CALIFORNIA HIGH-SPEED TRAIN

Project Environmental Impact Report / Environmental Impact Statement

Ridership and Revenue Model

DEVELOPMENT, APPLICATION, AND PROJECT-LEVEL EIR/EIS FORECASTS

June 2011

CALIFORNIA High-Speed Rail Authority

U.S. Department of Transportation
Federal Railroad Administration

Table of Contents

List of Figures

List of Tables

1.0 Overview

The purpose of this report is to provide the reader with more detailed technical information about how the ridership forecasts and ridership related items such as parking and access mode shares discussed in the Merced to Fresno Environmental Impact Report/Environmental Impact Statement (EIR/EIS) and the Fresno to Bakersfield EIR/EIS were developed. It is anticipated that this report will also support the other project specific HST environmental documents, including the San Francisco to San Jose, San Jose to Merced, Fresno to Bakersfield, Bakersfield to Palmdale, Palmdale to Los Angeles, and Los Angeles to Anaheim.

In 2004, as part of its development of the Bay Area Regional Rail Plan, the Metropolitan Transportation Commission (MTC) retained Cambridge Systematics to develop a new statewide multi-modal travel demand model to help evaluate alignments for high-speed train (HST) service in and out of the San Francisco Bay Area, and understand interaction of HST with potential regional rail improvements. The California High-Speed Rail Authority (Authority) provided technical support on HST service characteristics through its Program Manager and used the results in its 2007 Bay Area – Central Valley Program EIR/EIS. In the fall of 2007, the Authority engaged Cambridge Systematics to conduct further work with the same model to support alternatives analyses and project-level EIR/EIS work. Numerous additional runs were made, with different operating plans, fare inputs, travel costs, and parking costs assumed at stations. Refinements were made to the MTC portion of the model, but no changes were made to the structure of the models used to forecast inter-regional or intra-SCAG trips. Additional work was done to estimate the modes of access and volumes of parking demand at specific stations.

The purpose of travel demand models like the California High-Speed Rail Ridership and Revenue Model (HSR R&R Model) is to forecast future travel patterns and demand as a function of variables such as population and employment, travel time and cost, fuel costs, rail and airline schedules, etc. A model is developed through a process of estimation, calibration and validation based on revealed and stated traveler response to these variables obtained through surveys of travelers and their travel choices. The three model development steps should be defined to provide an understanding of the information contained in this report:

- Model estimation is the development of model parameters and coefficients based on statistical analyses of individuals' travel behaviors or from average traveler responses from aggregations of individuals. Model estimation includes reasonableness checks against values for coefficients estimated and used in similar models for other regions.
- Model calibration addresses modifications made to estimated models to better reproduce observed base year conditions. Typically, model calibration addresses adjustments of model constants rather than model coefficients although adjustments and assertions of model coefficients can also be considered.
- Model validation is the comparison of model results to base year conditions. Model validation tells "how well" a model reproduces the observed base year conditions. A validated model is then applied to forecast future travel based on specific assumptions of the future values for the input variables.

These activities are described in the five following chapters:

- Chapter 2 discusses the HSR R&R model structure and the estimation of the interregional model system. Chapter 2 also includes the model coefficients and constants finalized on February 7, 2007 and used for all model applications since that date.
- Chapter 3 summarizes the data and model inputs necessary for the development and application of the model. These requirements include:
  - Base year and forecast year demographic and socioeconomic projections;
  - Base year and forecast year transportation network information; and

  - Base year data on inter- and local intraregional travel patterns.

- Chapter 4 focuses on the calibration and validation results for the interregional and intraregional models. Chapter 4 also includes information on the March 2010 recalibration and revalidation of the intraregional model used for the MTC region.
- Chapter 5 presents forecasts of riders and revenue for various scenarios of HST service, fare structure and parking cost assumptions leading to the forecasts used for the EIR/EIS work.
- Chapter 6 describes the development of mode access shares and parking requirements at each station from the various forecasts described in Chapter 5.

This report summarizes all of the modeling development and application work to date. The resulting model is a valuable tool that will be used to assist planners and policy makers in analyzing the costs and benefits of various transportation alternatives.

The ridership and revenue forecasts in this appendix are based on the professional judgment of the analysts using assumptions based on officially adopted governmental plans as required by state and federal environmental regulations. The analysts did not independently assess the validity of these assumptions. Actual outcomes may differ materially from those forecasts. Additionally, the forecasts in this appendix were developed solely for purposes of the Authority's environmental planning and are not intended nor should they be used for any other purpose.

2.0 Model Development

2.1 Introduction

The approach to this statewide model explicitly recognizes the unique characteristics of both intra-regional and inter-regional travel demand. Intra-regional travel is defined as travel that stays within a certain region; whereas inter-regional travel is travel that crosses regional boundaries.

The inter-regional travel models rely on the statewide characteristics of highways, conventional rail and air services, local urban area highway and transit networks, and traveler behavior associated with longer-distance travel. The intra-regional travel models rely on local urban area highway and transit network characteristics and behavior associated with shorter-distance and more frequent trip making.

This chapter discusses the potential users (market segments) of the proposed high-speed rail system, the structure of the HSR R&R model, a description of its key components, and finally, the estimated model coefficients and calibrated model constants for the various model components.

2.2 Understanding Markets

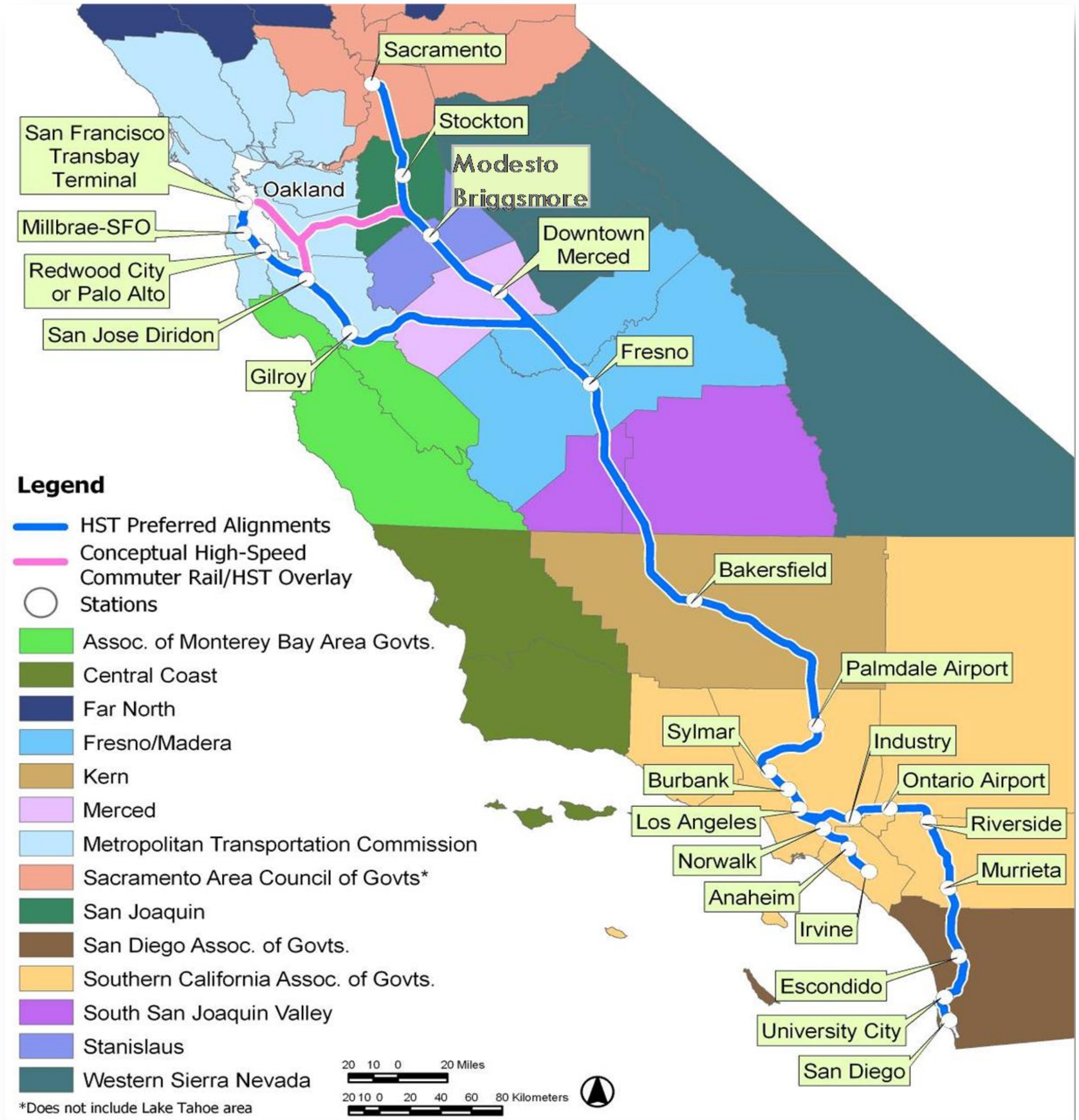
In order to model high-speed rail ridership, it is important to understand and examine all of the potential markets that would be served by the system. Market segmentation is carried out by trip purpose and attributes of the households and travelers making the trips. Income and household size are common examples of the latter. Widely accepted research has shown that the travel characteristics of these different market segments differ significantly, such that modeling them all together would result in less accurate travel forecasts. In such cases trips by higher income households – which form a significant share of potential high-speed rail riders – would be under-predicted by the model, while paradoxically over-predicting the number of low- income users of the system. Market segmentation avoids this bias in the modeling results by using rates and relationships appropriate to each market segment. These differences are distilled from the revealed and stated preference surveys used to construct the model.

2.2.1 Inter- vs. Intra-regional Travel Market

The initial market segmentation is geographical. The regions used for the HSR R&R model are shown in Figure 2-1.

The proposed HST system will serve both inter-regional and intra-regional travel. As mentioned above, inter-regional travel crosses the market boundaries while intra-regional travel represents travel made within a region. The HSR R&R model for inter-regional travel was developed utilizing surveys and other statewide travel information. Intra-regional travel models from the MTC and SCAG regions were adapted for use in the HSR R&R model from the models maintained by the MPOs for those regions. A factoring process was used to estimate intra-SANDAG ridership as described in a following chapter. Those three regions are the only regions anticipated to be served by multiple HST stations.

Figure 2-1: Regional Markets



Source: PT1_CAHSR_Ridership and Revenue Forecasting_v6-FINAL.pptx, presentation to San Joaquin Valley MPOs, October 2010.

2.2.2 Long Distance and Short Distance Travelers

Short and long distance interregional trips are modeled separately to differentiate between the characteristics of the trips undertaken. For example, short distance trips might be more likely to be made on a daily basis to more familiar areas while long distance trips might be more likely to be special trips made to less familiar areas and requiring more planning than the short distance trips. One hundred miles was chosen as the breakpoint for segmenting short distance from long distance trips. This breakpoint was selected based upon an evaluation of the trip length frequency distributions for inter-regional trips for each trip purpose from the surveys along with judgment about behavior for short versus long trips. This value was also used in the past as the lower limit for long distance trips in the 1995 American Traveler Survey (ATS) conducted by the U.S. Departments of Transportation and Commerce. The ATS represents the only large-scale travel survey conducted to date in the USA.

2.2.3 Business Travelers, Commuters and Other Travelers

The 2001 California statewide household activity/travel survey data set, described in more detail in Chapter 3, was used to determine the magnitude of the existing inter-regional travel market by purpose. Based on the 2,820 inter-regional trips captured in the survey, business travelers and commuters comprised more than 50 percent of the inter-regional travel market. The remaining market share was split between recreational and other travelers.

It is important to treat these purposes separately since the various markets have very different characteristics, such as reimbursement for travel expenses, travel party size, etc. These factors can have a significant effect on travel decisions.

The market segments for intra-regional travel include the typical urban travel demand model trip purposes: home-based purposes for work, school, university, shopping, social-recreational, and other trips, as well as non-home-based trips for work and non-work related purposes.

2.2.4 Household Characteristics and Travel Party Size

Several household market segmentations were used for the inter-regional models:

- Household size – 1 person, 2 people, 3 people, more than 4 people
- Household income range – Low, medium, or high
- Household auto-ownership – 0 autos, 1 auto, 2 or more autos
- Household number of workers – 0 workers, 1 worker, 2 or more workers

Party size (traveling alone versus traveling with others) is a segmentation variable primarily for the recreation and other segments because it has a large effect on the travel cost of the car mode versus the other modes, and thus, on the choices throughout the model chain.

2.2.5 Induced Travel

New travel would be induced by the gain in accessibility to destinations as a result of high-speed rail service. In effect, this market is an output of the inter-regional modeling process and, more specifically, the trip frequency and destination choice model components (described later in this chapter).

2.3 Model Structure

A key consideration in model design was the recognition that inter-regional and intra-regional travel have different trip purposes and other attributes, and are influenced in some cases by different factors. It was decided to model each separately in order to capture these distinctions accurately. This led to the development of separate, but integrated, inter-regional and intra-regional models. The former was designed to explicitly estimate induced demand.

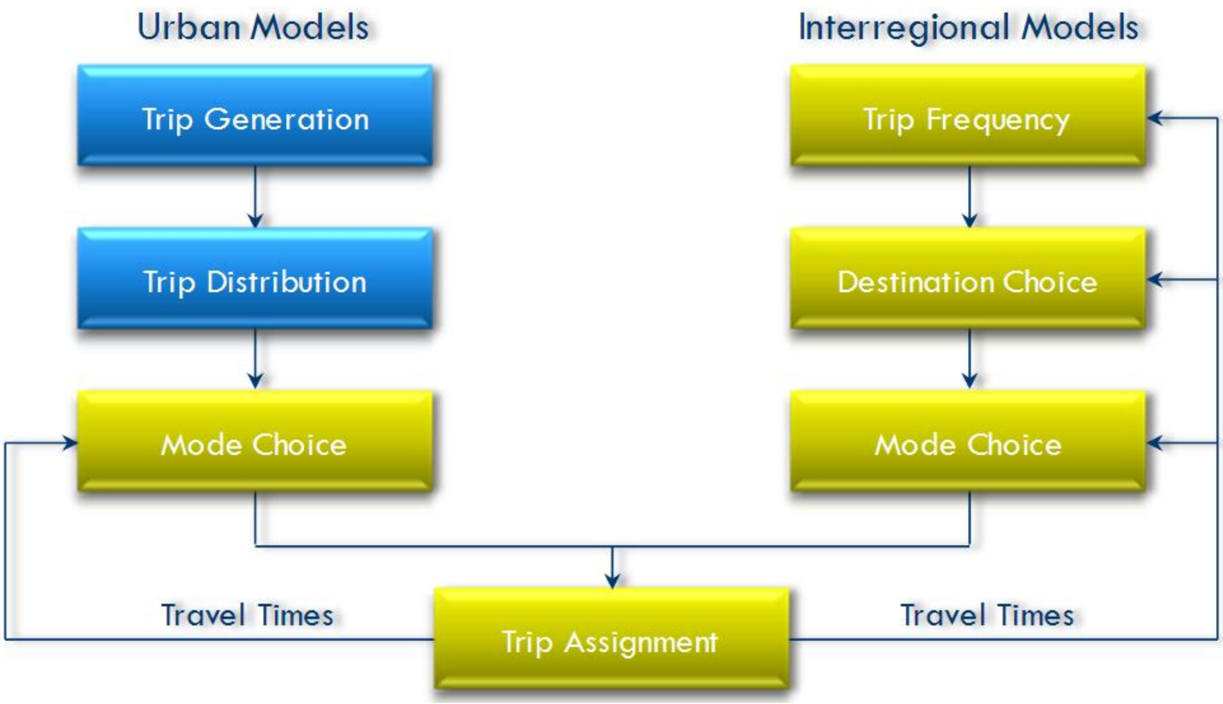
The overall model design for the Bay Area/California High-speed Rail Ridership and Revenue Forecasting Study includes the following principal components:

- Intra-regional Travel: all trips with both ends in one of the three urban areas with more than one proposed high-speed rail station. These areas are the San Francisco Bay Area, Greater Los Angeles, and San Diego regions.
- Inter-regional Travel: all trips with both ends in California and whose origins and destinations are in different regions having proposed high-speed rail stations.
- External Travel: trips with one end outside California and one end in an urban area with a proposed high-speed rail station. During the design and data collection of inter-regional trips through intercept surveys at air and rail stations, it was decided that resources for data collection should be focused on travel within California. As a result, there are no data on external travel that may access the high-speed rail system in California. However, external auto trips were included in auto assignments to accurately reflect the congestion caused by these external trips, but air and rail trips were not included explicitly.
- Trip Assignment: the merging of the urban, inter-regional, and external trips into modal trip tables that are assigned to highway, rail, and air networks.

