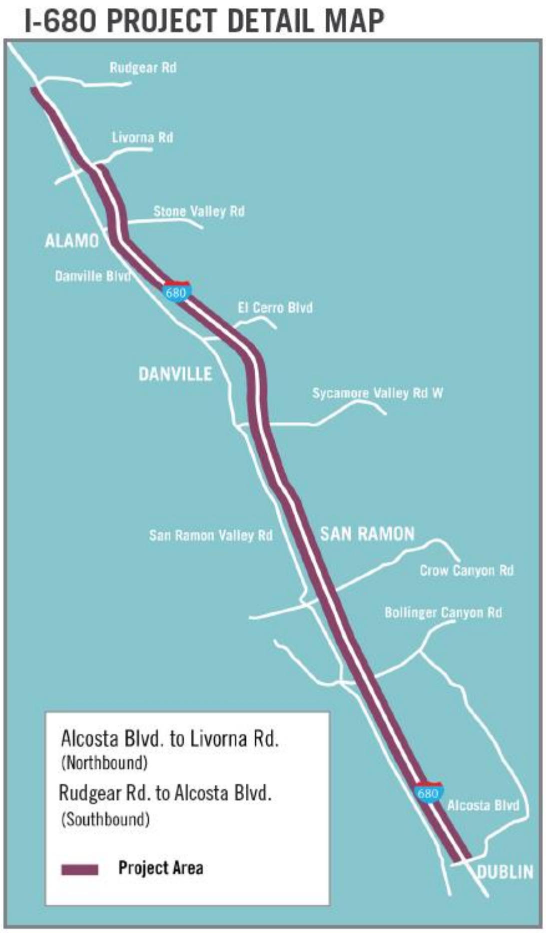
This summary was prepared by the MTC and in accordance with the Settlement Agreement dated June 18, 2014 among MTC and the Association of Bay Area Governments (ABAG), and Communities for a Better Environment and the Sierra Club. This summary is solely the work of the MTC. Caltrans was not involved in the production of this summary.

1.1 Project Description

The Project would convert 24.4 miles of existing high occupancy vehicle (HOV) lanes to express lanes in Contra Costa County between Alcosta Boulevard and Livorna Boulevard in the northbound direction and between Rudgear Road and Alcosta Boulevard in the southbound direction (Figure 1). For the Project, continuous access will be implemented along the length of the express lanes. Continuous access allows vehicles to enter and exit the express lane at any point; ingress and egress to and from the express lane is not restricted to designated locations. The technical analyses assume the Express Lane will be in operation during the existing peak period HOV hours of operation: 5 a.m.-9 a.m. and 3 p.m.-7 p.m.

Busses, qualifying HOVs (those with two or more persons) would be allowed to use express lanes free of charge. Vehicles with fewer than two occupants would be allowed to use the express lane upon payment of a toll. Tolls would be collected through FasTrak®, the electronic toll collection system used in California on all toll roads, toll bridges and express lanes. Vehicles eligible for toll-free travel would be required to have a FasTrak® account and carry a switchable toll tag to travel in the express lanes without charge. As on existing Bay Area Express Lanes on I-680 over the Sunol Grade and State Route 237, tolls would be set dynamically to keep the express lane free flowing as required under state and federal statute.

Figure 1: I-680 Project Map



1.2 Environmental Review

As the lead agency, Caltrans found the project to qualify as a Categorical Exemption under CEQA and Categorical Exclusion under NEPA. The state clearing house number for the Notice of Exemption posted on August 28, 2014 is 2014088399. See
http://www.ceqanet.ca.gov/NOEdescription.asp?DocPK=684420.

Section 2: Greenhouse Gas (GHG) Emissions Effects

This section summarizes the results of technical analyses of greenhouse gas emissions (GHG) as reported in the "Air Quality Technical Report for the Interstate 680 Northbound and Southbound Express Lanes Project" (April 2014). The Air Quality Technical Report examines potential impacts for the construction and operational phases of the Project.

2.1 Methodology

The GHG analysis methodology is described in Chapters 4 and 5 of the Air Quality Technical Report. The analysis of the operational phase involves a quantitative evaluation of GHG emissions without the Project (No Build) and with the Project (Build) for the existing year (2012)[1], design year (2015) and horizon year (2035). GHG emissions were modeled using the Caltrans Ct-EMFAC (Version 5, May 2013) model with EMFAC2011 emissions factors for vehicles in Contra Costa County. The quantitative analysis is based on GHG emissions with the Pavley and Low Carbon Fuel Standard requirements; however, emissions were predicted both with and without the requirement. The analysis used estimates of peak period and off-peak period traffic volumes, distance traveled and speed from traffic analysis.

The Caltrans Ct-EMFAC model was run using the procedures described in the UC Davis Methodology for Alameda and Contra Costa Counties. Under the UC Davis Methodology, daily traffic volumes were split between peak and off-peak hours, and emissions were calculated for each of these periods using average travel speeds for each period. This procedure was followed for each segment between interchanges and then summed to estimate the total GHG emissions from the Project. The peak period is the time the highway is congested and the off-peak period is all other times. This analysis included separate peak hour volumes for each of the six peak hour periods (i.e., 2p.m. – 3p.m., 3 p.m. – 4 p.m., 4 p.m. – 5 p.m., 5 p.m. – 6 p.m., 6 p.m. – 7 p.m., and 7 p.m. – 8 p.m.).

Caltrans' general procedures for construction analysis, including use of Sacramento Air Quality Managements District's Road Construction Model, were also used for the analysis.

2.2 Analysis Results

The Project's effect on GHG emissions is reported in Chapter 5 of the Air Quality Technical Report, in Section 5.2.4, which considers potential adverse contributions to climate change, and in Section 5.3.3, which considers GHG construction impacts.

2.2.1 Summary

The Air Quality Technical Report finds the Project would not produce substantial air quality impacts for GHG emissions in the operations phase, and therefore recommends no avoidance, minimization or mitigation measures. Construction GHG emissions are not quantified due to the limited construction

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[1] The Air Quality Technical Report used traffic results that assumed a base year of 2012 for the Project. There are three references in the Report where the existing year is listed as 2011 which is an error.

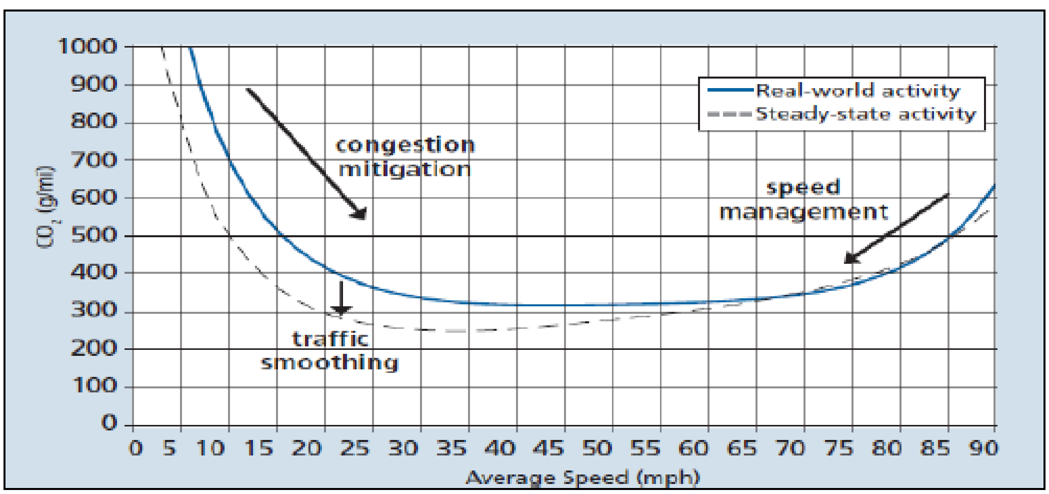
scope proposed. The report does not identify any mitigation measures for GHG emissions during construction.

2.2.2 Context

The analysis states that global climate change is a cumulative impact. An individual project does not generate enough GHG emissions to significantly influence global climate change. An individual project may, however, contribute to a potential impact through its incremental change in emissions when combined with the contributions of all other sources of GHG[2]. In assessing cumulative impacts, it must be determined if a project's incremental effect is "cumulatively considerable" (CEQA Guidelines sections 15064(h)(1) and 15130). To make this determination, the incremental impacts of the Project must be compared with the effects of past, current, and probably future projects.

The Air Quality Technical Report states that Caltrans has created and is implementing a Climate Action Program that was published in December 2006[3]. One of the main strategies in Caltrans' Climate Action Program to reduce GHG emissions is to make California's transportation system more efficient. The highest levels of carbon dioxide (CO_2) from mobile sources, such as automobiles, occur at stop-and-go speeds (0-25 mph) and speeds over 55 mph; the most severe emissions occur from 0-25 mph (see Figure 2 below). To the extent that a project relieves congestion by enhancing operations and improving travel times in high congestion travel corridors, GHG emissions, particularly CO_2, may be reduced.

Figure 2: Possible Effect of Traffic Operation Strategies in Reducing On-Road CO_2 Emissions (Figure 5-3 in the Air Quality Technical Report)[4]



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[2] This approach is supported by: Recommendations by the Association of Environmental Professionals on How to Analyze GHG Emissions and Global Climate Change in CEQA Documents (March 5, 2007), as well as the South Coast Air Quality Management District (Chapter 6: The CEQA Guide, April 2011) and the US Forest Service (Climate Change Considerations in Project Level NEPA Analysis, July 13, 2009).

[3] Caltrans Climate Action Program is located at the following address: http://www.dot.ca.gov/hq/tpp/offices/ogm/key_reports_files/State_Wide_Strategy/Caltrans_Climate_Action_Program.pdf

[4] Traffic Congestion and Greenhouse Gases: Matthew Barth and Kanok Boriboonsomsin (TR News 268 May-June 2010) http://www.uctc.net/access/35/access35_Traffic_Congestion_and_Grenhouse_Gases.shtml

2.2.3 Operational Phase

The Air Quality Technical Report shows that GHG emissions are predicted to go down from the existing year (2012) to the design year (2015) and then to the horizon year (2035) under either the Build and the No-Build alternatives, due mostly to the Pavley and Low Carbon Fuel Standard requirements.[5] Table 1 shows project GHG emissions expressed in metric tons per day of CO_2. GHG emissions are presented with the Pavley and Low Carbon Fuel Standard requirements.

The Air Quality Technical Report also finds the Build Alternative will help relieve congestion in the traffic peak hour periods during the day by shifting traffic from the mixed flow lanes to the HOV lanes, making more efficient use of the corridor's excess HOV lane capacity. In the design year, both No Build and Build Alternative would have lower CO_2 emissions than existing conditions, and Build emissions would be slightly higher than No Build due to slightly higher demand for the facility and higher speeds during the peak hours. Emissions for the horizon year of the No-Build and Build Alternative would have lower CO_2 emissions than the existing conditions, and Build emissions would be lower than No Build condition.

The speeds and VMT used in the emissions model are shown in Table 1. The speeds represent the average speeds during the off-peak period and the peak period along the I-680 corridor within the project limits. The Air Quality Technical Report states that the daily VMT will remain the same for both the Build and No-Build alternatives in the design year and the horizon year. In the Build alternative there will be a shift in the VMT from the off-peak period to the peak period and a slight increase in the average speeds during the peak period.

[5] This terminology refers to requirements resulting from Assembly Bill 1493 (AB1493) enacted in 2002 and Executive Order S-01-07. AB 1493, sponsored by assembly member Pavley, required the California Air Resources Board to develop and implement regulations to reduce automobile and light truck greenhouse gas emissions beginning in the 2009-model year. Executive Order S-01-07, signed by California Governor Arnold Schwarzenegger in 2007, established that the carbon intensity of California's transportation fuels was to be reduced by at least ten percent by the year 2020.

Table 1: CO_2 Emissions (Metric Tons per Day)
(Table 5-3 in the Air Quality Technical Report)

Peak and Off Peak Periods								
		South Bound		North Bound		SubTotal Metric Tons	Difference between Existing and Future	Difference between Build and No-Build
		VMT	Average Speed	VMT	Average Speed			
Existing	AM	489,600	47	363,170	49	1447		
	PM	509,725	56	587,745	39			
	Off Peak	892,905	60	872,140	60			
2015	No-Build							
	AM	496,760	42	371,297	46	1431	-17	
	PM	518,361	46	575,171	27			
	Off Peak	930,158	60	912,052	60			
	Build							
	AM	508,073	48	381,574	52	1440	-7	9
	PM	524,978	60	581,118	28			
	Off Peak	912,228	60	895,828	60			
2035	No-Build							
	AM	506,823	26	404,451	31	1440	-7	
	PM	528,962	26	492,219	14			
	Off Peak	1,065,241	60	1,055,658	60			
	Build							
	AM	522,306	28	413,004	33	1390	-57	-50
	PM	547,267	30	503,220	15			
	Off Peak	1,031,453	60	1,036,104	60			

The Air Quality Technical Report states that these computed CO_2 emissions are only useful for a comparison between alternatives. The numbers are not necessarily an accurate reflection of what the true CO_2 emissions will be because CO_2 emissions are dependent on other factors that are not part of the model, such as the fuel mix[6], rate of acceleration, and the aerodynamics and efficiency of the vehicles.

The Air Quality Technical Report does not evaluate the changes in CO_2 emissions translated throughout the entire Bay Area transportation network, which is conducted at the regional transportation plan level. The Project is included in the 2013 Regional Transportation Plan, Plan Bay Area, and 2013 TIP, which demonstrate that the region will remain below all approved “vehicle emission budgets” through the RTP study year.

The Air Quality Technical Report finds no avoidance, minimization, and/or mitigation measures are required during the operations phase, as the Project would not produce substantial operational air quality impacts for GHG emissions.

[6]EMFAC2011 model emission rates are only for direct engine-out CO2 emissions, not full fuel cycle; fuel cycle emission rates can vary dramatically depending on the amount of additives like ethanol and the source of the fuel components.