Both the intra- and inter-regional models consider both peak and off-peak conditions for an average weekday. Weekend travel demand and annual ridership estimates are developed using annualization factors based on Western US and California travel patterns and data on high-speed rail systems around the world. The model base year is 2000 and the forecast year is 2030.

The integrated modeling process for the development of the statewide model is presented in Figure 2-2. This process shows that the accessibility of the system (represented by travel time) is included in the mode choice models and in the inter-regional trip frequency and destination choice models. Intra-regional trip generation and trip distribution are performed by the MPOs using the regional travel models. The intra-regional travel component included in the HSR R&R model uses trip tables generated by the normal MPO modeling processes as input.

Figure 2-2: Integrated Modeling Process



2.3.1 Intra-regional (Urban) Models

For both the San Francisco Bay Area and the greater Los Angeles regions, mode choice models were adapted from existing models to include the high-speed rail mode. The updated mode choice models were applied using the MPO trip tables for each region as input.

San Diego is the only other region that contains the possibility of intra-regional high-speed rail trips, but the estimate of these riders was very low relative to the other regions. Because the level of effort to develop, calibrate, and apply the regional mode choice model was very high, intra-regional ridership for San Diego was developed using a population-based estimate rather than a traditional mode choice model. Detailed descriptions of the intra-regional models are provided in the "Key Components" section below.

2.3.2 Inter-regional Models

The inter-regional models are comprised of four sets of models: trip frequency, destination choice, primary mode choice, and access/egress mode choice. The structure and contents of the inter-regional modeling system are presented in Figure 2-3.

The trip frequency component predicts the number of inter-regional trips that individuals in a household are expected to make based upon the household's characteristics, location, and accessibility. The destination choice component predicts the destinations of the trips generated in the trip frequency component based on zonal characteristics and travel impedances. The mode choice components (main mode choice, access mode choice and egress mode choice) predict the modes that the travelers would choose based upon the modal service levels as well as characteristics of the travelers and trips being made. The individual components will be described in more detail in the "Key Components" section.

The mode choice models include a main mode choice, where the primary inter-regional mode is selected; and access/egress components, where the modes of access and egress for the air, conventional rail and high speed rail trips are selected. The nesting structures for the two mode choice components are shown in Figures 2-4 and 2-5, respectively. The main mode choice models produce probabilities that each trip will choose one of the main modes (auto, air, conventional rail, or high-speed rail).

Figure 2-3: Inter-regional Model Structure

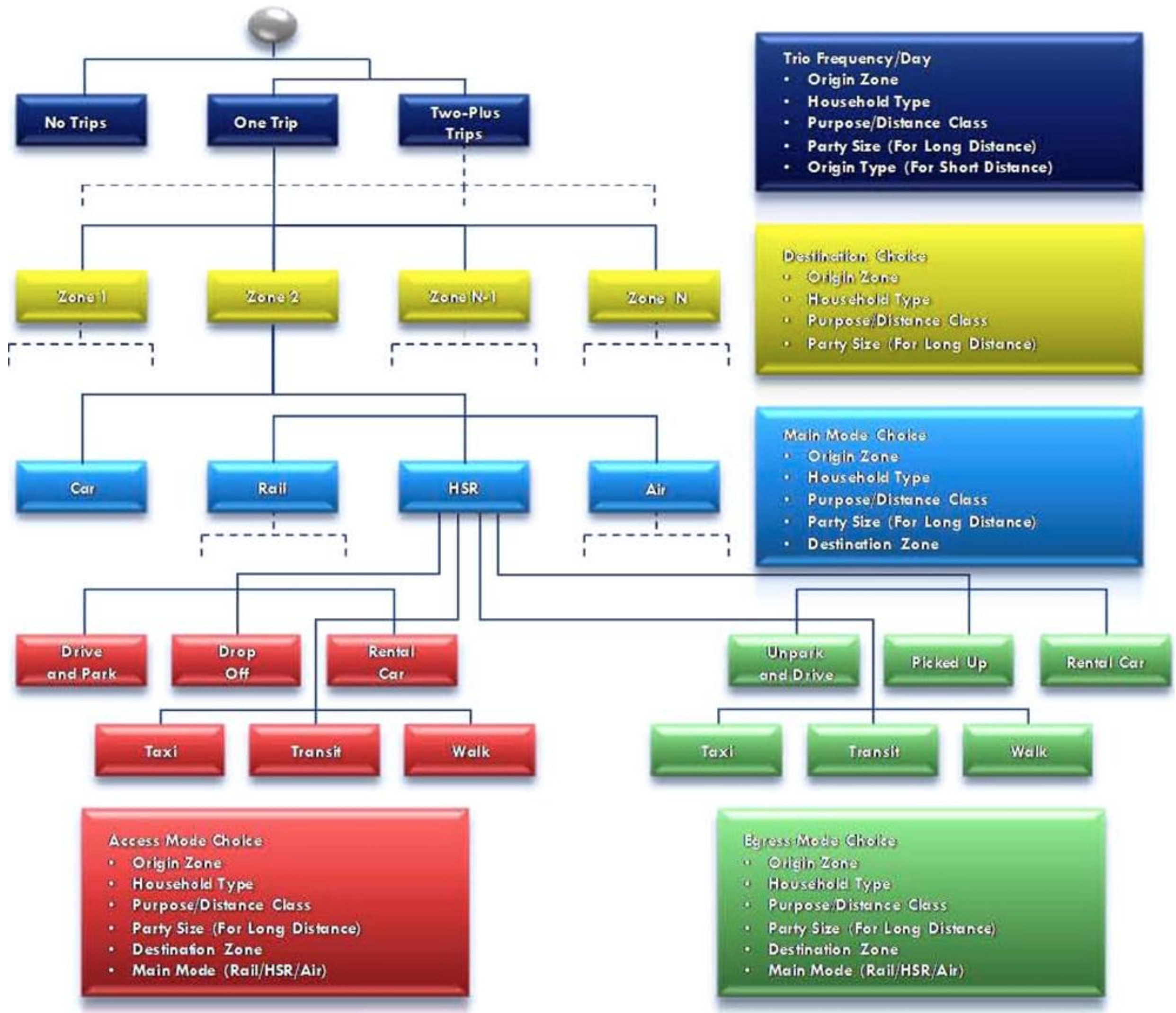


Figure 2-4: Main Mode Choice Model Structure

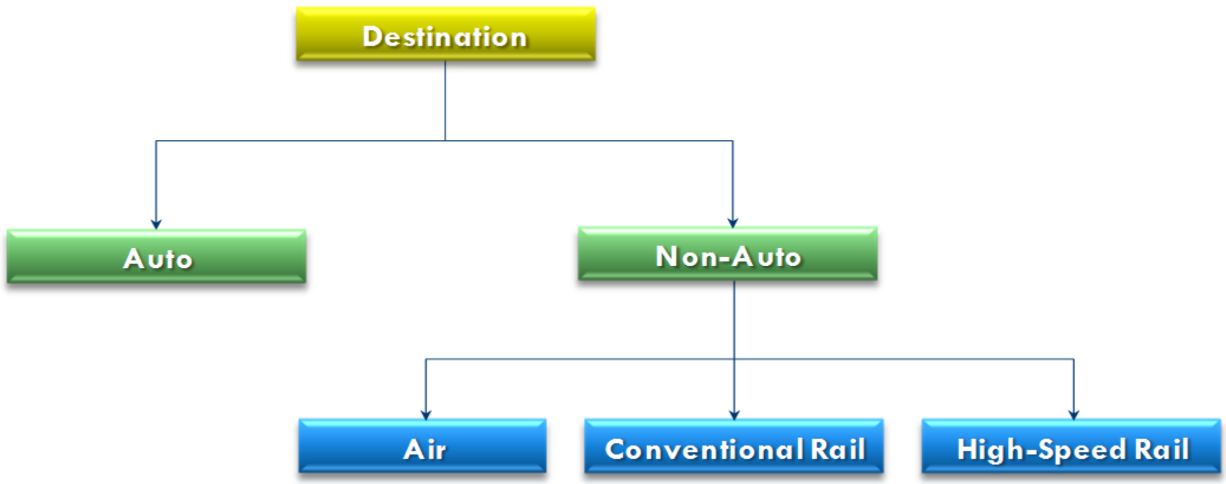
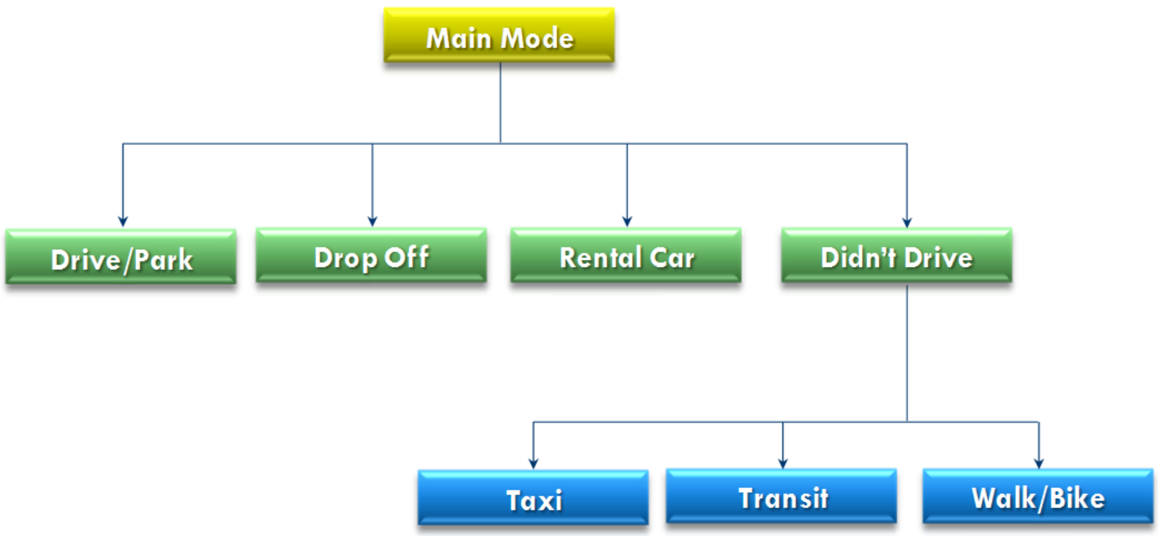


Figure 2-5: Access and Egress Model Choice Model Structure



2.3.3 Trip Assignment

Trips are combined from the intra- and inter-regional travel models into trip tables for each mode and trip purpose. The trips may then be assigned to their respective networks (highway, air, conventional rail, and high speed rail). In application, only the highway and high speed rail assignments are typically performed.

2.4 Key Components

2.4.1 Intra-regional (Urban) Models

The intra-regional models were developed so that they could be integrated with existing MPO regional models and the Caltrans Statewide Model. To that end, the intra-regional models relied upon existing trip tables to provide a more streamlined modeling process. School trips were included as trip tables for auto trips, but not in the mode choice models, as they were not likely to produce many high-speed rail trips. The following trip purposes were modeled:

- Home-based work
- Home-based shop/other
- Home-based social/recreation
- Non-home-based

The urban mode choice models included a variety of transit modes appropriate for each locale, but not specifically a high-speed rail mode. The San Francisco (MTC) urban mode choice models were modified to include a high-speed rail mode in order to model intra-regional high-speed rail trips for the San Francisco Bay Area and the Los Angeles region. The San Diego intra-regional trips were estimated based upon expected high-speed rail trips per person rather than by applying the local regional travel model.

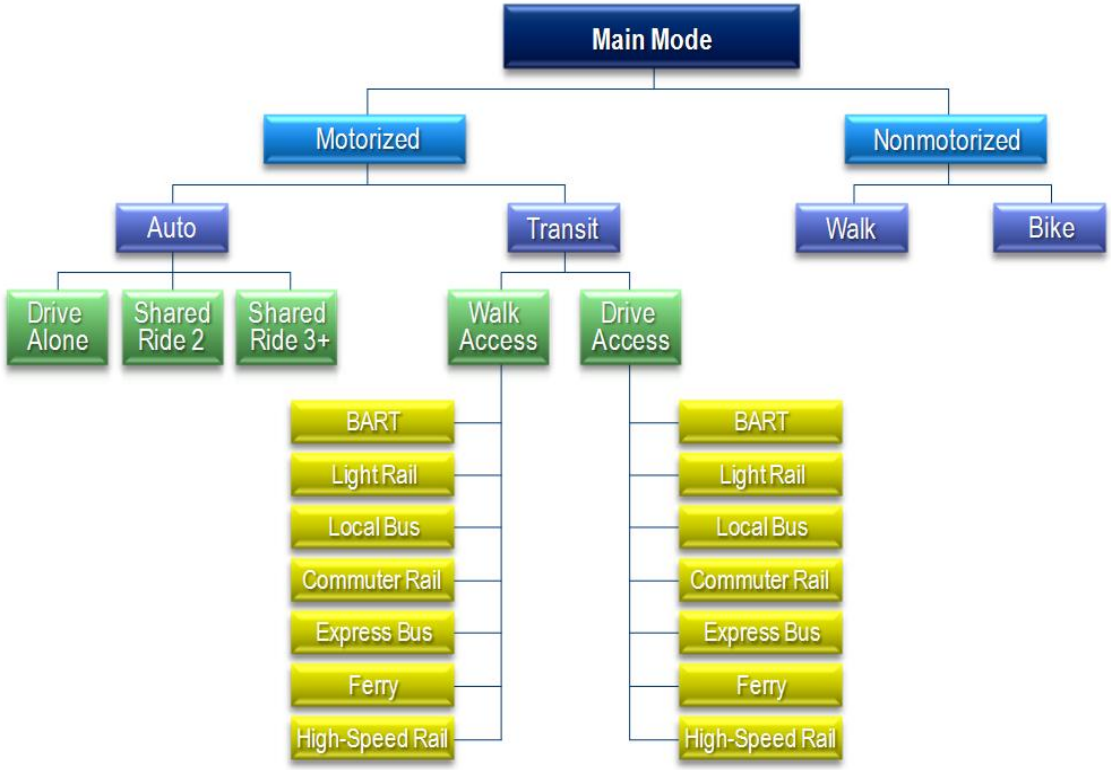
In addition to explicitly modeling mode choice in the three regions with multiple high-speed rail stations, it was necessary account for intra-regional auto travel for all other regions. Although there was no need for mode choice models in these regions, it was necessary to accurately represent congestion in these areas in order to model realistic travel times for auto trips across the State. These auto trip tables were derived from the Caltrans Statewide Model, but could be replaced with local or regional trip tables for statewide corridor or regional planning studies in the future.

San Francisco (MTC) Intra-regional Mode Choice Models

Intra-regional mode choice models for the high-speed rail study were developed using the MTC Baycast mode choice models as a starting point. In early 2010, the MTC intra-regional mode choice models were updated to include detailed consideration and modeling of sub-mode choices and were calibrated for both peak and off-peak periods for all trip purposes. The revised mode choice model structure is shown in Figure 2-6.

The coefficients and utility equations for all modes were derived from the original MTC mode choice models. The high-speed rail mode was established to emulate the commuter rail mode, with the same coefficients and constants for each purpose and time period. Model calibration consisted of adjusting mode-specific constants until the modeled mode shares matched observed targets for the year 2000. Model constants were specified in a manner similar to what was used for the original MTC Baycast model with the exception that constants were applied for transit submodes rather than just for total transit. Constants were calibrated by purpose, (production) county, time of day, and submode.