2.2.4 Construction Phase

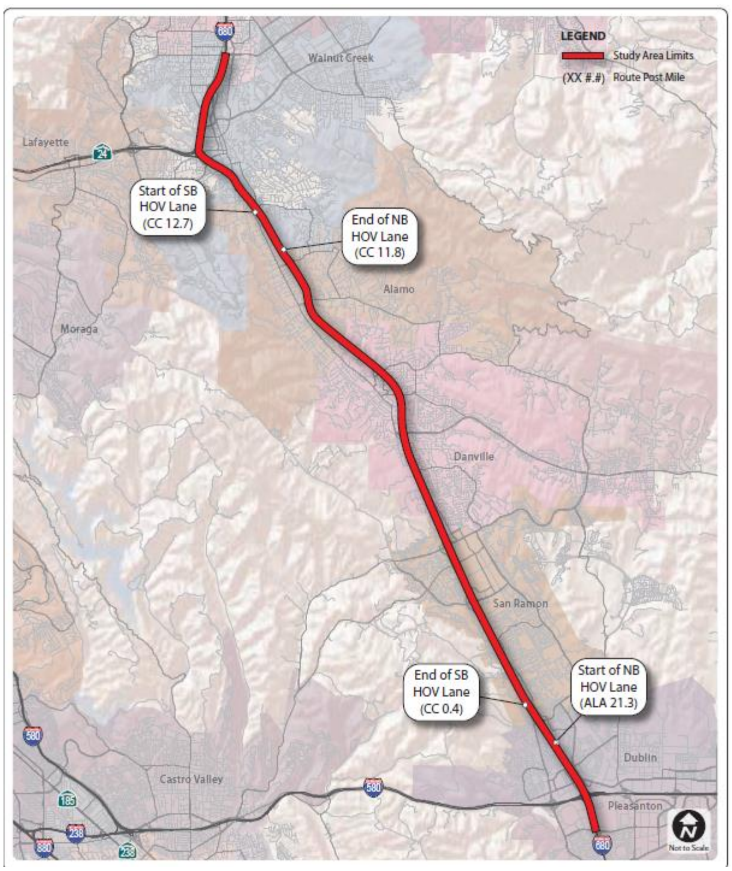
The Air Quality Technical Report states that construction GHG emissions for transportation projects include emissions produced as a result of material processing, emissions produced by onsite construction equipment, and emissions arising from traffic delays due to construction. These emissions will be produced at different levels throughout the construction phase; their frequency and occurrence can be reduced through innovations in plans and specifications and by implementing better traffic management during construction phases. In addition, with innovations such as longer pavement life cycles, improved traffic management plans, and changes in materials, the GHG emissions produced during construction can be reduced to some degree by longer intervals between maintenance and rehabilitation events. Currently, neither Caltrans nor the Bay Area Air Quality Management District (BAAQMD) have adopted GHG significance thresholds that apply to construction projects. Similar to construction exhaust and evaporative emissions, GHG emissions from construction activities have not been quantified due to the limited construction scope proposed. The Air Quality Technical Report does not identify any mitigation measures for GHG emissions during construction.

Section 3: Vehicle Miles Traveled (VMT) Effects

This section summarizes vehicle miles traveled (VMT) estimates as reported in the "Final Traffic Operations Report: MTC Phase I Express Lane Project-I-680 Corridor" (June 2014). The traffic operations report presents the existing and future conditions related to transportation without and with Express Lanes on the I-680, generally between the Rudgear Road and Alcosta Boulevard interchanges in the southbound direction and between the Alcosta Boulevard and Livorna Road interchanges in the northbound direction. The results in the Traffic Operations Report serve as the basis for the traffic operations section of the Project Approval/Environmental Document (PA/ED).

In the Traffic Operations Report, VMT is included as one of the System-wide Measures of Effectiveness (MOEs), and is not the focus of the report. The geographic area considered in the Traffic Operations Report extends beyond project limits in order to capture the effects of the proposed Express Lanes. The study area is from the Treat Boulevard interchange in the City of Walnut Creek to Stoneridge Drive interchange in the City of Pleasanton (Figure 1). This section of the summary most commonly uses the term "Project" to refer to the study area. The system-wide MOEs are based on all passenger vehicles in the study area.

Figure 1: Map of Traffic Study Area
(Figure 2-1 in the Traffic Operations Report)



3.1 Methodology

The traffic analysis methodology is described in Sections 2.4 and 4.0 of the Traffic Operations Report. Freeway analyses were conducted using procedures and methodologies consistent with the Highway Capacity Manual 2010 (Transportation Research Board, 2011) and applied using VISSIM traffic analysis software. The existing conditions traffic analysis model was validated to observed traffic counts, travel times, bottleneck locations and queues prior to extracting measures of effectiveness from the model. The procedures used are consistent with Traffic Analysis Toolbox Volume III: Guidelines for Applying Traffic Micro-simulation Modeling Software (FHWA, 2004).

Vehicle Miles of Travel (VMT), one of the Measures of Effectiveness (MOE), was computed with VISSIM models to quantify traffic operations of the I-680 corridor. The system-wide MOEs are presented for the northbound and southbound a.m. and p.m. study periods to provide a better understanding of overall traffic operations. VMT is a measure of the total vehicle throughput of the corridor. This measure takes into consideration the actual volume served versus the demand and the trip lengths of those vehicles and travelers.

The Contra Costa Transportation Authority (CCTA) serves as the designated Congestion Management Agency for Contra Costa County and in that capacity is responsible for maintaining a model and database that is consistent with MTC's model and database. The CCTA Model was used in the traffic forecast analysis for the traffic operations report. The CCTA Model is a regional travel demand model that covers the entire Bay Area, with higher level of geographic detail within Contra Costa County. The model receives its demographic inputs from the ABAG regional land use projections, and produces estimates of regional travel flows based on a standard four step modeling process. To ensure a high level of confidence in the forecasting process, the CCTA Model was first refined and validated within the project study area. The CCTA Model was updated to 2012 conditions and was validated to a level well within the application model validation guidelines. The analysis scenarios used in the report are opening year (2015) No Build, opening year (2015) with Express Lanes, horizon year (2035) No Build and horizon year (2035) with Express Lanes.[7]

3.2 Analysis Results

The estimated VMT associated with the Project is reported in Chapter 5 of the Traffic Operations Report in Sections 5.2.1.4 and 5.2.2.4, which considers the MOEs for the opening year (2015), and in Chapter 6 in Sections 6.2.1.4 and 6.2.2.4, which considers the MOEs for the horizon year (2035).

3.2.1 Existing Year (2012) VMT Forecasts

The CCTA Model was updated to 2012 conditions and was validated to a level well within the applicable model validation guidelines, so the base year model for the Project reflects year 2012 conditions.

[7]Since the Traffic Operations Report analyzes the impact to passenger vehicles, truck traffic is excluded from the Measures of Effectiveness analysis.

Existing year (2012) VMT forecasts are shown with other MOEs in Appendix A; Tables 3-11, 3-12, 3-13, & 3-14.

3.2.2 Opening Year (2015) VMT Forecasts

The Traffic Operations Report summarizes the VMT findings with other MOEs. The Traffic Operations Report states that for the opening year (2015) northbound a.m. study period the volume served, VMT and Person Miles of Travel (PMT) showed slight increases (2 to 3%) with the Express Lane. For the opening year (2015) northbound p.m. study period the volume served, VMT, PMT, overall Vehicle Hours of Delay (VHD) and overall Person Hours of Delay (PHD) remain relatively unchanged (1%) with the Express Lane. The Traffic Operations Report states that the Express Lane relieves northbound I-680 congestion during the a.m. peak period, allowing more drivers to reach their destination, and as a result calculated vehicles served and associated VMT increase at similar rates. These changes are small and are forecasted to occur during the a.m. peak period when the Express Lane is operational and so will not induce more traffic to use the corridor over the day.

The Traffic Operations Report states that for the southbound a.m. and p.m. study periods the volume served, VMT and PMT remains relatively unchanged (about 2%) with the Express Lane. The report also states that congestion relief with the Express Lane allows more drivers to reach their destination; resulting in calculated increases in vehicles served and associated VMT at similar rates of growth. These changes only occur during the a.m. and p.m. peak periods when the Express Lane is operational and so will not induce more traffic to use the corridor over the day. (Opening year (2015) VMT forecasts are shown with other MOEs in Appendix A; Tables 5-1, 5-2, 5-3, & 5-4).

3.2.3 Horizon Year (2035) VMT Forecasts

The Traffic Operations Report states that for the horizon year (2035) northbound a.m. and p.m. study periods the volume served, VMT and PMT remains relatively unchanged (about 2%) with the Express Lane.

The Traffic Operations Report states that for the horizon year (2035) southbound a.m. and p.m. study periods the volume served, VMT and PMT remains relatively unchanged (about 3%) with the Express Lane as a result of congestion relief which allows more drivers to reach their destination during the analysis period. (Horizon year (2035) VMT forecasts are shown with other MOEs in Appendix A; Tables 6-1, 6-2, 6-3, & 6-4).

Section 4: Use of Express Lanes by Low-Income Populations

This section summarizes information on the use of the Project by low-income populations as reported in the “MTC Regional Express Lanes I-680 Corridor: Environmental Justice Technical Memorandum” (October 2013). In accordance with Federal guidance, the purpose of the Environmental Justice Technical Memorandum is to identify and assess the project effects that could disproportionately and adversely affect minority or low-income populations[8]. Benefits of the Project and the public engagement activities are also discussed in the Technical Memorandum.

The Technical Memorandum addresses use of the express lanes by low-income populations to the degree it informs the main purpose of identifying disproportionate and adverse effects on minority or low-income populations. The following aspects of the analysis include information that addresses use of the Project by low-income populations:

- Summary of the current travel patterns of low-income populations in the study area. (Chapter 5: Transportation Travel Patterns)
- Analysis of the project effects, which discusses potential future use of the Project by low-income populations, considering current travel patterns, express lane design and operations, benefits of express lanes, and willingness and ability to pay to use the lanes. (Chapter 6: Project Effects)

4.1 Methodology

4.1.1 Identification of Low-Income Populations

Three study areas are defined and considered in the Technical Memorandum for the Project:

Direct Impact Area: The area is defined as the area in close proximity to the proposed project, and consequently includes the population most likely to experience the potential impacts of the physical improvements associated with the Project. The Direct Impact Area included all census tracts within one-quarter mile of the I-680 Corridor in the analysis (Figure 1).

Extended Resource Area: The Extended Resource Area is included to consider the potential impacts to the likely users of the Project. While it cannot be determined exactly who will be using the express lanes and from where they will be traveling, for the purposes of the analysis, based on existing trip patterns,

[8]The Technical Memo notes that the Federal Highway Administration (FHWA) requires that environmental justice be considered throughout the transportation decision-making process. A Presidential Order (EO) 12898 was created and contains the three major principles of environmental justice:

- Avoid, minimize, or mitigate disproportionately high and adverse human health and environmental effects, including social and economic effects, on minority and low-income populations;
- Ensure the full and fair participation by all potentially affected communities in the transportation decision-making process; and,
- Prevent the denial of, reduction in, or significant delay in the receipt of benefits by minority and low-income populations.

In response to EO 12898, the U.S. Department of Transportation (USDOT) issued Order 5610.2, Order to Address Environmental Justice in Minority Populations and Low-Income Populations. This order requires agencies to accomplish the following:

1. Explicitly consider human health and environmental effects related to transportation project that may have a disproportionately high and adverse effect on minority or low-income populations; and,
2. Implement procedures to provide “meaningful opportunities for public involvement” by members of those populations during project planning and development.

the entirety of Alameda and Contra Costa counties area included in the Extended Resource Area (Figure 1).

Region of Comparison: A Region of Comparison is necessary in order to determine if Project-related adverse impacts are disproportionate in comparison to the greater area. MTC's regional travel demand model (Travel Model One) was used to review regional travel patterns and identify the area most affected by the express lanes within the MTC Program. The results of the analysis revealed that Alameda, Contra Costa, Solano and Santa Clara Counties represent an appropriate study area for MTC's Regional Express Lane System.

Figure 1: Direct Impact Area and Extended Resource Area
(Figure 4-1 in the Environmental Justice Technical Memorandum)

The Technical Memorandum states that for environmental justice evaluations of its long-range plans, MTC identified concentrations of low-income persons where 30 percent or more of individuals within a geographic unit are below 200 percent of the poverty level. MTC uses 200 percent of the poverty level to account for the region's high cost of living relative to the nationwide federal standard. MTC confirmed the appropriateness of using this definition for analysis of express lanes by reviewing travel patterns in the MTC regional travel demand model (Travel Model One) and population and income data from the American Community Survey for Alameda, Contra Costa and Solano counties.

In the Direct Impact Area, 9.3 percent of population is below 200 percent of the federal poverty level. Only one census tract within the Direct Impact Area, Census Tract 3390.01, has a population with more than 30 percent of the individuals below 200 percent of the poverty level (48.4 percent), the MTC threshold for a low-income area. Census Tract 3390.01 is located adjacent to the east side of the I-680 freeway north of Rudgear Road. 24.3 percent of the individuals in the Extended Resource Area are below 200 percent of the poverty level. The percentage of individuals below 200 percent of the poverty level in the Region of Comparison, and each county comprising that region, are all below 30 percent.

4.1.2 Data Sources

Discussion of the use of express lanes by low-income populations in the Technical Memorandum is informed primarily by the following data sources:

- Data from the U.S Census Bureau's American Community Survey, 5-year Estimate (2006-2010) on population and commute travel characteristics. This data is used to identify areas with concentrations of low-income populations, and to understand how low-income populations travel today.
- Results from outreach and engagement directed at low-income and minority populations using focus group and intercept surveys in multiple express lanes corridors, including I-680 (described below).
- Data available on use of express lanes in operation throughout the United States.

The Technical Memorandum includes a summary of MTC's outreach and engagement efforts throughout Alameda, Contra Costa, and Solano Counties for the overall Regional Express Lane Network, including the I-680 corridor. The data gathered from communities with high concentrations of minority and low-income populations ("EJ communities") included: current travel patterns, perceptions about express lanes, ability and willingness to pay to use express lanes, and any potential barriers to using express lanes. The outreach effort included the collection of quantitative data through intercept surveys and qualitative or subjective data through focus group meetings. A total of 132 surveys were conducted at six locations typically frequented by a large and diverse number of people from November 10, 2012 to December 1, 2012. The locations were: Vallejo Farmers' Market, Laney College Flea Market, Coliseum Flea Market, Solano Swap Meet, 99 Ranch Market, and Grocery Outlet in Solano County. Six focus groups were conducted between November 5, 2012 and December 7, 2012 at various community-based organizations (CBOs) in Alameda, Contra Costa and Solano Counties. Seventy-five people participated in the focus groups.