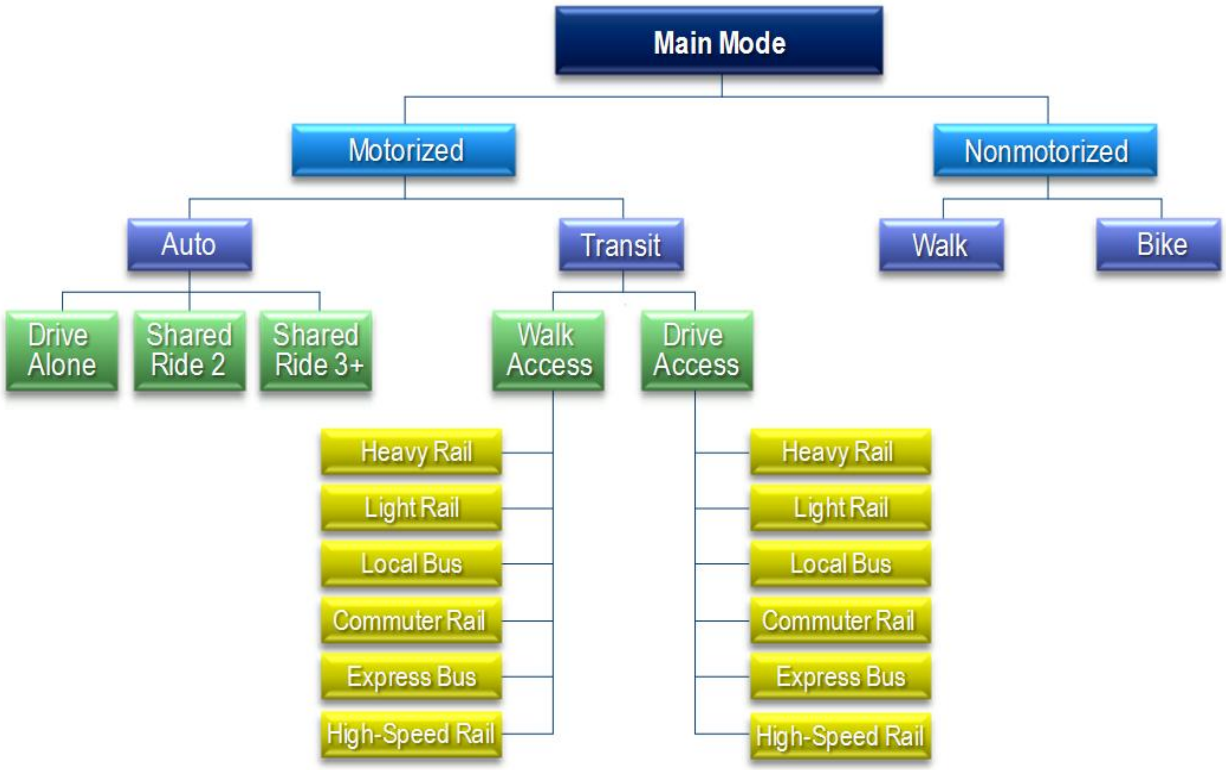
Figure 2-6: MTC Intra-Regional Mode Choice Structure



Greater Los Angeles (SCAG) Regional Mode Choice Models

The SCAG regional mode choice models were adapted from the MTC regional mode choice models for the same purposes and time period, with the exception that the home-based work off-peak and non-work purposes retained the full nested model structure with separate sub-modes for drive access. The revised SCAG mode choice model structure is shown in Figure 2-7. This procedure was used to meet the schedule for high-speed rail forecasts required for environmental documentation, and is a more simplified mode choice model than is used by SCAG. It was calibrated to match SCAG's validation dataset by mode, purpose, and time period.

Figure 2-7: SCAG Intra-Regional Mode Choice Structure



California Statewide Auto Trip Tables

None of the other California regions have more than one proposed high-speed rail station and do not generate intra-regional high-speed rail trips. However, intra-regional auto trips were estimated from the Caltrans Statewide Model and included in auto assignments to accurately reflect congestion for these other regions.

The Caltrans Statewide Model was used to develop auto trip tables for the 11 other regions in the State beyond San Francisco and Los Angeles regions:

Sacramento region	Fresno/Madera Counties	Central Coast region
San Joaquin County	South San Joaquin Valley region	West Sierra Nevada region
Stanislaus County	Kern County	Far North region
Merced County	Monterey Bay Area region	

The Caltrans Statewide Model does not distinguish between drive alone and shared ride, so these were all assumed to be drive alone trips. Since the majority of the high-occupancy vehicle (HOV) lanes are contained within the San Francisco and Los Angeles regions in the State, this assumption was reasonable given the available data and resources.

2.4.2 Inter-regional Models

Inter-regional trips were estimated using survey data collected for this study, coupled with other relevant survey data sources. The model estimated all inter-regional trips by purpose and length; identified which region the inter-regional trips were destined to; and access, egress, and line-haul modes used during the inter-regional trips. The inter-regional models were comprised of four sets of models: trip frequency, destination choice, main mode choice, and access/egress mode choice.

Trip Frequency Model

The trip frequency model component forecasted the number of inter-regional trips that individuals in a household made based upon the household's characteristics and location. There were eight multinomial logit (MNL) trip frequency models that predicted daily inter-regional person trips, segmented by trip purpose (business, commute, recreation, and other) and length (over or under 100 miles). The MNL formulation allowed important explanatory variables, such as accessibility measures, to affect the propensity to make inter-regional trips. In this case, the composite logsums[1] from the destination choice model were fed back to the trip frequency model to account for travel induced by high-speed rail (or any other new services). The trip frequency models were segmented by length to allow different model specifications and parameters for short and long trips. For each model, the choice set for each person included zero, one, or two or more inter-regional trips per day.

Destination Choice

The destination choice component predicted the destinations of the generated trips based on zonal characteristics and travel impedances. The dataset used for the trip frequency models (comprised of interregional trips from the 2000/2001 California Statewide survey, the SCAG household survey, the SACOG household survey and the MTC/BATS household survey) was combined with revealed travel data collected in the stated-preference (SP) survey (used in the mode choice models) to produce a combined estimation dataset for the destination choice estimation models. The addition of the SP dataset significantly increased the number of "long" (more than 100 miles) trips in the dataset (by nature, the household surveys are generally better at capturing the more typical "short" trips).

The short trip destination choice models used all four trip purposes modeled in the trip frequency step: business, commute, recreation, and other. Due to sample size considerations, only two aggregate trip purposes were estimated for the long trip destination choice models: business/commute and recreation/other.

The models used multimodal composite logsums from the mode choice models. In the destination choice models, this measure represents the combined utility of all available modal choices and level of service characteristics. All of the destination choice models used a distance power series, including distance, distance squared, and distance cubed. An area type was assigned to each destination zone (rural, suburban, or urban). The models included several interaction terms to capture whether travelers were starting and ending in the same area type (rural to rural, suburban to suburban, and urban to urban).

Mode Choice

The mode choice components predict the modes that the travelers would choose based on the mode service levels and characteristics of the travelers and trips. The mode choice models include a main mode choice, where the primary inter-regional mode is selected; and access/egress components, where the modes of access and egress for the air and rail trips are selected. The models were based on actual reported and stated preference data. The nesting structure for the main mode choice model is shown in Figure 2-4.

[1] A logsum is the expected maximum utility (EMU) of all the alternatives in a choice set

The main mode choice models were estimated using the SP data collected for the study. The main mode choice used the access and egress mode choice logsums to represent the combined utilities of all available access and egress modal choices and level of service characteristics. In the SP surveys, for people who were intercepted making actual air or rail journeys, the access and egress mode choices were the actual reported modes. For people whose actual journey was by car, the air and conventional rail access/egress mode choices were hypothetical. Obviously, the high-speed rail access and egress mode choices are hypothetical for all respondents.

For access, the majority of respondents reported either driving or parking at the station/airport or else being dropped off. For egress, the reported mode shares varied more by purpose and distance, with transit more popular for short trips, and rental car and taxi more popular for long trips and business trips. In all there were six modes considered for each. A nested structure was adopted, as shown in Figure 2-5.

2.5 Model Estimation Results

The travel characteristics of the market population were measured in revealed and stated preference surveys, which link information about the traveler to travel choices they made. In the former case those choices are those actually made, while the latter are used to assess their likely choices for situations or choices that do not exist, such as markedly higher fuel prices, new modes of transportation, etc. Once these data were collected and cross-tabulated, mathematical models that correlate traveler and household characteristics to the observed or hypothetical travel choices were constructed. Most of these models included parameters that are derived through a formal process known as statistical (or model) estimation. Statistical measure of the value, variation, and statistical significance of each parameter are developed during this process. However, statistical estimation is only the beginning of the modeling building process. The estimated parameters might deviate from accepted norms or be logically inconsistent, lack the desired level of statistical significance, or be difficult to forecast in practice. This might be due to limitations in the survey design, small sample sizes, inability of the survey respondents to understand or quantify questions, etc. Thus, analyst judgment and peer review are required for their interpretation. Moreover, the estimated values are often adjusted during model calibration or constrained to fall within commonly accepted bounds.

This section describes the results of the model estimation and calibration process. The model coefficients and constants described in this section were finalized in April 2007 and have been used for all model applications since that date.

2.5.1 Trip Frequency

The trip frequency models were segmented by trip length to allow different model specifications and parameters for short and long trips. For each model, the choice set for each person was zero, one, or two or more inter-regional trips per day. The final model specification constrained the variable coefficients of one-trip and two-trip choices to be equal, while allowing the alternative-specific constants for one- and two- trip choices to be estimated individually. As a result, the model was estimated as a binary MNL choice model comparing two "categories" of long distance trips: "don't make a long distance trip" versus "make a long distance trip". The "two or more trips" subcategory basically represented those travelers who elected to not stay overnight at their destination. In the application of the model, the "two or more trips" choice was specified using the same model coefficients as the "make a trip" choice and a constant was calibrated to produce the correct number of "two or more trips" trip makers (i.e. those who elected to not stay overnight at their destination).

Three types of variables were tested in the trip frequency models: socioeconomic, accessibility, and geographic region of residence. Even though the trip frequency models were estimated at the person level, estimation variables were constrained at the household level to be consistent with existing future year socioeconomic predictions. Socioeconomic variables that were tested in model specifications included:

- household size
- household size greater than two dummy variable
- number of household workers; zero-worker household dummy variable
- number of household vehicles
- number of household vehicles is less than the number of household workers dummy variable
- zero-vehicle household dummy variable; high household income (greater than $75,000);
- medium household income (between $35,0000 and $75,000); low household income (less than or equal to $35,000)
- a missing income dummy variable for survey records with no income collected. The missing income dummy variable was used during model estimation, but omitted from the final model specification for application.

As discussed above, the trip frequency models included measures that captured the accessibility of all relevant travel opportunities from travelers' home zones. For each residence, three peak/work and three off-peak/non-work accessibility measures were calculated for destinations in 1) their home region; 2) outside their region, within 100 miles of home; and 3) over 100 miles from home. The final model specifications relied on synthesized accessibility measures (a weighted travel time) for the within home region destinations, and on logsums calculated from the destination choice models for the remaining accessibility measures. The synthesized accessibility measure was necessary within the home region since the urban area models were not destination choice models (they were gravity models), and are therefore not capable of producing logsums for the destination choices within the region. A high calculated "regional accessibility" to jobs, goods, and services within one's region of residence indicated less need to travel outside of the region. Therefore, as expected, this variable had a negative effect on all inter-regional travel. Separate short (within 100 miles of residence and outside the residence region) and long (outside 100 miles of residence and outside the residence region) logsums were calculated to represent accessibility to goods and services outside of one's home region. A higher logsum outside a home region increased the likelihood that an inter-regional trip would be undertaken.

Tables 2-1 and 2-2 present the model estimation and model calibration results for the long and short trips in each of the four trip purposes (business, commute, recreation, and other). For the most part, only those variables that were significant at the 95 percent level were retained in the models. Logsum and regional accessibility coefficients for business, recreation and commute trips were constrained to those originally estimated for the commute purpose for both the short and long trip market segments. The basis for use of this value is that the commute purpose had the smallest coefficient of all purposes and resulted in more conservative and stable estimates of induced travel.

The estimation results followed an intuitive pattern. More workers per household increased the propensity to make inter-regional business and commute trips, but reduced the propensity to make inter-regional recreation and other trips. The income coefficients indicated that as income increased more inter-regional trips were taken. Households with fewer cars than workers were less likely to have the resources to undertake inter-regional travel. Three-person households were less likely to undertake inter-regional recreation and other trips, perhaps substituting this type activity closer to home.

Table 2-1: Trip Frequency Models - Long Trips

			Trip Purpose							
			Business		Commute		Recreation		Other	
Variable	Acronym	Definition	Coefficient	t-stat	Coefficient	t-stat	Coefficient	t-stat	Coefficient	t-stat
1	regacc	Regional accessibility	-0.217	Constr	-0.217	Constr	-0.217	Constr	-0.217	Constr
2	slogsum	Short trip logsum								
3	llogsum	Long trip logsum	0.123	Constr	0.123	Constr	0.123	Constr	0.123	Constr
4	hhsizen	Household size								
5	onephh	One person household? (0/1)							-0.424	-2.0
6	threephh	Three person household? (0/1)					-0.482	-3.9	-0.378	-2.8
7	medinc	Medium income household? (0/1)	0.527	1.5	0.188	0.8				
8	highinc	High income household? (0/1)	1.139	3.0	0.291	1.1	-0.246	-1.3	0.393	2.1
9	missinc	Missing income household? (0/1) (used for model estimation only)	0.955	2.3	0.340	1.1	0.282	1.3	0.158	0.7
10	nocars	Zero car household? (0/1)								
11	carsltw	Fewer autos than workers? (0/1)	-0.412	-1.0	-0.457	-1.6	-0.922	-2.4	-0.915	-2.2
12	wkrspps	Workers / household size	0.537	1.9	1.274	5.8				
13	sacog	Resident in SACOG region? (0/1)	0.234	Constr	0.011	Constr	1.807	Constr	4.080	Constr
14	sandag	Resident in SANDAG region? (0/1)	-0.174	Constr	-0.342	Constr	1.286	Constr	3.685	Constr
15	mtc	Resident in MTC region? (0/1)	-0.683	Constr	-1.421	Constr	3.002	Constr	4.676	Constr
16	nowkrs	No worker household? (0/1)	-2.098	-3.4	-2.668	-3.7			0.372	2.4
17	scag	Resident in SCAG region? (0/1)	-0.274	Constr	-0.948	Constr	1.571	Constr	3.899	Constr
21	const1	Constant for 1 trip	-4.611	Constr	-2.674	Constr	-4.518	Constr	-8.510	Constr
22	const2	Constant for 2 or more trips	-5.247	Constr	-4.110	Constr	-6.081	Constr	-9.840	Constr

Table 2-2: Trip Frequency Tables - Short Trips

			Trip Purpose							
			Business		Commute		Recreation		Other	
Variable	Acronym	Definition	Coefficient	t-stat	Coefficient	t-stat	Coefficient	t-stat	Coefficient	t-stat
1	regacc	Regional accessibility	-0.176	Constr	-0.176	Constr	-0.176	Constr	-0.176	Constr
2	slogsum	Short trip logsum	0.262	Constr	0.262	Constr	0.262	Constr	0.262	Constr
3	llogsum	Long trip logsum								
4	hhsizen	Household size					-0.136	-3.5		
5	onephh	One person household? (0/1)					-0.401	-2.6		
6	threephh	Three person household? (0/1)								
7	medinc	Medium income household? (0/1)	0.331	1.2	1.045	6.0	0.355	2.5		
8	highinc	High income household? (0/1)	0.835	3.1	1.523	8.6	0.432	2.8		
9	missinc	Missing income household? (0/1) (used for model estimation only)	0.446	1.4	0.696	3.4	0.137	0.8		
10	nocars	Zero car household? (0/1)					-1.270	-2.5	-0.736	-1.6
11	carsltw	Fewer autos than workers? (0/1)	-0.947	-2.4	-0.225	-1.6				
12	wkrspps	Workers / household size	1.153	5.0	1.570	13.0				
13	sacog	Resident in SACOG region? (0/1)	-0.653	Constr	-0.816	Constr	-2.365	Constr	-3.181	Constr
14	sandag	Resident in SANDAG region? (0/1)	-0.121	Constr	-1.673	Constr	-1.767	Constr	-1.157	Constr
15	mtc	Resident in MTC region? (0/1)	-0.898	Constr	-2.216	Constr	-1.834	Constr	-3.306	Constr
16	nowkrs	No worker household? (0/1)	-0.863	-2.5	-2.163	-5.9	-0.493	-4.8		
17	scag	Resident in SCAG region? (0/1)	-2.002	Constr	-2.406	Constr	-0.879	Constr	-0.467	Constr
21	const1	Constant for 1 trip	-4.614	Constr	-3.062	Constr	-2.958	Constr	-3.798	Constr
22	const2	Constant for 2 or more trips	-5.182	Constr	-3.890	Constr	-3.864	Constr	-4.575	Constr

Regional dummy variables for the MTC, SANDAG, SACOG, and SCAG regions were included to account for the different inter-regional trip-making patterns observed for residents of large metropolitan areas compared to residents in the rest of California. These were calibrated to match observed trips in these regions. Generally, the size and sign of the constants were reasonable. The large negative constants on inter-regional trips (i.e. the 1 trip and 2 or more trips constants) indicated that, all other things being equal, people would prefer to travel within their own region

A number of coefficients and constants shown in Tables 2-1 and 2-2 are listed as "Constr" for "constrained." There are two types of constraints implied. The first, used for the regional accessibility and logsum coefficients are constraints used in the model estimation process. The second type of constraint was for model constants adjusted during the model calibration process. For the trip frequency models, the model constants included the region specific dummy variables for the MTC, SANDAG, SACOG, and SCAG regions and the 1 trip and 2 or more trips constants.

2.5.2 Destination Choice

The destination choice models were estimated using a simple multinomial logit model structure. The estimation dataset used the trip frequency dataset combined with the SP survey (used in the mode choice models) to increase the number of long (more than 100 miles) trips in the dataset[2] Since the trip frequency models already differentiate between the two, this information can be used as a valuable input to the destination choice models. This not only constrained an individual's choice set based on destinations being greater or less than 100 miles, but it recognized that an individual may have valued different trip characteristics for different distance categories of travel.

The short trip destination choice models used all four trip purposes modeled in the trip frequency step (business, commute, recreation, and other). Due to sample size considerations, only two aggregate trip purposes were estimated for the long trip destination choice models (business/commute and recreation/other). The estimated coefficients of the long and short trip destination models are shown in Tables 2-8 and 2-9.

All of the destination choice models used a distance power series, including distance, distance squared, and distance cubed. An area type is assigned to each destination zone (rural, suburban, or urban). The models use several interaction terms to capture whether travelers were starting and ending in the same area type (rural to rural, suburban to suburban, and urban to urban).

Similar to the area type interaction variables, regional interaction variables related where the traveler wanted to go, based on the origin and destination regions for the trip. Based on the four major regions (MTC, SCAG, SANDAG, and SACOG) twelve regional interaction variables (excluding intra-regional interactions) were used for the long distance destination choice models. For the short distance destination choice models, only regional interactions between MTC and SACOG, and between SCAG and SANDAG were logical. These were adjusted during model calibration to match observed travel patterns.

Size functions measured the amount of activity that occurred at each destination zone, and incorporate this into the utility of alternative variables. This variable was used in the destination choice models to account for differences in zone sizes and employment levels. Four size variables were used in these models (retail employment, service employment, other employment, and households). Other employment was used as the base size variable for business and commute trips and is constrained to 1.0, while retail and service were further segmented by household income levels – low, medium, high, and missing. Households were used as the base size variable for recreation and other trips. Income was used as a per person variable as an interaction between employment and income to show that different income levels of the destination choices affected the attractiveness of the zone for particular travelers.

[2] By nature, the household surveys are generally better at capturing the more typical "short" trips.

A number of coefficients and constants shown in Tables 2-3 and 2-4 are listed as "Constr" for "constrained." As with the trip frequency models, there are two types of constraints implied. The first, used for the mode choice logsum and logsum multiplier (L_S_M) coefficients, includes constraints used in the model estimation process. The second type of constraint was for model constants and dummy variables that, in effect, acted like model constants. The constants were adjusted during the model calibration process. For the destination choice models, the variables included in the second "constraint" group included destination district and regional interaction variables.

2.5.3 Mode Choice

2.5.3.a Access/Egress Mode Choice Models

Two types of mode choice models were developed for this study. One focused on the primary mode choice, while the other addressed access and egress to and from airports and rail stations serving the main modes.

The results of the access/egress mode choice models are shown in Table 2-5 and 2-6 below. A reasonable value of time was asserted for each market segment through the constraint of the coefficients of in-vehicle time and cost. These constraints were based upon a review of other research. As the survey was not designed primarily to estimate access and egress choice models, and the zone size in a statewide model was quite large for this type of local choice, the fact that access and egress time and cost parameters had to be constrained was, perhaps, not surprising. Also note that the costs of options, such as taxi and rental car and airport/station parking, could not be readily obtained from network data. Other results of note included:

- The out-of-vehicle time coefficients were estimated for most segments, and resulted in ratios of out-of-vehicle time to in-vehicle time in the range of 2.0 to 2.9.
- The drop off and pick up alternatives had an additional negative in-vehicle time effect, capturing the disutility of the driver that had to make a round trip to the airport.
- Taxi cost was not explicitly included, but the model did include an additional distance coefficient for taxi, which was statistically significant and negative for most segments, typically with an equivalent value of over $1.00 per mile.
- For most segments, transit was less likely to be chosen if there was no reasonable walk access to transit, meaning that a drive to transit path was included instead.
- For most segments, transit (which can include rail and/or bus) was more likely to be chosen if rail was included in the best transit path.
- For the long segments, taxi, parking, and rental cars were generally less desirable to rail stations than to airports, while transit was more desirable from rail stations. Walking was very rare to or from airports, capturing accessibility effects that were not captured well in the zone system.
- Drive-and-park access was less likely at the busiest airports – SFO, LAX, and SAN – and, somewhat, at SJC as well. This may have captured both cost and inconvenience effects at those airports. For most segments, those in larger households were more likely to be dropped off.

In general, high income favored rental car, taxi, and drive and park, while low income slightly favored transit in some segments.

Table 2-3: Destination Choice Models for Long Trips

			Trip Purpose			
			Business / Commute		Recreation / Other	
Variable	Acronym	Definition	Coefficient	t-stat	Coefficient	t-stat
Accessibility Variables						
1	mlogsum	Mode choice logsum	0.053	Constr	0.053	Constr
2	distance	Distance (miles)	-0.024	-8.5	-0.031	-11.7
3	distsqu	Distance squared	0.000	8.9	0.000	10.8
4	distcub	Distance cubed	0.000	-8.0	0.000	-9.5
Area Types						
6	durban	Urban destination? (0/1)	0.724	6.7	0.810	9.5
7	drural	Rural destination? (0/1)	0.222	2.0	0.607	6.8
8	urburb	Urban to urban movement? (0/1)	-0.010	-0.1	-0.096	-0.8
9	subsub	Suburban to suburban movement? (0/1)	-0.185	-1.5	-0.029	-0.3
10	rurrur	Rural to rural movement? (0/1)	-0.112	-0.7	-0.036	-0.3
Destination District						
41	AMBAG	AMBAG	-0.242	Constr	0.183	Constr
42	CC	Central Coast	-0.255	Constr	1.334	Constr
43	FN	Far North	-1.728	Constr	-0.839	Constr
44	FM	Fresno	-0.685	Constr	-0.150	Constr
45	Kern	Kern	0.476	Constr	0.522	Constr
46	Merced	Merced	-0.855	Constr	-0.094	Constr
47	SSJ	S. San Joaquin	-0.144	Constr	0.547	Constr
48	SACOG	SACOG				
49	SANDAG	SANDAG	-5.072	Constr	-4.395	Constr
50	SJ	San Joaquin	-0.108	Constr	-0.375	Constr
51	Stan	Stanislaus	-1.043	Constr	-1.426	Constr
52	WSN	W. Sierra Nevada	-0.134	Constr	0.407	Constr
53	MTC	Alameda	-0.678	Constr	5.000	Constr
54	MTC	Contra Costa	0.226	Constr	5.000	Constr
55	MTC	Marin/Sonoma/Napa	0.149	Constr	5.000	Constr
56	MTC	San Francisco	-0.847	Constr	5.000	Constr
57	MTC	San Mateo	-0.687	Constr	5.000	Constr
58	MTC	Santa Clara	-0.710	Constr	5.000	Constr
59	MTC	Solano	0.800	Constr	5.000	Constr
60	SCAG	Los Angeles	-1.810	Constr	5.000	Constr
61	SCAG	Orange	-2.945	Constr	5.000	Constr
62	SCAG	Riverside	0.096	Constr	5.000	Constr
63	SCAG	San Bernardino	-4.416	Constr	5.000	Constr
64	SCAG	Ventura	-3.831	Constr	5.000	Constr
65	SCAG	Destination district	-3.001	Constr	5.000	Constr
Regional Interactions						
71	mtcscag	MTC to SCAG	-1.123	Constr	-6.400	Constr
72	mtcsandag	MTC to SANDAG	1.142	Constr	3.632	Constr
73	sacogscag	SACOG to SCAG	-1.736	Constr	-1.274	Constr
74	sacogsand	SACOG to SANDAG	0.368	Constr	8.000	Constr
75	scagmtc	SCAG to MTC	-1.123	Constr	-6.400	Constr
76	scagsacog	SCAG to SACOG	-1.736	Constr	-1.274	Constr
77	sandagmtc	SANDAG to MTC	1.142	Constr	3.632	Constr
78	sandagsac	SANDAG to SACOG	0.368	Constr	8.000	Constr
79	mtcsacog	MTC to SACOG	0.770	Constr	0.532	Constr
80	sacogmtc	SACOG to MTC	0.770	Constr	0.532	Constr
81	scagsanda	SCAG to SANDAG	5.403	Constr	8.098	Constr
82	sandagsca	SANDAG to SCAG	5.403	Constr	8.098	Constr
Size Variables						
0	L_S_M		1.000	Constr	1.000	Constr
101	loincret	Retail employment - low income	1.061	2.1	-0.041	-0.1
102	loincsvc	Service employment - low income	0.547	1.5	-1.250	-3.6
103	mdincret	Retail employment - medium income	2.232	4.9	-0.163	-0.4
104	mdincsvc	Service employment - medium income	0.829	1.8	-0.985	-3.3
105	hiincret	Retail employment - high income	1.993	5.6	0.326	0.8
106	hiincsvc	Service employment - high income	0.926	2.8	-0.933	-2.4
107	msincret	Retail employment - missing income (model estimation only)	12.991	0.1	-6.851	-0.1
108	msincsvc	Service employment - missing income (model estimation only)	12.343	0.1	-0.836	-1.4

Table 2-4: Destination Choice Models For Short Trips

		Trip Purpose							
		Business		Commute		Recreation		Other	
Variabl Acronym	Definition	Coefficient	t-stat	Coefficient	t-stat	Coefficient	t-stat	Coefficient	t-stat
Accessibility Variables									
1 mlogsum	Mode choice logsum	0.332	Constr	0.332	Constr	0.332	Constr	0.332	Constr
2 distance	Distance (miles)	-0.130	-3.7	-0.130	-6.1	-0.166	-7.9	-0.104	-4.0
3 distsqu	Distance squared	0.002	2.3	0.001	2.7	0.001	3.3	0.001	1.1
4 distcub	Distance cubed	0.000	-1.7	0.000	-1.8	0.000	-1.2	0.000	-0.3
Area Types									
6 durban	Urban destination? (0/1)	0.760	3.8	0.872	7.4	0.502	3.8	0.419	2.3
7 drural	Rural destination? (0/1)	0.036	0.2	0.126	1.1	0.081	0.6	0.190	1.1
8 urburb	Urban to urban movement? (0/1)	-0.499	-1.6	-0.019	-0.1	-0.142	-0.7	0.457	1.9
9 subsub	Suburban to suburban movement? (0/1)	0.253	1.1	-0.055	-0.4	0.051	0.3	-0.016	-0.1
10 rurrur	Rural to rural movement? (0/1)	-0.505	-1.8	-0.075	-0.5	0.336	1.9	0.245	1.0
Destination District									
41 AMBAG	AMBAG	-0.245	Constr	-5.730	Constr	5.366	Constr	6.909	Constr
42 CC	Central Coast	-2.553	Constr	-11.136	Constr	-4.168	Constr	-0.469	Constr
43 FN	Far North	4.294	Constr	0.805	Constr	11.121	Constr	15.867	Constr
44 FM	Fresno	-0.441	Constr	-7.272	Constr	2.226	Constr	4.798	Constr
45 Kern	Kern	0.274	Constr	-12.241	Constr	-5.457	Constr	-0.586	Constr
46 Merced	Merced	-1.435	Constr	-7.268	Constr	2.332	Constr	2.307	Constr
47 SSJ	S. San Joaquin	-0.008	Constr	-2.153	Constr	3.938	Constr	3.948	Constr
48 SACOG	SACOG								
49 SANDAG	SANDAG	-3.182	Constr	-13.230	Constr	-3.518	Constr	-2.171	Constr
50 SJ	San Joaquin	0.556	Constr	0.474	Constr	4.412	Constr	4.915	Constr
51 Stan	Stanislaus	0.244	Constr	-0.352	Constr	4.894	Constr	4.152	Constr
52 WSN	W. Sierra Nevada	1.634	Constr	0.386	Constr	5.284	Constr	4.601	Constr
53 MTC	Alameda	-0.275	Constr	0.816	Constr	1.601	Constr	2.174	Constr
54 MTC	Contra Costa	0.265	Constr	1.254	Constr	2.294	Constr	2.311	Constr
55 MTC	Marin/Sonoma/Napa	0.118	Constr	1.129	Constr	2.831	Constr	1.166	Constr
56 MTC	San Francisco	-0.109	Constr	0.447	Constr	0.878	Constr	1.140	Constr
57 MTC	San Mateo	-0.010	Constr	0.961	Constr	1.288	Constr	1.588	Constr
58 MTC	Santa Clara	-0.244	Constr	0.325	Constr	2.296	Constr	2.010	Constr
59 MTC	Solano	-0.218	Constr	1.453	Constr	1.525	Constr	2.398	Constr
60 SCAG	Los Angeles	-2.226	Constr	-9.274	Constr	4.265	Constr	4.549	Constr
61 SCAG	Orange	-3.617	Constr	-10.991	Constr	2.931	Constr	2.665	Constr
62 SCAG	Riverside	-3.139	Constr	-1.875	Constr	-1.207	Constr	-2.258	Constr
63 SCAG	San Bernardino	-3.764	Constr	-9.920	Constr	2.438	Constr	2.456	Constr
64 SCAG	Ventura	-2.226	Constr	-9.274	Constr	3.274	Constr	4.437	Constr
65 SCAG	Destination district	-3.072	Constr	-9.405	Constr	3.663	Constr	3.749	Constr
Regional Interactions									
71 mtcscag	MTC to SCAG								
72 mtcsandag	MTC to SANDAG								
73 sacogscag	SACOG to SCAG								
74 sacogsand	SACOG to SANDAG								
75 scagmtc	SCAG to MTC								
76 scagsacog	SCAG to SACOG								
77 sandagmtc	SANDAG to MTC								
78 sandagsac	SANDAG to SACOG								
79 mtcsacog	MTC to SACOG	2.700	Constr	-0.467	Constr	7.140	Constr	10.368	Constr
80 sacogmtc	SACOG to MTC	2.700	Constr	-0.467	Constr	7.140	Constr	10.368	Constr
81 scagsanda	SCAG to SANDAG	-1.079	Constr	0.095	Constr	0.746	Constr	-2.362	Constr
82 sandagsca	SANDAG to SCAG	-1.079	Constr	0.095	Constr	0.746	Constr	-2.362	Constr
Size Variables									
0 L_S_M		1.000	Constr	1.000	Constr	1.000	Constr	1.000	Constr
101 loincret	Retail employment - low income	0.038	0.0	2.285	3.7	0.149	0.3	-10.195	0.0
102 loincsvc	Service employment - low income	1.228	2.1	1.106	1.7	-2.674	-1.0	-1.478	-2.4
103 mdincret	Retail employment - medium income	0.718	1.2	1.162	4.1	-0.108	-0.2	-11.112	0.0
104 mdincsvc	Service employment - medium income	-0.057	-0.1	0.057	0.2	-0.716	-2.0	-0.987	-2.2
105 hiincret	Retail employment - high income	3.146	3.1	2.328	6.1	-0.157	-0.2	1.007	1.8
106 hiincsvc	Service employment - high income	1.002	0.9	1.114	2.9	-1.778	-1.4	-1.002	-0.8
107 msincret	Retail employment - missing income (model estimation only)	0.567	0.6	0.811	1.3	0.630	0.8	0.286	0.4
108 msincsvc	Service employment - missing income (model estimation only)	-1.592	-0.7	-0.249	-0.4	-1.167	-0.8	-11.537	-0.1

There was a logsum coefficient less than 1.0 in the nest that included transit, walk, and taxi. Each of the other three alternatives was in its own branch of the nest, and scaled by the same logsum parameter to preserve equal scaling at the elemental level. The scale (the inverse of the residual error variance) for the hypothetical choices relative to the actual choices was significantly lower than 1.0 for most of the egress model segments.