Seventy-one percent of the focus group participants provided income information, and 44 percent of the participants reported that their income is below 200 percent of the poverty level, qualifying them as "low-income", based on the definition used in the Technical Memorandum. Eighty-two percent of the intercept survey participants provided income information, and 40 percent of the participants reported their income is below 200 percent of the poverty level.

4.2 Analysis Results

The use of the Project's lanes by low-income populations is reported in Chapter 6 of the Environmental Justice Technical Memorandum, which considers Transportation Impacts, Economic Impacts and Benefits. The Technical Memorandum concludes that the Project will not result in the degrading of existing travel choices or disproportionate adverse economic impacts; and will provide a benefit by providing a choice to low-income populations.

4.2.1 Summary

Transportation Impacts: The Technical Memorandum concludes that operation of the Project and the options it provides to drivers along the project freeways would affect transportation usage; however, there is no evidence to suggest that the express lanes will in any way substantially degrade existing travel choices. The Project will improve transportation operations along these freeways by maximizing the capacity of the system by making carpool lanes available to solo drivers for a fee. For those opting to pay the fee to use the carpool lane, they will experience less congestion and a decrease in travel time. This benefit of the Project is available to all users; however, this option for low-income and minority populations may have particular benefit at times when their travel is very time-sensitive and the fee to reach their destination sooner will ultimately be less than the cost of lost wages or late fees at a childcare center.

Economic Impacts: The Technical Memorandum states that the Project has an inherent economic effect on users. To take advantage of the transportation benefits provided by the Project, a user must incur a fee. The data and analysis reveal that most people understand this benefit; however, the financial hardship associated with obtaining a toll tag and paying the fee to access the express lane is dependent on income levels. Similar to other agencies which have implemented express lanes across the country, BATA has an extensive program in place to allow customers to obtain a toll tag and pay the fees in several ways. Lower-income drivers who may lack a credit card or bank account would still have alternative means of obtaining a toll tag and paying fees to access the express lanes. MTC's surveys and focus groups found most people of all income levels would be willing to pay a small fee to use the lane; however, lower-income drivers would be less likely than higher-income drivers to pay a fee higher than $2.00. For lower-income drivers who set up a toll account and choose to use the express lanes, even only in emergencies, the fee is balanced with the potential larger cost of being late.

Benefits: The Technical Memorandum states that the results in a number of benefits to low-income drivers using the I-680 corridor, as well as some potential economic impacts to lower-income drivers who may experience a financial hardship in obtaining a toll tag or using express lanes. Since the Project will provide a choice for solo drivers to access to express lanes for a fee and carpoolers will still be able to use it for free, lower-income drivers who use the facility will experience benefits that will likely outweigh the cost. The Technical Memorandum concludes that the Project will not result in disproportionate adverse economic impacts to low-income populations.

4.2.2 Current Travel Patterns

Commute Patterns

Within Alameda County and Contra Costa County, which comprise the Extended Resource Area, the majority of workers age 16 and older are employed within their county of residence; however, there are a large number of workers who commute to other counties. This is true regardless of income status. There are slightly higher percentages of lower income workers in Contra Costa County that are employed within their own county than for the population in general. The use of I-680 would be a popular commute route for intra-county and inter-county travel. Commuters driving alone comprise the majority of all commuters in the Extended Resource Area. Table 5 shows the modes of transportation for commuters who are above and below 150 percent of the poverty level within the Extended Resource Area. Carpooling and transit are more common for those below 150 of the poverty level. Along the I-680 Corridor, these lower income carpoolers are likely using the HOV lanes on I-680.

Table 1: Modes of Transportation and Low-income Status-Extended Resource Area[9]
(Table 5-6 from the Environmental Justice Technical Memorandum)

		Total workers 16 years & over	Percentage who drive alone	Percentage who carpool	Percentage who use transit[1]	Percentage who use another mode[2]
Alameda	At or Above 150% of Poverty Level	624,563	68.4%	10.4%	10.8%	10.5%
	Below 150% of Poverty Level	68,203	48.9%	12.7%	17.0%	21.4%
Contra Costa	At or Above 150% of Poverty Level	428,446	71.1%	11.5%	8.9%	8.5%
	Below 150% of Poverty Level	39,036	58.7%	17.5%	9.5%	14.3%
Total Extended Resource Area	At or Above 150% of Poverty Level	1,053,009	69.50%	10.85%	10.03%	9.69%
	Below 150% of Poverty Level	107,239	52.47%	14.45%	14.27%	18.82%

[1]Transit includes bus, streetcar, trolley, subway, railroad and ferry
[2]Other modes include taxicab, motorcycle, bicycle, walking and working from home
Source: U.S. Census Bureau, ACS 2006-2010 5-year Estimates

[9] For the poverty status analysis, a threshold of 150 percent below the poverty level was used to identify low-income populations since data for 200 percent below poverty level was unavailable for this analysis.

Travel Characteristics of Focus Group and Intercept Survey Participants

All intercept survey respondents indicated that they travel regularly on freeways and bridges in the project area. Most respondents regularly drive alone, regardless of which freeways they use. Intercept survey respondents and focus group participants reported adjusting their driving behaviors to avoid using freeways during peak hours, including changing work schedules and departure times.

Focus group and intercept survey results show that carpooling is a relatively popular mode of travel for about one-third of respondents and transit is less common. Respondents reported that the majority of regular trips are long trips (a trip over five miles). Focus group participants also reported that although they do carpool, there are potential barriers to carpooling on a consistent basis. Participants stated that getting three people for a carpool is difficult and the HOV lane is not always faster and is often as congested as other lanes. Other participants expressed frustration with underutilized carpool lanes, admitting that they use carpool lanes as solo drivers.

Other Research on Travel Behavior

The Technical Memorandum states that additional data on low-income use of HOV lanes are limited. It cites data from the National Household Travel Survey (NHTS)/Nationwide Personal Transportation Survey (NPTS) that shows that low-income populations take fewer trips, travel fewer vehicle miles, travel to work within their county of residence at a proportionately higher rate, and also carpool at a higher rate than non-low-income populations. The Technical Memorandum also notes a study from Los Angeles, showing low-income drivers used HOV lanes at a higher rate than general purpose lanes on the I-10 and I-110 freeways. These results are in line with the higher carpooling rates for low-income travelers in the Direct Impact Area and Extended Resource Area from the U.S. Census data.

4.2.3 Project Effects: Future Use

Travel within the I-680 Corridor

The Technical Memorandum stated low-income populations who cannot use the express lane will not have any change in their travel; however, there is the potential for congestion in the general purpose lanes to improve as traffic shifts to the extra capacity in the express lane. The Technical Memorandum stated that the Project will not impact access and connectivity. Existing interchanges will not be modified, the number of lanes on the freeways and ramps will not change, and ability to enter and exit the freeway will not be affected for low-income travelers or other travelers.