This result indicated that many respondents had difficulty making an accurate assessment of mode choice options in less familiar surroundings at the non-home end of their trip, so that hypothetical choices were weighted less in estimation than actual ones.

The coefficients for in-vehicle time and travel cost were the primary model coefficients that had to be constrained in the access and egress mode choice models. Other constrained variables in Tables 2-5 and 2-6 related to constants that were adjusted as part of the model calibration process. Constraints on logsum coefficients and scale parameters reflected the upper bounds on reasonable model coefficients. Those coefficients were not asserted in the model estimation process as were the in-vehicle time and travel cost coefficients, nor were they adjusted during the model calibration process. Rather, they were "constrained" in the model estimation process to be between 0 and 1.0.

2.5.3.b Primary Mode Choice Models

To prepare the data for estimation, the access and egress mode choice models were first applied to calculate access and egress mode logsums for each alternative. Then, a nested logit model was estimated across the four main modes for each of the segments (only three alternatives for the short segments since air was not available for those segments). The estimated coefficients for the primary mode choice model are shown in Table 2-7 below.

In initial model estimations, the value of frequency (headway) was statistically significant for all segments, but only at about 20 percent as large as the in-vehicle time coefficient. However, attempts to calibrate and validate the initial models were unsuccessful. Because none of the levels used in the SP had headways higher than a few hours, the implications for scheduling may not have been large enough to greatly influence mode choice. Since frequency of service is an important policy consideration, the coefficient was constrained in order to develop a model that could be successfully calibrated.

If wait time were half the headway and valued twice as highly as in-vehicle time (as is common in urban travel models), one would expect the same coefficient on headway and in-vehicle time. For these modes, and particularly air, headway is less related to wait time than it is to scheduling convenience[3]. Thus, a decision was made to estimate a common coefficient for travel time and frequency (headway). This type of constraint is different than asserting the value of a model coefficient since the variations in travel time and in frequency are both considered in the estimation of the common coefficient. In Table 2-7, the coefficients for travel time and service headway are the same within each market segment. The coefficient of service headway has an associated t-score while the coefficient of travel time is shown as "constrained." In effect, the t-score is for the common coefficient estimated for service headway and travel time. The model was successfully calibrated and validated using this approach.

[3] Note that average wait times by mode are included in the main mode choice models. Wait times were found to be a function of mode, not frequency of service – average wait times for air travel were 55 minutes, regardless of the airport, frequency of service, or trip purpose. Since wait times are modeled as constant values for each of the three "public" modes, the effect of the wait times could be accounted for in the mode specific constants. In short, wait time for the main inter-regional modes is not a function of frequency of service and the frequency of service coefficient should not be construed as a measure of average wait time.

Table 2-5: Access Mode Choice Model

		Coefficient / Constant Applied for Mode						Long Trip: Business / Commute		Long Trip: Recreation / Other		Short Trip: Business		Short Trip: Commute		Short Trip: Recreation / Other	
Variab Acronym	Definition	Drive/ Park	Rental Car	Pick-up/ Drop-off	Taxi	Transit	Walk	Coefficient	t-stat	Coefficient	t-stat	Coefficient	t-stat	Coefficient	t-stat	Coefficient	t-stat
Level of Service Coefficients																	
1 ivt	In-vehicle time (minutes)	x	x	x	x	x		-0.060	Constr	-0.030	Constr	-0.040	Constr	-0.030	Constr	-0.025	Constr
2 cost	Cost ($)	x	x	x		x		-0.075	Constr	-0.120	Constr	-0.050	Constr	-0.100	Constr	-0.100	Constr
4 aivt-pkup	Pick-up/drop-off auto in-vehicle time (minutes)			x				-0.014	-2.5	-0.031	-3.1					-0.003	-0.7
5 adis-taxi	Pick-up/drop-off auto distance (miles)				x			-0.084	-4.8	-0.070	-3.8	-0.041	-0.8			-0.014	-2.4
12 ovt	Walk and wait time (minutes)					x	x	-0.147	-6.4	-0.083	-2.5	-0.100	-2.9	-0.060	Constr	-0.061	-2.5
17 carused	Car access to transit in transit access to main mode? (0/1)					x		-4.836	-4.6	-1.807	-1.9	-1.469	-1.1			-3.345	-3.6
21 railused	Rail used to access main mode? (0/1)					x		3.689	5.2	1.727	2.4	3.313	2.7			3.271	4.2
Constants																	
101 dp-acc	Access constant	x						4.923	Constr	4.356	Constr	4.166	Constr	5.000	Constr	3.232	Constr
102 dp-egr	Egress constant	x															
103 dp-cvr	To/from conventional rail? (0/1)	x															
104 dp-hsr	To/from high speed rail? (0/1)	x															
105 dp-alone	Traveling alone? (0/1)	x								-1.925	-3.0						
106 dp-nocars	Zero car household? (0/1)	x															
107 dp-carsltw	Fewer autos than workers? (0/1)	x						-1.547	-2.2	-1.903	-2.8			-3.775	-1.9	-1.166	-3.2
108 dp-lowinc	Low income household? (0/1)	x						-2.741	-1.8	-1.960	-2.8	-2.017	-1.2			-0.493	-1.6
109 dp-hiinc	High income household? (0/1)	x						0.709	1.6	0.339	1.4						
110 dp-misinc	Missing income household? (0/1) (for model estimation only)	x															
111 dp-laxacc	Access LAX airport? (0/1)	x						-3.128	-3.8	-1.275	-1.7						
112 dp-sfoacc	Access SFO airport? (0/1)	x						-4.082	-4.4	-3.036	-2.6						
113 dp-oakacc	Access OAK airport? (0/1)	x															
114 dp-sjcacc	Access SJC airport? (0/1)	x								-1.479	-2.1						
115 dp-sanacc	Access SAN airport? (0/1)	x						-1.410	-2.3	-1.370	-2.3						
116 dp-buracc	Access BUR airport? (0/1)	x															
201 rc-acc	Access constant		x					-5.547	Constr	-5.000	Constr						
202 rc-egr	Egress constant		x														
203 rc-cvr	To/from conventional rail? (0/1)		x					-3.000	Constr	-5.000	Constr						
204 rc-hsr	To/from high speed rail? (0/1)		x														
205 rc-alone	Traveling alone? (0/1)		x														
206 rc-nocars	Zero car household? (0/1)		x					5.110	3.2								
207 rc-carsltw	Fewer autos than workers? (0/1)		x														
208 rc-lowinc	Low income household? (0/1)		x														
209 rc-hiinc	High income household? (0/1)		x					2.953	2.4								
211 rc-misinc	Missing income household? (0/1) (for model estimation only)		x														
301 sp-onephh	One person household? (0/1)			x													
302 sp-hhsize	Household size			x				0.606	2.9	0.478	2.8			0.672	1.4	0.273	2.6
401 tx-acc	Access constant				x			1.771	Constr	-2.155	Constr	-1.682	Constr	-4.104	Constr	-0.024	Constr
402 tx-egr	Egress constant				x												
403 tx-cvr	To/from conventional rail? (0/1)				x			-2.827	-2.6	-2.265	-2.4						
404 tx-hsr	To/from high speed rail? (0/1)				x					-1.092	-2.1						
405 tx-alone	Traveling alone? (0/1)				x					-0.877	-1.8						
406 tx-nocars	Zero car household? (0/1)				x												
407 tx-carsltw	Fewer autos than workers? (0/1)				x												
408 tx-lowinc	Low income household? (0/1)				x			-3.010	-1.9								
409 tx-hiinc	High income household? (0/1)				x					0.849	1.9						
411 tx-misinc	Missing income household? (0/1) (for model estimation only)				x												
501 tr-acc	Access constant					x		4.390	Constr	-1.908	Constr	5.000	Constr	5.000	Constr	1.052	Constr
502 tr-egr	Egress constant					x											
503 tr-cvr	To/from conventional rail? (0/1)					x											
504 tr-hsr	To/from high speed rail? (0/1)					x											
505 tr-alone	Traveling alone? (0/1)					x				1.569	2.3						
506 tr-nocars	Zero car household? (0/1)					x				1.439	1.7						
507 tr-carsltw	Fewer autos than workers? (0/1)					x		1.480	2.1							1.985	2.6
508 tr-lowinc	Low income household? (0/1)					x				0.846	1.0						
509 tr-hiinc	High income household? (0/1)					x										0.000	Constr
511 tr-misinc	Missing income household? (0/1) (for model estimation only)					x											
601 wk-acc	Access constant						x	5.000	Constr	4.696	Constr	5.000	Constr	5.796	Constr	1.391	Constr
602 wk-egr	Egress constant						x										
603 wk-air	To/from airport? (0/1)						x	-3.000	Constr	-2.634	-1.0						
98 mlogsum	Logsum							0.387	5.9	0.451	3.3	0.570	4.3	0.458	2.0	1.000	Constr
99 hscale	Scale on hypothetical choices							0.682	15.9	1.000	Constr	1.000	Constr	1.000	Constr	1.000	Constr
Implied Value of Time								$48.00		$15.00		$48.00		$18.00		$15.00	
Ratio OVT/IVT								2.45		2.76		2.51		2.00		2.43	

Table 2-6: Egress Mode Choice Model

			Coefficient / Constant Applied for Mode						Long Trip				Short Trip					
									Business / Commute		Recreation / Other		Business		Commute		Recreation / Other	
Variable	Acronym	Definition	Drive/ Park	Rental Car	Pick-up/ Drop-off	Taxi	Transit	Walk	Coefficient	t-stat	Coefficient	t-stat	Coefficient	t-stat	Coefficient	t-stat	Coefficient	t-stat
Level of Service Coefficients																		
1	ivt	In-vehicle time (minutes)	x	x	x	x	x		-0.060	Constr	-0.030	Constr	-0.040	Constr	-0.030	Constr	-0.025	Constr
2	cost	Cost ($)	x	x	x		x		-0.075	Constr	-0.120	Constr	-0.050	Constr	-0.100	Constr	-0.100	Constr
4	aivt-pkup	Pick-up/drop-off auto in-vehicle time (minutes)			x						-0.015	-3.9						
5	adis-taxi	Pick-up/drop-off auto distance (miles)				x			-0.126	-7.9	-0.052	-6.6	-0.230	-3.1			-0.096	-3.5
12	ovt	Walk and wait time (minutes)					x	x	-0.139	-6.2	-0.060	Constr	-0.117	-3.1	-0.075	Constr	-0.050	Constr
17	carused	Car access to transit in transit access to main mode? (0/1)					x						-5.118	-4.3	-4.466	-6.2		
21	railused	Rail used to access main mode? (0/1)					x				2.960	5.0					2.570	3.5
Constants																		
101	dp-acc	Access constant	x															
102	dp-egr	Egress constant	x						1.751	Constr	-5.418	Constr	-0.635	Constr	-0.723	Constr	5.000	Constr
103	dp-cvr	To/from conventional rail? (0/1)	x						-9.490	-2.5								
104	dp-hsr	To/from high speed rail? (0/1)	x						-2.251	-1.8								
105	dp-alone	Traveling alone? (0/1)	x															
106	dp-nocars	Zero car household? (0/1)	x															
107	dp-carsltw	Fewer autos than workers? (0/1)	x															
108	dp-lowinc	Low income household? (0/1)	x						-18.006	-2.5	-1.263	-1.1						
109	dp-hiinc	High income household? (0/1)	x															
110	dp-misinc	Missing income household? (0/1) (for model estimation only)	x															
111	dp-laxacc	Access LAX airport? (0/1)	x															
112	dp-sfoacc	Access SFO airport? (0/1)	x															
113	dp-oakacc	Access OAK airport? (0/1)	x															
114	dp-sjcacc	Access SJC airport? (0/1)	x															
115	dp-sanacc	Access SAN airport? (0/1)	x															
116	dp-buracc	Access BUR airport? (0/1)	x															
201	rc-acc	Access constant		x														
202	rc-egr	Egress constant		x					5.979	Constr	1.827	Constr	-0.988	Constr	-5.000	Constr	5.000	Constr
203	rc-cvr	To/from conventional rail? (0/1)		x					-3.522	-2.4	-1.176	-3.1						
204	rc-hsr	To/from high speed rail? (0/1)		x							-0.552	-2.4						
205	rc-alone	Traveling alone? (0/1)		x							-2.588	-4.7						
206	rc-nocars	Zero car household? (0/1)		x														
207	rc-carsltw	Fewer autos than workers? (0/1)		x														
208	rc-lowinc	Low income household? (0/1)		x					-2.082	-0.9	-1.891	-3.7						
209	rc-hiinc	High income household? (0/1)		x														
211	rc-misinc	Missing income household? (0/1) (for model estimation only)		x														
301	sp-onephh	One person household? (0/1)			x													
302	sp-hhsize	Household size			x				0.974	2.8								
401	tx-acc	Access constant				x												
402	tx-egr	Egress constant				x			5.000	Constr	1.055	Constr	4.653	Constr	-1.425	Constr	5.000	Constr
403	tx-cvr	To/from conventional rail? (0/1)				x												
404	tx-hsr	To/from high speed rail? (0/1)				x			2.507	3.6								
405	tx-alone	Traveling alone? (0/1)				x					-2.768	-4.6						
406	tx-nocars	Zero car household? (0/1)				x												
407	tx-carsltw	Fewer autos than workers? (0/1)				x												
408	tx-lowinc	Low income household? (0/1)				x			-3.002	-2.3	-1.038	-2.3						
409	tx-hiinc	High income household? (0/1)				x											1.499	2.8
411	tx-misinc	Missing income household? (0/1) (for model estimation only)				x												
501	tr-acc	Access constant					x											
502	tr-egr	Egress constant					x		5.000	Constr	-3.655	Constr	5.000	Constr	5.000	Constr	5.000	Constr
503	tr-cvr	To/from conventional rail? (0/1)					x		3.580	5.2	1.830	2.8						
504	tr-hsr	To/from high speed rail? (0/1)					x		0.592	0.7	1.032	1.9						
505	tr-alone	Traveling alone? (0/1)					x											
506	tr-nocars	Zero car household? (0/1)					x											
507	tr-carsltw	Fewer autos than workers? (0/1)					x											
508	tr-lowinc	Low income household? (0/1)					x				1.216	1.9					1.948	2.2
509	tr-hiinc	High income household? (0/1)					x								-0.581	-1.1		
511	tr-misinc	Missing income household? (0/1) (for model estimation only)					x											
601	wk-acc	Access constant						x										
602	wk-egr	Egress constant						x	5.000	Constr	3.076	Constr	5.000	Constr	5.000	Constr	5.000	Constr
603	wk-air	To/from airport? (0/1)						x	-2.074	-2.0								
98	mlogsum	Logsum							0.280	6.9	0.470	5.3	0.649	2.9	0.487	2.6	0.758	4.1
99	hscale	Scale on hypothetical choices							0.516	9.8	1.000	Constr	0.412	3.0	0.334	5.2	0.610	4.8
Implied Value of Time									$48.00		$15.00		$48.00		$18.00		$15.00	
Ratio OVT/IVT									2.32		2.00		2.92		2.50		2.00	

Some of the results from the mode choice model estimation included the following:

- The cost and joint travel time/service headway parameters gave very reasonable values of time (VOT). In general, VOT for the longer, more expensive trips was higher than for the shorter, more frequent trips. This is a typical and expected outcome.
- The value of reliability was fairly low for all segments, although with the correct sign. It was very difficult to measure the effect of reliability in a large-scale mail-out SP survey, so it was decided to use a somewhat higher effect of reliability in application, based on evidence from elsewhere.
- Those traveling with others were more likely to use auto modes and less likely to use air. This effect was also tested on the cost coefficients and not found to be significant, so this relative mode preference appeared to be related to more than just cost (such as the fact that people can share driving for long trips). Party size models were estimated to generate these data, but not included here for brevity.
- People in larger households were more likely to use auto modes. Even though the group/alone segmentation was already used, people in larger households were likely to travel in larger groups.
- Higher income generally favored air and high speed rail over auto.
- Low auto availability within the household was related to less chance of choosing the auto.
- A nest with air, rail, and high-speed rail (with car in its own nest) produced a logsum coefficient below 1.0 for all segments, indicating that this was a reasonable nesting structure for inter-regional trips.
- The access mode choice logsums were estimated with positive coefficients in the range of 0.14 to 0.46 for all segments.

For the long trips, the egress mode accessibility seemed to have somewhat more influence on mode choice than did the access mode. Travelers may have been less constrained at the home end, where they knew the options and use their own auto than they were at the destination end.

The main mode choice model alternative specific constants are presented in Table 2-7. These constants include the wait time and terminal time, which were determined to be the same for each mode based on the evaluation of the level-of-service (LOS) assumptions. The table includes the actual constant for each mode including the effects of the wait time and terminal time components.

The high-speed rail constants were set based on an analysis of the original high-speed rail constants in the model estimation and the relationship to the air and rail constants by mode and purpose from the calibrated models. For short trips, the high-speed rail constant was similar to the rail constant, and for long trips the high-speed rail constant was between the air and rail constants. Airport interchange dummy variables were used as calibration constants to more closely match observed airport-to-airport trip movements.

Table 2-7: Main Mode Choice Models

			Coefficient / Constant Applied for Mode				Long Trip				Short Trip					
							Business / Commute		Recreation / Other		Business		Commute		Recreation / Other	
Variable	Acronym	Definition	Car	Air	Conv. Rail	High Speed Rail	Coefficient	t-stat	Coefficient	t-stat	Coefficient	t-stat	Coefficient	t-stat	Coefficient	t-stat
Level of Service Coefficients																
1	cost	Cost ($)	x	x	x	x	-0.017	-12.8	-0.035	-18.5	-0.109	Constr	-0.148	-11.3	-0.108	-8.1
2	time	In-vehicle time (minutes)	x	x	x	x	-0.018	Constr	-0.011	-14.2	-0.050	Constr	-0.025	Constr	-0.014	-5.2
3	reli	Reliability (Percent on time)	x	x	x	x	0.023	Constr	0.005	1.9	0.023	1.8	0.007	0.7	0.004	0.7
4	freq	Service headway (minutes)		x	x	x	-0.018	-19.1	-0.011	-14.7	-0.050	-18.1	-0.025	-12.7	-0.014	-8.4
5	accls	Access mode choice logsum					0.136	3.4	0.204	3.7	0.463	Constr	0.330	Constr	0.303	3.4
6	egrls	Egress mode choice logsum					0.171	3.9	0.399	7.1			0.330	Constr		
7	accls<-5	Access mode choice logsum less than -5? (0/1)														
8	egrls<-5	Egress mode choice logsum less than -5? (0/1)														
9	freq>60	Service headway greater than 60 minutes? (0/1)														
10	reli>90	Reliability greater than 90 percent? (0/1)														
Constants																
104	c-group	Traveling in a group? (0/1)	x				1.086	4.6	1.430	9.1						
105	c-nocars	Zero car household? (0/1)	x													
106	c-carslt2	Fewer than 2 cars for household size greater than 1? (0/1)	x						-0.308	-2.3	-1.114	-1.2	-1.824	-1.3	-0.728	-2.3
107	c-hhsize	Household size	x				0.182	1.2	0.296	4.4			0.877	1.7		
108	c-hiinc	High income household? (0/1)	x								-1.232	-2.3	-1.180	-1.6		
200	a-const	Mode constant		x			-10.269	Constr	-4.683	Constr						
207	a-loinc	Low income household? (0/1)		x												
208	a-hiinc	High income household? (0/1)		x			1.180	4.6								
209	a-msinc	Missing income household? (0/1) (for model estimation only)		x												
210	a-group	Traveling in a group? (0/1)		x			-0.356	-2.8	-0.505	-3.7						
211	{lax-sfo}	Airport interchange served? (0/1)		x			5.000	Constr	5.000	Constr						
212	{sfo-lax}	Airport interchange served? (0/1)		x			5.000	Constr	5.000	Constr						
213	{lax-oak}	Airport interchange served? (0/1)		x			5.000	Constr	5.000	Constr						
214	{oak-lax}	Airport interchange served? (0/1)		x			5.000	Constr	5.000	Constr						
215	{lax-sjc}	Airport interchange served? (0/1)		x			5.000	Constr	5.000	Constr						
216	{sjc-lax}	Airport interchange served? (0/1)		x			5.000	Constr	5.000	Constr						
217	{lax-sac}	Airport interchange served? (0/1)		x			5.000	Constr	5.000	Constr						
218	{sac-lax}	Airport interchange served? (0/1)		x			5.000	Constr	5.000	Constr						
221	{bur-sfo}	Airport interchange served? (0/1)		x			4.151	Constr	4.151	Constr						
222	{sfo-bur}	Airport interchange served? (0/1)		x			5.363	Constr	5.363	Constr						
223	{bur-oak}	Airport interchange served? (0/1)		x			2.032	Constr	2.032	Constr						
224	{oak-bur}	Airport interchange served? (0/1)		x			4.145	Constr	4.145	Constr						
225	{bur-sjc}	Airport interchange served? (0/1)		x			3.757	Constr	3.757	Constr						
226	{sjc-bur}	Airport interchange served? (0/1)		x			5.000	Constr	5.000	Constr						
227	{bur-sac}	Airport interchange served? (0/1)		x			5.602	Constr	5.602	Constr						
228	{sac-bur}	Airport interchange served? (0/1)		x			1.421	Constr	1.421	Constr						
231	{ont-sfo}	Airport interchange served? (0/1)		x			5.000	Constr	5.000	Constr						
232	{sfo-ont}	Airport interchange served? (0/1)		x			5.000	Constr	5.000	Constr						
233	{ont-oak}	Airport interchange served? (0/1)		x			2.233	Constr	2.233	Constr						
234	{oak-ont}	Airport interchange served? (0/1)		x			2.269	Constr	2.269	Constr						
235	{ont-sjc}	Airport interchange served? (0/1)		x			3.263	Constr	3.263	Constr						
236	{sjc-ont}	Airport interchange served? (0/1)		x			5.000	Constr	5.000	Constr						
237	{ont-sac}	Airport interchange served? (0/1)		x			5.907	Constr	5.907	Constr						
238	{sac-ont}	Airport interchange served? (0/1)		x			3.787	Constr	3.787	Constr						
241	{sna-sfo}	Airport interchange served? (0/1)		x			4.652	Constr	4.652	Constr						
242	{sfo-sna}	Airport interchange served? (0/1)		x			2.409	Constr	2.409	Constr						
243	{sna-oak}	Airport interchange served? (0/1)		x			-0.231	Constr	-0.231	Constr						
244	{oak-sna}	Airport interchange served? (0/1)		x			-2.852	Constr	-2.852	Constr						
245	{sna-sjc}	Airport interchange served? (0/1)		x			4.348	Constr	4.348	Constr						
246	{sjc-sna}	Airport interchange served? (0/1)		x			2.963	Constr	2.963	Constr						
247	{sna-sac}	Airport interchange served? (0/1)		x			3.571	Constr	3.571	Constr						
248	{sac-sna}	Airport interchange served? (0/1)		x			-1.996	Constr	-1.996	Constr						
251	{san-sfo}	Airport interchange served? (0/1)		x			5.000	Constr	5.000	Constr						
252	{sfo-san}	Airport interchange served? (0/1)		x			5.000	Constr	5.000	Constr						
253	{san-oak}	Airport interchange served? (0/1)		x			1.704	Constr	1.704	Constr						
254	{oak-san}	Airport interchange served? (0/1)		x			1.952	Constr	1.952	Constr						
255	{san-sjc}	Airport interchange served? (0/1)		x			5.000	Constr	5.000	Constr						
256	{sjc-san}	Airport interchange served? (0/1)		x			5.000	Constr	5.000	Constr						
257	{san-sac}	Airport interchange served? (0/1)		x			5.000	Constr	5.000	Constr						
258	{sac-san}	Airport interchange served? (0/1)		x			5.686	Constr	5.686	Constr						
300	h-const	Mode constant				x	-6.757	Constr	-0.713	Constr	-7.530	Constr	-6.964	Constr	-5.685	Constr
307	h-loinc	Low income household? (0/1)				x										
308	h-hiinc	High income household? (0/1)				x	1.147	4.8								
309	h-msinc	Missing income household? (0/1) (for model estimation only)				x										
400	r-const	Mode constant			x		-4.620	Constr	1.272	Constr	-6.232	Constr	-7.126	Constr	-5.541	Constr
407	r-loinc	Low income household? (0/1)			x											
408	r-hiinc	High income household? (0/1)			x		0.613	1.4								
409	r-msinc	Missing income household? (0/1) (for model estimation only)			x											
99	Theta0099	Nesting coefficient		x	x	x	0.692	10.4	0.738	13.0	0.516	Constr	0.420	3.9	0.689	6.1
Implied Value of Time							$63.64		$18.45		$27.60		$10.12		$7.95	

3.0 Data Development

3.1 Introduction

The development and application of the HSR R&R model required the assembly and collection of several types of data and model inputs. Broadly speaking, these requirements included:

- Base year and forecast year demographic and socioeconomic projections
- Base year and forecast year transportation supply information
- Base year data on inter-regional and local intra-regional travel patterns

The forecasting model related the base year travel pattern data to transportation supply and socioeconomic information, and then applied those relationships to the forecast year supply and socioeconomic projections to estimate potential high-speed rail usage in 2030 and 2035. Fortunately, several data sources in each of these categories were available to the study.

3.2 Socioeconomic Data and Trends

The core drivers of demand for inter-regional travel in California are the socioeconomic characteristics of Californians and the State's economic and employment outlook. Among the relevant sources of current year data and projections were:

- Decennial Census data products, specifically the Census Transportation Planning Package (CTPP) and the Summary Tape File (STF) 1
- Local agency socioeconomic estimates and projections,
- State Department of Finance (DOF) projections

3.2.1 Census Transportation Planning Package 2000 (CTPP 2000) Data

CTPP 2000 is a set of special tabulations from the decennial census designed for transportation planners. CTPP contains tabulations by place of residence (Part I), place of work (Part II) and for flows between home and work (Part III). The Part III – Journey-To-Work (JTW) tables provided detailed information about commuting from home to work[4].

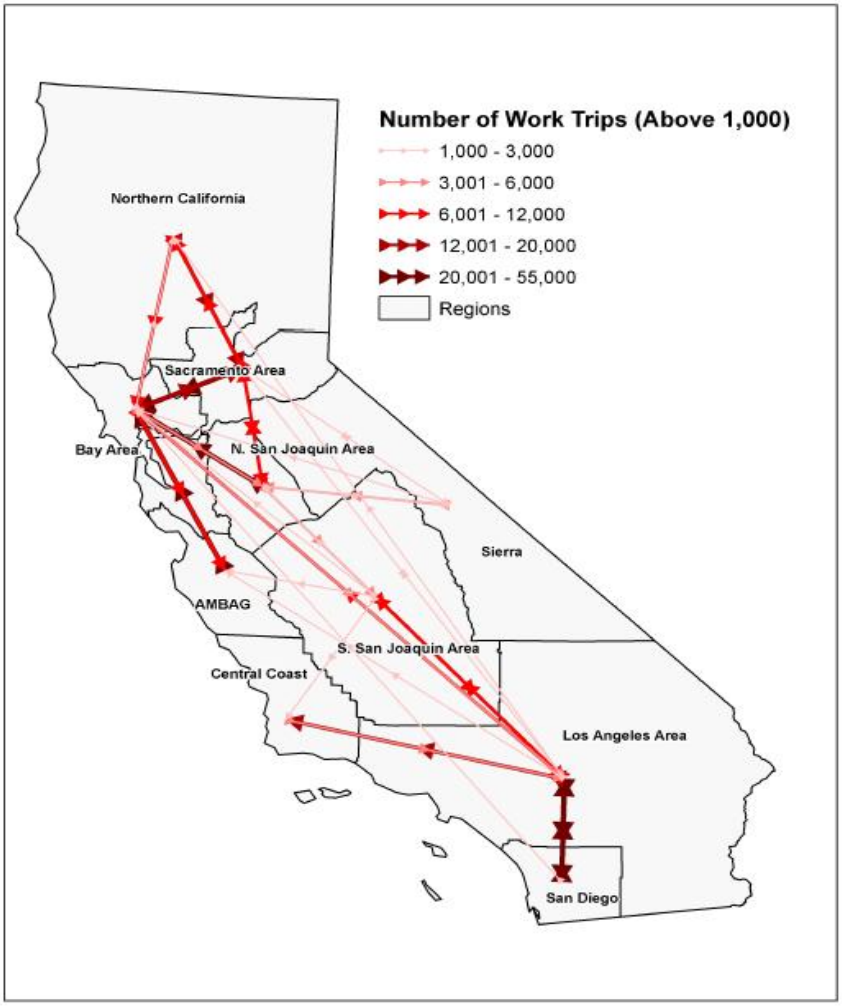
The modes of travel to work were taken from the Census 2000 Long Form questionnaire Number 23. There were 17 modes in the questionnaire:

Drive alone	Bus or trolley bus	Walk
2-person car pool	Streetcar or trolley car	Taxicab
3-person car pool	Subway or elevated	Motorcycle
4-person car pool	Railroad	Other means
5- or 6-person car pool	Ferryboat	Worked at home
7 or more person car pool	Bicycle	

Out of 14.5 million Journey to Work (JTW) trips, about 72 percent are drive alone trips; 15 percent are car pool trips; and about 5 percent are public transit trips. The public transportation category included workers who used a bus or trolley bus, streetcar or trolley car, subway or elevated, railroad, ferryboat, or taxicab. The total JTW trips are shown in graphical form in Figure 3-1. As can be seen in the figure, there are a significant number of work trips happening on a daily basis between major cities in California along the corridor proposed for the high-speed rail system.

[4] This data is available at the CTPP web site http://www.fhwa.dot.gov/ctpp/.

Figure 3-1: Census 2000 Journey to Work Trips – All Trips



Source: 20090403112607_R4g_Socioeconomic, Supply, & Travel Data_All Text-DRAFT.pdf

3.2.2. Local Agency Socioeconomic Estimates and Projections

The statewide high-speed rail model was applied for years 2000 and 2030. The year 2000 model data are available from the Statewide Travel Model (STM) and the four urban models being used:

- Metropolitan Transportation Commission (MTC),
- Southern California Association of Governments (SCAG),
- San Diego Association of Governments (SANDAG), and
- Sacramento Area Council of Governments (SACOG).

Horizon years in this data vary between 2025 (STM), 2027 (SACOG), and 2030 (MTC). Local projections for future years were used in all regions except SCAG and SANDAG where theses were not available and STM data were used. Table 3-1 presents the population by region for the base (2000), horizon, and forecast year (2030). Table 3-2 presents the employment for the same timeframe.