Experiences on Operational Express Lanes

Studies have been conducted following the construction and start of operation of express lanes. The studies indicate low-income drivers pay tolls to use express lanes, but they do not pay tolls as frequently as higher-income households. This shows that low income drivers may find it worthwhile to pay the toll in some situations even though it may be a greater burden on their household budget than it would be for higher-income households. All income groups placed a value on the reliability and reduced travel time provided by express lanes. For lower-income groups, the value of travel time savings (VTTS) varied substantially depending on travel conditions and expected or unexpected trip urgency (Patil et al. 2011). The Technical Memorandum notes that at times, calculated value of travel time savings for lower-income groups exceeded the value of ordinary trips for higher income groups, particularly due to fixed schedule constraints associated with lower-paying jobs.

Ability to Obtain a Toll Tag

In its consideration of the economic impacts of the Project on low-income populations, the Technical Memorandum assesses the ability of low-income populations to obtain a toll tag. Express lane users need to have a toll tag to use the lane as a paying customer. In addition, carpoolers will need to have a switchable toll tag to access the express lane without incurring a fee. The Technical Memorandum reviewed express lanes nationally and found that, as in the Bay Area, there is commonly an up-front cost to acquire a toll tag, and most systems also require a pre-paid balance from which tolls are deducted. These requirements can make it difficult for low-income persons who do not have bank accounts, debit cards, or credits cards to purchase a toll tag and maintain an account balance. It was found that in 2009, in the San Francisco Metropolitan Statistical Area (MSA), 4.7 percent of households in the MSA are unbanked, or over 74,000 households. A similar study conducted in 2011 reported 5.9 percent of households were unbanked, totaling 108,000 (FDIC, 2012).

In the Bay Area, the FasTrak® Regional Customer Service Center (RCSC) offers a variety of options, similar to other California toll operators. Customers can replenish their account with cash, check, money order or debit or credit cards. The RCSC and numerous retail locations such as Safeway, Costco or Walgreens include the option to purchase a toll tag for $25.00 which includes $5.00 for use to pay tolls and a deposit of $20.00. Customers can check account balances, make a one-time toll payment, and pay a violation notice or an invoice at numerous Cash Payment Networks (CPN). Customers can establish anonymous accounts that do not require personal identification, and pay with cash or money order. If a motorist receives a first-time violation and sets up a new account within 30 days, the violation penalty of $25.00 is dismissed.

The ability to obtain a toll tag was also explored in the focus group and intercept surveys. Focus group participants stated that their preference would be to use a debit or credit card, but that many do not have one. The majority (85 percent) expressed willingness to pre-pay the deposit although for 41 percent of these participants it would involve cutting other expenses. Fifty-four percent of intercept survey respondents reported being able to maintain the minimum balance on a FasTrak® toll tag without cutting expenses when paying with a debit/credit card, while 23 percent made the same statement when using the cash/check option. These results indicate that those with access to debit/credit cards have a substantially higher ability to maintain a minimum balance on a FasTrak® toll tag. Focus group participants who reported that they would use cash or a check to maintain a FasTrak® toll tag balance also shared concerns about having money “tied up” in an account. Few participants reported that they currently use a FasTrak® toll tag to pay bridge tolls. Those that do use toll tag acknowledged the ease of using a FasTrak® toll tag with a credit or debit card and stated that they would continue to use a FasTrak® toll tag in the future to pay express lane fees. A majority of Intercept Survey respondents (65 percent) responded that a cash payment network - locations such as grocery, convenience, drug stores, gas stations, check cashers, and dollar stores equipped to replenish account balances - would increase the likelihood that they would obtain a FasTrak® toll tag.

Willingness to Pay Toll

There are transportation benefits to low-income populations with the Project. The ability to reach a destination faster and spend less time in traffic could result in an economic benefit. The majority of focus group participants and intercept survey respondents expressed willingness to pay a moderate fee to use an express lane at least some of the time. When asked specifically about their ability to afford express lane usage fees, focus group participants and intercept survey respondents' responses diverged. The majority of intercept survey respondents stated that they could afford to pay a fee to utilize express lanes without having to cut expenses. When asked about willingness to pay a fee to avoid congestion on freeways, 32 percent of the 129 intercept survey respondents replied that they are willing to pay money to be able to drive as a solo car in an express lane. An additional 30 percent responded that they were willing to pay at least sometimes. No respondents with incomes below 200 percent of the Federal Poverty Level were "willing" or "very willing" to pay a congestion pricing fee of $6.00; however, they were willing to use the lane for free as a bus rider or carpooler. Focus group participants indicated that they would not be able to afford to use express lanes regularly, citing the unpredictability of cost and their limited budgets as primary concerns. Focus group participants across geographic locations indicated that a $2.00 fee to use an express lane is the maximum fee they could afford, and for some, even that would require cutting other expenses. Sixty-two percent of low-income Intercept Survey respondents indicated that they would be willing to pay a $2.00 toll to access the express lanes, and 55 percent of the respondents indicated that they would be unwilling to pay a toll of $4.00 or more to access the express lanes.

4.2.4 Conclusion

The Environmental Justice Technical Memorandum concludes that the Project results in a number of benefits to low-income drivers using the I-680 corridor, as well as some potential economic impacts to lower-income drivers who may experience a financial hardship in obtaining a toll tag or using express lanes. Since the Project will provide a choice for solo drivers to access to express lanes for a fee and carpoolers will still be able to use it for free, lower-income drivers who use the facility will experience benefits that will likely outweigh the cost. The Environmental Justice Technical Memorandum states that the Project will not result in disproportionate adverse economic impacts to low-income populations.

Appendix A: Measures of Effectiveness for Existing, 2015 and 2035 Years

TABLE 3-11
EXISTING NORTHBOUND I-680 AM STUDY PERIOD NETWORK MEASURES OF EFFECTIVENESS

Measure	HOV	SOV (Excludes Trucks)
All Origin-Destination Pairs		
Volume Served	5,128	43,965
Vehicle Miles of Travel (VMT)	34,739	310,253
Person Miles of Travel (PMT)	72,953	310,253
Vehicle Hours of Delay (VHD) in hours	64	1,634
Person Hours of Delay (PHD) in hours	135	1634
Travel Through the Corridor		
Average Travel Time (minutes)	17.8	20.7
Average Travel Speed (mph)	65	56
Maximum Individual Vehicle Delay (minutes)	0.9	12.8

Notes
All origin-destination pairs consider all on- and off-ramps in the study network
Travel through the corridor includes only those vehicles that travel from one end of the corridor to the end of the corridor
Assumed vehicle occupancy is 2.1 for HOV and 1.0 for all other vehicles
Delay is calculated relative to 65 mph
Source: Fehr & Peers, 2014

TABLE 3-12
EXISTING NORTHBOUND I-680 PM STUDY PERIOD NETWORK MEASURES OF EFFECTIVENESS

Measure	HOV	SOV (Excludes Trucks)
All Origin-Destination Pairs		
Volume Served	13,829	80,840
Vehicle Miles of Travel (VMT)	91,714	490,648
Person Miles of Travel (PMT)	192,599	490,648
Vehicle Hours of Delay (VHD) in hours	636	5,029
Person Hours of Delay (PHD) in hours	1,336	5,029
Travel Through the Corridor		
Average Travel Time (minutes)	24.9	31.7
Average Travel Speed (mph)	46	36
Maximum Individual Vehicle Delay (minutes)	13.2	24.2

Notes
All origin-destination pairs consider all on- and off-ramps in the study network
Travel through the corridor includes only those vehicles that travel from one end of the corridor to the end of the corridor
Assumed vehicle occupancy is 2.1 for HOV and 1.0 for all other vehicles
Delay is calculated relative to 65 mph
Source: Fehr & Peers, 2014

TABLE 3-13
EXISTING SOUTHBOUND I-680 AM STUDY PERIOD NETWORK MEASURES OF EFFECTIVENESS

Measure	HOV	SOV (Excludes Trucks)
All Origin-Destination Pairs		
Volume Served	7,231	63,812
Vehicle Miles of Travel (VMT)	57,684	423,377
Person Miles of Travel (PMT)	121,135	423,377
Vehicle Hours of Delay (VHD) in hours	250	2,744
Person Hours of Delay (PHD) in hours	524	2,744
Travel Through the Corridor		
Average Travel Time (minutes)	19.8	23.7
Average Travel Speed (mph)	58	49
Maximum Individual Vehicle Delay (minutes)	6.4	14.3

Notes
All origin-destination pairs consider all on- and off-ramps in the study network
Travel through the corridor includes only those vehicles that travel from one end of the corridor to the end of the corridor
Assumed vehicle occupancy is 2.1 for HOV and 1.0 for all other vehicles
Delay is calculated relative to 65 mph
Source: Fehr & Peers, 2014

TABLE 3-14
EXISTING SOUTHBOUND I-680 PM STUDY PERIOD NETWORK MEASURES OF EFFECTIVENESS

Measure	HOV	SOV (Excludes Trucks)
All Origin-Destination Pairs		
Volume Served	7,758	73,718
Vehicle Miles of Travel (VMT)	58,664	444,995
Person Miles of Travel (PMT)	123,194	444,995
Vehicle Hours of Delay (VHD) in hours	81	1,343
Person Hours of Delay (PHD) in hours	169	1,343
Travel Through the Corridor		
Average Travel Time (minutes)	17.5	20.1
Average Travel Speed (mph)	66	57
Maximum Individual Vehicle Delay (minutes)	2.0	6.5

Notes
All origin-destination pairs consider all on- and off-ramps in the study network
Travel through the corridor includes only those vehicles that travel from one end of the corridor to the end of the corridor
Assumed vehicle occupancy is 2.1 for HOV and 1.0 for all other vehicles
Delay is calculated relative to 65 mph
Source: Fehr & Peers, 2014

TABLE 5-1
2015 NORTHBOUND I-680 AM STUDY PERIOD NETWORK MEASURES OF EFFECTIVENESS

Measure	2015 No Build			2015 Build		
	HOV	TOLL[1]	SOV	HOV	TOLL[1]	SOV
All Origin-Destination Pairs						
Volume Served	5,279	1,094	43,946	5,342	1,261	44,938
Vehicle Miles of Travel (VMT)	35,759	23,116	304,011	36,037	24,964	311,866
Person Miles of Travel (PMT)	75,095	23,116	304,011	75,677	24,964	311,866
Vehicle Hours of Delay (VHD) in hours	103	239	2,046	71	33	1,272
Person Hours of Delay (PHD) in hours	217	239	2,046	149	33	1,272
Travel Through the Corridor						
Average Travel Time (minutes)	17.8	21.7	21.7	17.8	17.8	20.0
Average Travel Speed (mph)	65	53	53	65	65	58
Maximum Individual Vehicle Delay (minutes)	1.1	17.7	17.7	1.2	1.2	9.2

Notes
All origin-destination pairs consider all on- and off-ramps in the study network
Travel through the corridor includes only those vehicles that travel from one end of the corridor to the end of the corridor
1 TOLL refers to that sub-group of Cash and Fastrak drivers that would use the Express Lane if it were available.
Assumed vehicle occupancy is 2.1 for HOV and 1.0 for all other vehicles
Delay is calculated relative to 65 mph
Source: Fehr & Peers, 2014

TABLE 5-2
2015 NORTHBOUND I-680 PM STUDY PERIOD NETWORK MEASURES OF EFFECTIVENESS

Measure	2015 No Build			2015 Build		
	HOV	TOLL[1]	SOV	HOV	TOLL[1]	SOV
All Origin-Destination Pairs						
Volume Served	14,115	986	78,002	14,152	1,030	78,651
Vehicle Miles of Travel (VMT)	93,687	18,355	457,732	93,749	18,705	463,207
Person Miles of Travel (PMT)	196,742	18,355	457,732	196,872	18,705	463,207
Vehicle Hours of Delay (VHD) in hours	1,244	369	10,303	1,220	140	9,900
Person Hours of Delay (PHD) in hours	2,613	369	10,303	2,561	140	9,900
Travel Through the Corridor						
Average Travel Time (minutes)	28.5	43.4	43.4	28.9	28.9	42.6
Average Travel Speed (mph)	41	27	27	40	40	27
Maximum Individual Vehicle Delay (minutes)	15.3	41.5	41.5	16.8	16.8	40.0

Notes
All origin-destination pairs consider all on- and off-ramps in the study network
Travel through the corridor includes only those vehicles that travel from one end of the corridor to the end of the corridor
1 TOLL refers to that sub-group of Cash and Fastrak drivers that would use the Express Lane if it were available.
Assumed vehicle occupancy is 2.1 for HOV and 1.0 for all other vehicles
Delay is calculated relative to 65 mph
Source: Fehr & Peers, 2014

TABLE 5-3
2015 SOUTHBOUND I-680 AM STUDY PERIOD NETWORK MEASURES OF EFFECTIVENESS

Measure	2015 No Build			2015 Build		
	HOV	TOLL[1]	SOV	HOV	TOLL[1]	SOV
All Origin-Destination Pairs						
Volume Served	7,208	630	64,261	7,346	841	65,296
Vehicle Miles of Travel (VMT)	56,476	12,577	418,637	57,936	15,543	426,333
Person Miles of Travel (PMT)	118,600	12,577	418,637	121,665	15,543	426,333
Vehicle Hours of Delay (VHD) in hours	373	219	3,474	209	69	2,505
Person Hours of Delay (PHD) in hours	784	219	3,474	440	69	2,505
Travel Through the Corridor						
Average Travel Time (minutes)	21.6	25.7	25.7	19.2	19.7	22.7
Average Travel Speed (mph)	53	45	45	60	60	51
Maximum Individual Vehicle Delay (minutes)	11.4	19.2	19.2	4.4	4.4	11.6

Notes
All origin-destination pairs consider all on- and off-ramps in the study network
Travel through the corridor includes only those vehicles that travel from one end of the corridor to the end of the corridor
1 TOLL refers to that sub-group of Cash and Fastrak drivers that would use the Express Lane if it were available.
Assumed vehicle occupancy is 2.1 for HOV and 1.0 for all other vehicles
Delay is calculated relative to 65 mph
Source: Fehr & Peers, 2014