Table 3-1: Population by California Region

Region	2000 Population	Horizon Population	Avg. Annual Population Growth	Horizon Year	2030 Population
San Diego	2,803,511	3,586,238	0.8%	*2025*	3,674,176
Los Angeles Region	16,475,947	22,865,552	1.3%	*2025*	24,414,507
Sierras	172,467	262,181	1.7%	*2025*	285,089
South San Joaquin Valley	2,050,700	3,869,762	2.6%	*2025*	4,393,804
Central Coast	626,278	1,053,300	2.1%	*2025*	1,168,716
Monterey Bay Area	684,593	1,145,764	2.1%	*2025*	1,270,070
San Francisco Bay Area	6,783,762	8,747,102	0.9%	*2030*	8,747,102
North San Joaquin Valley	1,229,749	2,340,712	2.6%	*2025*	2,662,283
Sacramento Region	1,949,488	2,971,778	1.6%	*2027*	3,114,299
Northern California	977,696	1,567,071	1.9%	*2025*	1,722,129
Total	**33,887,529**	**48,362,763**	**1.2%**		**51,452,176**

Source: 20090403112607_R4g_Socioeconomic, Supply, & Travel Data_All Text-DRAFT.pdf

Table 3-2: Employment by California Region

Region	2000 Employment	Horizon Employment	Avg. Annual Employment Growth	Horizon Year	2030 Employment
San Diego	1,230,860	1,826,398	1.3%	*2025*	2,053,176
Los Angeles Region	6,906,602	9,897,951	1.4%	*2025*	10,636,567
Sierras	55,358	90,122	2.0%	*2025*	99,348
South San Joaquin Valley	785,304	|1,491,914	2.6%	*2025*	1,696,231
Central Coast	278,494	407,896	1.5%	*2025*	440,247
Monterey Bay Area	286,937	398,598	1.3%	*2025*	425,682
San Francisco Bay Area	3,753,533	5,120,598	1.0%	*2030*	5,120,598
North San Joaquin Valley	425,801	759,313	2.3%	*2025*	852,440
Sacramento Region	868,340	1,233,803	1.3%	*2027*	1,282,911
Northern California	335,737	482,380	1.5%	*2025*	518,642
Total	**14,727,282**	**21,713,107**	**1.3%**		**23,125,841**

Source: 20090403112607_R4g_Socioeconomic, Supply, & Travel Data_All Text-DRAFT.pdf

3.2.3. Department of Finance Data

The DOF population data was checked against the Bay Area forecasts prepared by the Association of Bay Area Governments (ABAG). The DOF data forecasted regional Bay Area population five percent higher than compared to the ABAG projections. This difference would otherwise be considered a less-than-significant difference, except many of the county-level differences are far greater. Three counties had differences of 24 percent or more, and only three of nine counties show differences of less than 10 percent. These differences cast doubt on the usefulness of the DOF data for long-term forecasting and DOF data were therefore not used.

3.3 Air Travel Trends

Air passenger trips are forecast to grow substantially over the next 25 years, both at the national level and for California airports. The FAA and Caltrans produce regular forecasts of aviation growth. In the large metropolitan areas, local planning agencies have expanded upon the Federal and state forecasts to address their regional transportation planning requirements. The FAA forecasts for California airports are shown in Table 3-3.

Table 3-3: Enplanement Forecasts for California Airports

Airport	City	2000	2005	2010	2015	2020
Burbank-Glendale-Pasadena	Burbank	2,371,365	2,584,030	2,951,819	3,277,406	3,637,658
Fresno Yosemite International	Fresno	503,689	607,126	654,626	702,125	749,625
Los Angeles Intl	Los Angeles	32,153,099	29,835,634	35,645,383	41,341,669	48,302,110
Long Beach/ Daughterty Field	Long Beach	349,266	1,488,124	1,888,943	2,227,379	2,604,099
Monterey Peninsula	Monterey	238,089	157,838	179,543	201,248	222,954
Metropolitan Oakland Intl	Oakland	5,087,602	7,207,940	9,080,929	10,717229	12,659304
Ontario Intl	Ontario	3,180,302	3,324,316	3,929,078	4,497,516	5,155,176
Palm Springs International	Palm Springs	656,241	688,661	783,237	877,816	972,397
Santa Barbara Muni	Santa Barbara	395,455	433,350	482,055	530,765	579,476
San Diego Intl Lindbergh Fld	San Diego	7,845,829	8,516,556	9,920,561	11,242353	12,712900
Norman Y. Mineta San Jose International	San Jose	6,024,835	5,268,378	6,717,769	8,223,021	9,936,618
Sacramento International	Sacramento	3,954,858	4,749,530	5,502,954	6,256,379	7,009,806
San Francisco International	San Francisco	19,647,516	15,849,316	19,951,109	23,285,749	26,615,130
John Wayne Airport – Orange County	Santa Ana	3,917,169	4,580,539	5,372,664	6,110,037	6,873,365

Source: FAA Terminal Area Forecasts

The FAA Terminal Area Forecasts also project demand for each of the towered airports in the U.S. through 2020. As Table 3-4 shows, the aviation growth rate for the Western Pacific states is expected to be similar to that of the U.S., as a whole, with each growing about 76 percent between 2003 and 2020.

Table 3-4: Enplanement Forecasts (in Millions) for the Western Pacific Region

Year	National	Growth from 2003	Western Pacific	Growth from 2003
1999 – Actual	675.566		139.613	
2000 – Actual	704.897		147.357	
2001 – Actual	693.186		144.571	
2002 – Actual	627.676		128.87	
2003 – Actual	643.917		133.406	
2004	686.167	6.6%	142.642	6.9%
2005	720.894	12.0%	148.957	11.7%
2010	855.817	32.9%	177.77	33.3%
2015	989.076	53.6%	205.244	53.8%
2020	1,130.979	75.6%	234.828	76.0%

Source: FAA Terminal Area Forecasts.

Table 3-5: FAA National Forecasts of Aviation Demand

		Short-Range Forecasts			Long-Range Forecasts			
	2004 Actual	2005	2010	2015	2020	2025	2030	Growth 2004-2030
Enplanements (in millions)								
Mainline Carriers								
Domestic	502.2	505.7	588	679	787.1	912.5	1,059.9	111%
International	134	145.4	185.6	224.5	268.8	319.5	378	182%
Regional/Commuter	128.9	148.9	196.1	236.7	283.6	335.8	394.1	206%
Freight RTMs	35.1	37	47.5	60.8	77.5	98.6	125.9	259%
Aircraft Fleets (in thousands)								
Mainline Carriers								
Large Jets	4	4.1	5	5.8	6.7	7.7	8.9	123%
Cargo Jets	1	1	1.1	1.3	1.4	1.6	1.8	80%
Regional/Commuter								
Regional Jets	1.6	1.9	2.5	2.9	3.3	3.8	4.3	169%
Turboprops	1.2	1.2	1	1	1	1	0.9	-25%

Source: FAA Long Range Aerospace Forecasts, 2004-2030.

At the national level, the FAA predicts air travel growth through 2030 with its Long Range Aerospace Forecasts. The forecasts include estimates of future year passenger enplanements by airline carrier type and air freight revenue ton miles (RTMs), as well as projections of the U.S. aircraft fleet. Table 3-5 summarizes the long range forecasts. In the period from 2004 to 2030, domestic enplanements for mainline air carriers are expected to double from 502 million per year to 1.06 billion per year. Regional/commuter service enplanements are forecast to triple from 128.9 million per year to 394 million per year. These relative growth rates are reflective of recent trends to serve short- and mid-range air markets with regional jets.

3.4 Travel Survey Data

In 2005, the Metropolitan Transportation Commission (MTC) hired Corey, Canapary & Galanis Research (CC&G) of San Francisco to conduct a combination of intercept and household travel surveys to obtain the data required to develop and apply the model for this study. Surveys are done to understand the trade-offs people will make and the extent to which certain variables influence their travel decisions. The survey data included revealed preference (RP) and stated preference (SP) mode choice data from air, rail, and auto trip passengers. In total, 3,172 surveys were collected as part of their work:

1,234 completed airline passenger intercept surveys – 32% response rate

249 completed rail passenger intercept surveys – 60% response rate

181 completed rail telephone surveys – 73% response rate

1,508 auto trip telephone surveys – 70% response rate

The data presented below is summarized from the CC&G December 2005 report: *High Speed Rail Study, Survey Documentation*. This report is available on the Authority's website at http://www.cahighspeedrail.ca.gov/assets/0/152/198/55941a0b-3c42-4616-8046-9c6e5c5a2930.pdf

3.4.1 Air Passenger Intercept Surveys

Airline passenger surveys were conducted at six key airports throughout California. The surveys were conducted on the following dates:

Location	Date(s)
Sacramento Airport	August 17 to 18, 2005
San Jose Airport	August 24 to 25, 2005
San Francisco Airport	September 20 to 22, 2005
Fresno Airport	October 13, 2005
Oakland Airport	November 1, 2005
San Diego Airport	November 9, 2005

Surveying was conducted inside the terminals at boarding gates at Sacramento (SMF), San Jose (SJC), San Francisco (SFO), and Fresno (FAT) airports. Surveying was conducted outside the security areas at Oakland (OAK) and San Diego (SAN) airports. In the airports where surveying was done at the boarding gates, teams of surveyors were assigned to specific flights that were going to targeted destination airports in California.

Surveying was not allowed at LA area airports. To compensate for the potential bias this preclusion might have caused, the survey sampling approach was modified to ensure that a good selection of trips to/from LA airports was obtained. This objective was accomplished by:

- Adding an airport with service to LA (Fresno) as a survey site;
- Sampling flights at non-LA airports to reflect the share of flights observed to each of the LA airports; and
- Expanding the period during which surveys were conducted to allow interviews with travellers making a round trip originating in LA.

The air intercept survey was conducted during morning, midday and evening hours to ensure a mixture of outbound and return trips. For example, interviewing travelers at SFO allowed us to capture both SF area residents who were making their outbound trip to LA Basin airports and LA Basin residents who were making their return trip back to LA.

A question in the air intercept survey asked for a traveler's home zip code[5]. Of the 1,016 air intercept surveys that had a valid California home zip code, the distribution of these home zip codes was as follows:

Region	**Percent**
MTC	26%
SACOG	17%
SANDAG	14%
SCAG	35%
San Joaquin	4%
Elsewhere in California:	4%

As shown by these data, the survey sample included a substantial proportion of households in the SCAG region (which includes the Los Angeles Basin) even though intercept surveys were not allowed at airports in the LA Basin.

- Air travelers were asked questions about themselves and about their current trip such as:
- What is your age?
- What is your gender?
- What is your household income?
- How many cars are available to your household?
- Where did your trip begin?
- Where are you going?
- Why are you traveling?
- How many people are you traveling with?
- Could you have driven if you wanted to?
- How much did you pay for your ticket?

[5] Corey, Canapary & Galanis Research (December 2005). *High Speed Rail Study Survey Documentation.* p. 2; and p. 1 of example survey form.

- How will you get to your destination from the airport?

Once that information was obtained, the interview explained some details about the proposed high-speed rail system and asked the same air travelers some hypothetical questions related to a similar trip they might take in the future. The over-arching question was: *What if you were to make the same trip by High-Speed Rail?* This time the traveler was asked to consider that following:

- At which station would you begin your trip?
- Where would you get off the train?
- How would you get to your destination from the rail station?

Finally the travelers were asked to choose their preferred mode (car, air, high-speed rail) for a trip similar to the one they were taking given a set of parameters for those choices - access/egress to station and wait time, frequency of service, travel time, reliability of service, and cost. Four different scenarios were described, with differing values for the five parameters, and the traveler was asked to choose their preferred mode given each different set of choices.

Mailback envelopes with postage paid were offered to respondents who did not complete the questionnaire in time to give it back to surveyor at the airport. Most surveys completed at the SMF, SJC, SFO, and FAT airports were collected at the airport from passengers who filled them out while waiting for their planes. Nearly all of the surveys distributed at OAK and SAN were mailed back by respondents. This is because passenger at these two airports did not have a significant amount of time to complete the survey outside the security area.

Overall, 7,246 people were approached but only 3,870 were identified as a targeted traveler. Of those 3,870, 32% completed the survey (1,234 completed surveys).

3.4.2 Rail Passenger Surveys

The rail passenger survey was conducted using two methods. An onboard self-administered survey similar to the air passenger survey was used, as well as a telephone survey conducted among qualified users of existing rail services. Onboard surveys were conducted on two commuter rail systems on the following dates:

- Altamont Commuter Express (ACE) Trains (October 11, 2005)
- Metrolink Trains (November 10, 2005)

Telephone surveys were conducted using a rider database from Amtrak that included riders from the Capitol Corridor, Pacific Surliner, and San Joaquin services.

Rail passenger intercept (on-board) surveys were conducted on-board the Altamont Commuter Express (ACE) and Metrolink trains. Teams of surveyors were assigned to specific routes that were traveling across targeted regions served by this system. For example, on the Metrolink trains, routes that traveled between the San Diego and Los Angeles region were targeted. Mailback envelopes with postage paid were offered to respondents who did not complete the questionnaire in time to give it back to surveyor on the train.

As with the air survey, several questions were asked about the rail traveler and the current trip that was being taken. Questions such as:

- What is your age?
- What is your gender?

- What is your household income?
- How many cars are available to your household?
- At which station did you board this train?
- At which station will you exit?
- What is your purpose for traveling today?
- How many people are traveling with you?
- What was the cost of your ticket?

After the details of the current trip were collected, rail travelers were asked a series of questions as if they were making the same trip by air and by high-speed rail instead of conventional rail. Questions included:

- At which airport/high-speed rail station would you have departed from?
- At which airport/high-speed rail station would you have arrived?
- How would you get from airport/rail station to your destination?

Finally the travelers were asked to choose their preferred mode (car, air, conventional rail, high-speed rail) for a trip similar to the one they were taking given a set of parameters for those choices – access/egress to station and wait time, frequency of service, travel time, reliability of service, and cost. Four different scenarios were described, with differing values for the five parameters, and the traveler was asked to choose their preferred mode given each different set of choices.

For the rail intercept survey, 761 people were approached. Of those, only 416 were eligible to take the survey. The response rate was 60%, implying 249 total completes. For the Amtrak rail telephone survey, 249 telephone numbers were called and 181 surveys were completed for a 73% response rate.

3.4.3 Auto Passenger Surveys

To capture the mode choice decisions of inter-regional travelers who have chosen to use autos, a Random Digit Dial (RDD) sample of household surveys was conducted among residents of the study area. A stratified sampling approach was utilized. This entailed dividing the State into the relevant regions, and setting a targeted number of completes for households within each region. The final target quotas for the retrieval surveys were:

- A minimum of 120 responses from 9 regions = 1,080
- 120 additional responses from some combination of the six smaller areas (Bakersfield, Tulare/Visalia, Fresno, Merced, Modesto/Stockton, Sacramento)
- 250 additional responses from some combination of the three larger areas (San Diego, Los Angeles, San Francisco Bay)

The final retrievals by region are as follows:

San Diego (158)	Tulare County/Visalia (98)	San Francisco Bay Area (283)
Los Angeles (243)	Fresno (149)	Modesto/Stockton (145)
Bakersfield (144)	Merced (155)	Sacramento (133)

A total of 1,508 completed surveys were retrieved. Table 3-6 presents a summary of the air, rail, and auto passenger surveys collected for this project. These are presented by trip purpose, mode, and distance to demonstrate the contribution to each market segment used in the inter-regional travel models.