TABLE 5-4
2015 SOUTHBOUND I-680 PM STUDY PERIOD NETWORK MEASURES OF EFFECTIVENESS

Measure	2015 No Build			2015 Build		
	HOV	TOLL[1]	SOV	HOV	TOLL[1]	SOV
All Origin-Destination Pairs						
Volume Served	7,922	1,336	74,224	8,061	1,397	74,846
Vehicle Miles of Travel (VMT)	57,585	22,990	431,347	58,924	23,558	435,980
Person Miles of Travel (PMT)	120,928	22,990	431,347	123,740	23,558	435,980
Vehicle Hours of Delay (VHD) in hours	231	174	2,982	53	15	816
Person Hours of Delay (PHD) in hours	485	174	2,982	112	15	816
Travel Through the Corridor						
Average Travel Time (minutes)	21.6	25.2	25.2	17.1	17.1	18.6
Average Travel Speed (mph)	53	46	46	67	67	62
Maximum Individual Vehicle Delay (minutes)	10.2	14.6	14.6	0.0	0.0	3.8

Notes
All origin-destination pairs consider all on- and off-ramps in the study network
Travel through the corridor includes only those vehicles that travel from one end of the corridor to the end of the corridor
1 TOLL refers to that sub-group of Cash and Fastrak drivers that would use the Express Lane if it were available.
Assumed vehicle occupancy is 2.1 for HOV and 1.0 for all other vehicles
Delay is calculated relative to 65 mph
Source: Fehr & Peers, 2014

TABLE 6-1
2035 NORTHBOUND I-680 AM STUDY PERIOD NETWORK MEASURES OF EFFECTIVENESS

Measure	2035 No Build			2035 Build		
	HOV	TOLL[1]	SOV	HOV	TOLL[1]	SOV
All Origin-Destination Pairs						
Volume Served	6,448	512	49,201	6,520	621	50,025
Vehicle Miles of Travel (VMT)	44,457	10,709	340,748	45,049	12,205	346,976
Person Miles of Travel (PMT)	93,359	10,709	340,748	94,603	12,205	346,976
Vehicle Hours of Delay (VHD) in hours	432	255	5,899	399	87	5,467
Person Hours of Delay (PHD) in hours	908	255	5,899	837	87	5,467
Travel Through the Corridor						
Average Travel Time (minutes)	19.2	26.1	26.1	19.3	19.3	25.5
Average Travel Speed (mph)	60	44	44	60	60	45
Maximum Individual Vehicle Delay (minutes)	7.8	36.5	36.5	7.8	7.8	33.5

Notes
All origin-destination pairs consider all on- and off-ramps in the study network
Travel through the corridor includes only those vehicles that travel from one end of the corridor to the end of the corridor
1 TOLL refers to that sub-group of Cash and Fastrak drivers that would use the Express Lane if it were available.
Assumed vehicle occupancy is 2.1 for HOV and 1.0 for all other vehicles
Delay is calculated relative to 65 mph
Source: Fehr & Peers, 2014

TABLE 6-2
2035 NORTHBOUND I-680 PM STUDY PERIOD NETWORK MEASURES OF EFFECTIVENESS

Measure	2035 No Build			2035 Build		
	HOV	TOLL[1]	SOV	HOV	TOLL[1]	SOV
All Origin-Destination Pairs						
Volume Served	15,346	1,003	67,220	15,307	1,137	68,871
Vehicle Miles of Travel (VMT)	101,343	15,412	369,894	100,713	16,194	380,674
Person Miles of Travel (PMT)	212,820	15,412	369,894	211,497	16,194	380,674
Vehicle Hours of Delay (VHD) in hours	3,822	912	21,431	3,890	390	21,682
Person Hours of Delay (PHD) in hours	8,025	912	21,431	7,348	390	21,682
Travel Through the Corridor						
Average Travel Time (minutes)	55.0	93.5	93.5	51.4	51.4	89.0
Average Travel Speed (mph)	21	12	12	22	22	13
Maximum Individual Vehicle Delay (minutes)	42.0	109.2	109.2	35.4	35.4	103.3

Notes
All origin-destination pairs consider all on- and off-ramps in the study network
Travel through the corridor includes only those vehicles that travel from one end of the corridor to the end of the corridor
1 TOLL refers to that sub-group of Cash and Fastrak drivers that would use the Express Lane if it were available.
Assumed vehicle occupancy is 2.1 for HOV and 1.0 for all other vehicles
Delay is calculated relative to 65 mph
Source: Fehr & Peers, 2014

TABLE 6-3
2035 SOUTHBOUND I-680 AM STUDY PERIOD NETWORK MEASURES OF EFFECTIVENESS

Measure	2035 No Build			2035 Build		
	HOV	TOLL[1]	SOV	HOV	TOLL[1]	SOV
All Origin-Destination Pairs						
Volume Served	8,018	505	63,230	8,102	634	65,531
Vehicle Miles of Travel (VMT)	64,844	11,522	420,376	65,573	12,479	433,917
Person Miles of Travel (PMT)	136,171	11,522	420,376	137,704	12,479	433,917
Vehicle Hours of Delay (VHD) in hours	579	412	10,269	520	286	9,490
Person Hours of Delay (PHD) in hours	1,217	412	10,269	1,091	286	9,490
Travel Through the Corridor						
Average Travel Time (minutes)	19.6	42.4	42.4	20.6	27.8	39.3
Average Travel Speed (mph)	59	27	27	56	41	29
Maximum Individual Vehicle Delay (minutes)	9.8	79.4	79.4	6.5	25.0	65.2

Notes
All origin-destination pairs consider all on- and off-ramps in the study network
Travel through the corridor includes only those vehicles that travel from one end of the corridor to the end of the corridor
1 TOLL refers to that sub-group of Cash and Fastrak drivers that would use the Express Lane if it were available.
Assumed vehicle occupancy is 2.1 for HOV and 1.0 for all other vehicles
Delay is calculated relative to 65 mph
Source: Fehr & Peers, 2014

TABLE 6-4
2035 SOUTHBOUND I-680 PM STUDY PERIOD NETWORK MEASURES OF EFFECTIVENESS

Measure	2035 No Build			2035 Build		
	HOV	TOLL[1]	SOV	HOV	TOLL[1]	SOV
All Origin-Destination Pairs						
Volume Served	8,663	1,283	78,452	9,000	1,742	79,969
Vehicle Miles of Travel (VMT)	61,104	21,204	438,631	64,128	28,377	446,706
Person Miles of Travel (PMT)	128,318	21,204	438,631	134,670	28,377	446,706
Vehicle Hours of Delay (VHD) in hours	557	501	10,795	416	483	8,894
Person Hours of Delay (PHD) in hours	1,170	501	10,795	874	483	8,894
Travel Through the Corridor[1]						
Average Travel Time (minutes)	19.0	41.1	41.1	17.5	32.2	37.3
Average Travel Speed (mph)	61	28	28	66	36	31
Maximum Individual Vehicle Delay (minutes)	1.9	27.7	27.7	0.1	18.2	21.7

Notes
All origin-destination pairs consider all on- and off-ramps in the study network
Travel through the corridor includes only those vehicles that travel from one end of the corridor to the end of the corridor
1 TOLL refers to that sub-group of Cash and Fastrak drivers that would use the Express Lane if it were available.
Assumed vehicle occupancy is 2.1 for HOV and 1.0 for all other vehicles
Delay is calculated relative to 65 mph
Source: Fehr & Peers, 2014