Table 3-6: Surveys Collected by Trips

	Drive	Air	Rail	Bus	Other	Total
Long Trips						
Business	138	611	27	–	–	**776**
Commute	4	15	8	–	–	**27**
Recreation	805	228	80	–	–	**1113**
Other	159	82	15	–	–	**256**
Short Trips						
Business	43	14	46	–	–	**103**
Commute	6	0	159	–	–	**165**
Recreation	146	2	27	–	–	**175**
Other	54	1	8	–	–	**63**
Total	**1,355**	**953**	**370**	**–**	**–**	**2,678**

3.4.5 Caltrans Household Travel Survey

The California Statewide Travel Survey was conducted in 2000-2001 for weekday travel. This survey was an activity-based survey and included all in-home activities and travel completed in accessing activity locations over a 24-hour period. The survey of 17,040 households was conducted in each of the 58 counties throughout the State. NuStats Research and Consulting, who surveyed randomly selected households using the telephone recruitment/diary mail-out/telephone trip retrieval method, conducted the survey. These data were used in this study as disaggregate data so the use of expansion and adjustment factors developed for the survey was not required. This included adjustment factors developed from Global Positioning System (GPS) surveys conducted to identify trip underreporting and those developed to account for changes in travel behavior due to the September 11, 2001, attacks on the World Trade Center and Pentagon, which severely disrupted travel throughout the U.S. The survey was conducted in waves, with the fall 2000 and spring 2001 waves completed before 9/11 and the fall 2001 wave completed before and after 9/11. The survey reported 8.6 total trips per household. A summary of the California Department of Transportation (Caltrans) household travel surveys filtered for inter-regional travel is shown in Table 3-7. These are presented by trip purpose, mode, and distance to demonstrate the contribution to each market segment used in the inter-regional travel models.

Table 3-7: CalTrans Household Travel Surveys

	Drive	Air	Rail	Bus	Other	Total
Long Trips						
Business	110	9	–	–	–	**119**
Commute	181	–	1	–	4	**186**
Recreation	175	–	–	1	3	**179**
Other	122	3	1	5	7	**138**
Short Trips						
Business	271	–	2	2	–	**275**
Commute	854	–	9	9	7	**879**
Recreation	550	–	–	1	3	**554**
Other	465	–	–	14	11	**490**
Total	**2,728**	**12**	**13**	**32**	**35**	**2,820**

3.4.6 Urban Area Household Travel Surveys

Three urban area household travel surveys supplemented the statewide travel survey for inter-regional travel:

- Southern California Association of Governments (SCAG)
- Bay Area Metropolitan Transportation Commission (MTC)
- Sacramento Area Council of Governments (SACOG)

The SANDAG survey was obtained and reviewed but did not have sufficient geocoding of inter-regional travel to retain these trips for use in this study. The SCAG survey was a large-scale regional household travel survey conducted in six counties in Southern California. The survey was conducted using Random Digit Dial (RDD) methods for six sample types (base, Caltrans, Regional Statistical Area Augment, Weekend, Mode User Augment, and a GPS sample). Data collection was conducted during spring 2001, fall 2001, and spring 2002. After data quality and cleaning, a total of 16,939 households completed the survey.

The following three tables present a summary of the SCAG, MTC and SACOG household travel surveys filtered for inter-regional travel. These are presented by trip purpose, mode, and distance to demonstrate the contribution to each market segment used in the inter-regional travel models.

Table 3-8: SCAG Travel Surveys of Inter-regional Trips by Mode

	Drive	Air	Rail	Bus	Other	Total
Long Trips						
Business	–	–	–	16	5	**21**
Commute	21	–	–	–	1	**22**
Recreation	42	–	–	–	1	**43**
Other	15	–	–	–	2	**17**
Short Trips						
Business	39	–	–	–	–	**39**
Commute	120	–	–	–	2	**122**
Recreation	53	–	–	–	1	**54**
Other	25	–	–	–	–	**25**
Total	**315**	**–**	**–**	**16**	**12**	**343**

Table 3-9: MTC Travel Surveys of Inter-regional Trips by Mode

	Drive	Air	Rail	Bus	Other	Total
Long Trips						
Business	6	–	–	1	3	**10**
Commute	24	–	–	1	15	**40**
Recreation	55	–	–	2	18	**75**
Other	38	–	1	1	10	**50**
Short Trips						
Business	22	–	–	1	15	**38**
Commute	156	–	–	–	99	**255**
Recreation	117	–	2	2	47	**168**
Other	44	–	2	9	32	**87**
Total	**462**	**–**	**5**	**17**	**239**	**723**

Table 3-10: SACOG Travel Surveys of Inter-regional Trips by Mode

	Drive	Air	Rail	Bus	Other	Total
Long Trips						
Business	60	–	–	1	9	**70**
Commute	33	–	–	–	54	**87**
Recreation	37	–	–	–	1	**38**
Other	31	–	–	2	72	**105**
Short Trips						
Business	6	–	–	–	–	**6**
Commute	-	–	–	–	–	**–**
Recreation	7	–	–	–	1	**8**
Other	3	–	–	–	1	**4**
Total	**177**	**–**	**–**	**3**	**138**	**318**

A full summary of the combined surveys by mode and purpose is presented in Table 3-11. There were 6,882 trip records of inter-regional travel in this combined dataset that were used (in part or in full) to estimate the inter-regional travel models described in the next section.

Table 3-11: Total of All Survey Inter-regional Trips by Mode, Distance and Purpose

	Drive	Air	Rail	Bus	Other	Total
Long Trips						
Business	314	620	27	18	17	**996**
Commute	263	15	9	1	74	**362**
Recreation	1114	228	80	3	23	**1448**
Other	365	85	17	8	91	**566**
Short Trips						
Business	381	14	48	3	15	**461**
Commute	1136	0	168	9	108	**1421**
Recreation	873	2	29	3	52	**959**
Short Other	591	1	10	23	44	**669**
Total	**5,037**	**965**	**388**	**68**	**424**	**6,882**

3.5 Networks and Service Definition

3.5.1 Highway Networks

The level of detail in the highway network and the attributes associated with the roadway system, such as lanes, distances, speed, and capacity primarily determined the representation of highway network supply. The highway network was constructed by incorporating network detail from each of the urban model networks into the California statewide model network. A brief summary of these networks is provided here.

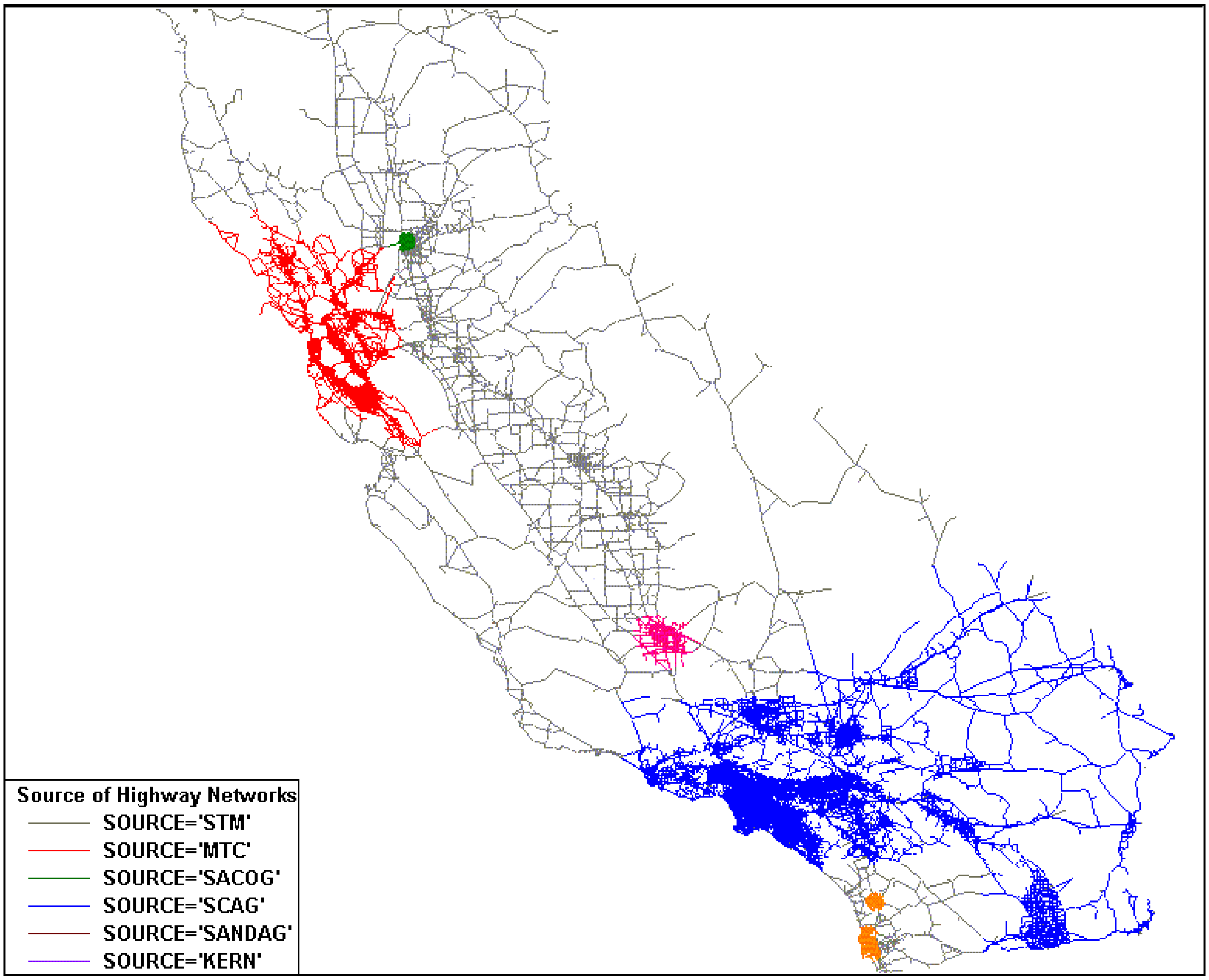
Beginning with the existing statewide highway network, detail was added using the following regional models:

- In the Metropolitan Transportation Commission (MTC) region, the entire highway network was incorporated into the model
- In the Southern California Association of Governments (SCAG) region, the entire highway network was incorporated into the model;
- In the San Diego Association of Governments (SANDAG) region, highway network was incorporated only within a five-mile radius of the three proposed high-speed rail stations;
- In the Sacramento Area Council of Governments (SACOG) region, highway network was incorporated only within a five-mile radius of the proposed high-speed rail station
- In the Kern County region, highway network was incorporated only within a five-mile radius of the proposed high-speed rail station.

Figure 3-2 shows the highway network as rendered in the Citilabs Cube software[6]. The new highway network included 4,667 zones, 127,600 links, and 206,150 nodes. Roadway and area type classifications from the various regional models were consolidated. Speed and capacity definitions by functional class and area type were different for each regional model. These values were based on local conditions in each region and modifications made during model validation. To take advantage of the work done in each region, values from the individual models were kept intact instead of developing a new lookup table based on area type and functional class.

[6] See www.citilabs.com for more information regarding this software package.

Figure 3-2: Statewide Model Highway Network



3.5.2 Air Networks

The State of California has 28 airports that offer commercial airline passenger service between California cities and elsewhere. Of these, 18 airports represent more than 99 percent of the in-state demand, so were selected to represent the air network for the statewide model. Table 3-12 lists these airports and provides estimates of their numbers of annual passenger boardings in 2000 and 2005. After the events of September 11, 2001, air demand in California (and elsewhere) declined overall, but the biggest decline was in 2002 and 2003. From 2003 until 2007, when the model was completed, air demand slowly increased back to its former levels. The dramatic increase in demand at Long Beach airport was due to the beginning of service by Jet Blue.

Table 3-12: California Airport Demand for In-State Travel

Airport Code	City	Airport Name	2000 In-state Boardings	2005 In-state Boardings	Percent Change
OAK	Oakland	Metropolitan Oakland International	2,357,530	2,608,620	10.7%
LAX	Los Angeles	Los Angeles International	2,647,460	1,724,530	-34.9%
SMF	Sacramento	Sacramento International	1,573,400	1,649,350	4.8%
SAN	San Diego	San Diego International	1,791,980	1,548,700	-13.6%
SJC	San Jose	Norman Y. Mineta San Jose International	1,930,520	1,502,460	-22.2%
SNA	Santa Ana	John Wayne Airport-Orange County	1,253,290	1,130,960	-9.8%
BUR	Burbank	Bob Hope	1,219,680	1,038,020	-14.9%
ONT	Ontario	Ontario International	962,780	884,530	-8.1%
SFO	San Francisco	San Francisco International	1,961,320	812,670	-58.6%
LGB	Long Beach	Long Beach/Daugherty Field	260	233,250	89611.5%
PSP	Palm Springs	Palm Springs International	89,190	88,910	-0.3%
ACV	Arcata/Eureka	Arcata	29,200	35,790	22.6%
FAT	Fresno	Fresno Yosemite International	26,390	22,340	-15.3%
SBA	Santa Barbara	Santa Barbara Municipal	84,950	22,150	-73.9%
MRY	Monterey	Monterey Peninsula	19,380	21,270	9.8%
MOD	Modesto	Modesto City County-Harry Sham Field	6,080	3,720	-38.8%
BFL	Bakersfield	Meadows Field	5,940	3,130	-47.3%
OXR	Oxnard	Oxnard	6,260	2,280	-63.6%
All		**Total**	**15,965,610**	**13,332,680**	**-16.5%**

3.5.3 Conventional Rail Networks

Year 2000 passenger rail services consist of a variety of intra-regional and inter-regional services. Passenger rail services were also subdivided by mode – metro rail (e.g. BART), conventional rail (both intercity and commuter services), and light rail:

- The San Diego Region has two rail operators – San Diego Trolley (light rail) and the Coaster (conventional rail).
- The SCAG region has metro, conventional, and light-rail services. The Los Angeles Metropolitan Transportation Authority (MTA) operates metro and light-rail services. The Southern California Regional Rail Authority (SCCRA) operates Metrolink conventional commuter rail services. The MTA Rail system is comprised of the Metro Blue, Green, Red, and Gold Lines. The Metro Red Line subway operates between Union Station, the Mid-Wilshire area, Hollywood, and the San Fernando Valley. The remaining light-rail lines are the Blue Line (Long Beach to Los Angeles), the Green Line (Norwalk to Redondo Beach), and the Gold Line (Los Angeles Union Station [LAUS] to Pasadena).
- Within the MTC region, metro, conventional, and light-rail services are provided. Services include BART, Caltrain, Muni Metro, and Santa Clara VTA light-rail systems. In 2000, the BART system consisted of 39 stations serving four East Bay lines (Fremont, Dublin/Pleasanton, Pittsburg/Bay Point, and Richmond), as well as the Daly City/Colma line through San Francisco and the West Bay. In 2002, BART service was extended south of Colma to San Francisco Airport and to Millbrae, and four new stations were added. San Francisco rail and cable car routes include the five light-rail (metro) lines that operate in the Market Street subway, three cable car routes, and the historic trolley line operating on Market Street. Santa Clara light-rail lines have been extended to East San Jose (Alum Rock) and to Winchester (Vasona line) since 2000.
- Also in the MTC region, Caltrain currently operates 86 daily trains between San Jose and San Francisco, including three daily peak periods, peak direction round trips to Gilroy. Trains run to San Francisco an average of every 12 minutes during peak periods, and 30 minutes during off-peak periods. Since the year 2000, Baby Bullet trains have been introduced, significantly reducing San Jose to San Francisco Express train travel times.
- The SACOG region's rail services are limited to the Sacramento RT light-rail system. Since 2000, two RT extensions have come on-line. In 2003, the South Line extension was implemented. This new extension resulted in RT running two lines for the first time. More recently, the Folsom extension became operational. The Folsom Line is an extension of the existing line that operates along the U.S. 50 corridor.
- Inter-regional rail services are all conventional rail systems. These include the Capitol Corridor, Altamont Commuter Express (ACE), Surfliner, and San Joaquin systems.

3.5.4 Urban Area Transit Networks

The Statewide model intercity routes were updated to include urban area transit networks from the MTC, SACOG, SCAG, SANDAG, and Kern regional systems. In addition, local transit services serving areas around high-speed rail stations in Stanislaus, Merced, and San Joaquin Counties were added. Figure 3-3: Statewide Model Transit Network shows the transit network detail for the intercity routes and the regional transit in the MTC area. Figure 3-4: Transit Network in Southern California shows the transit routes for Southern California.

Figure 3-3: Statewide Model Transit Network

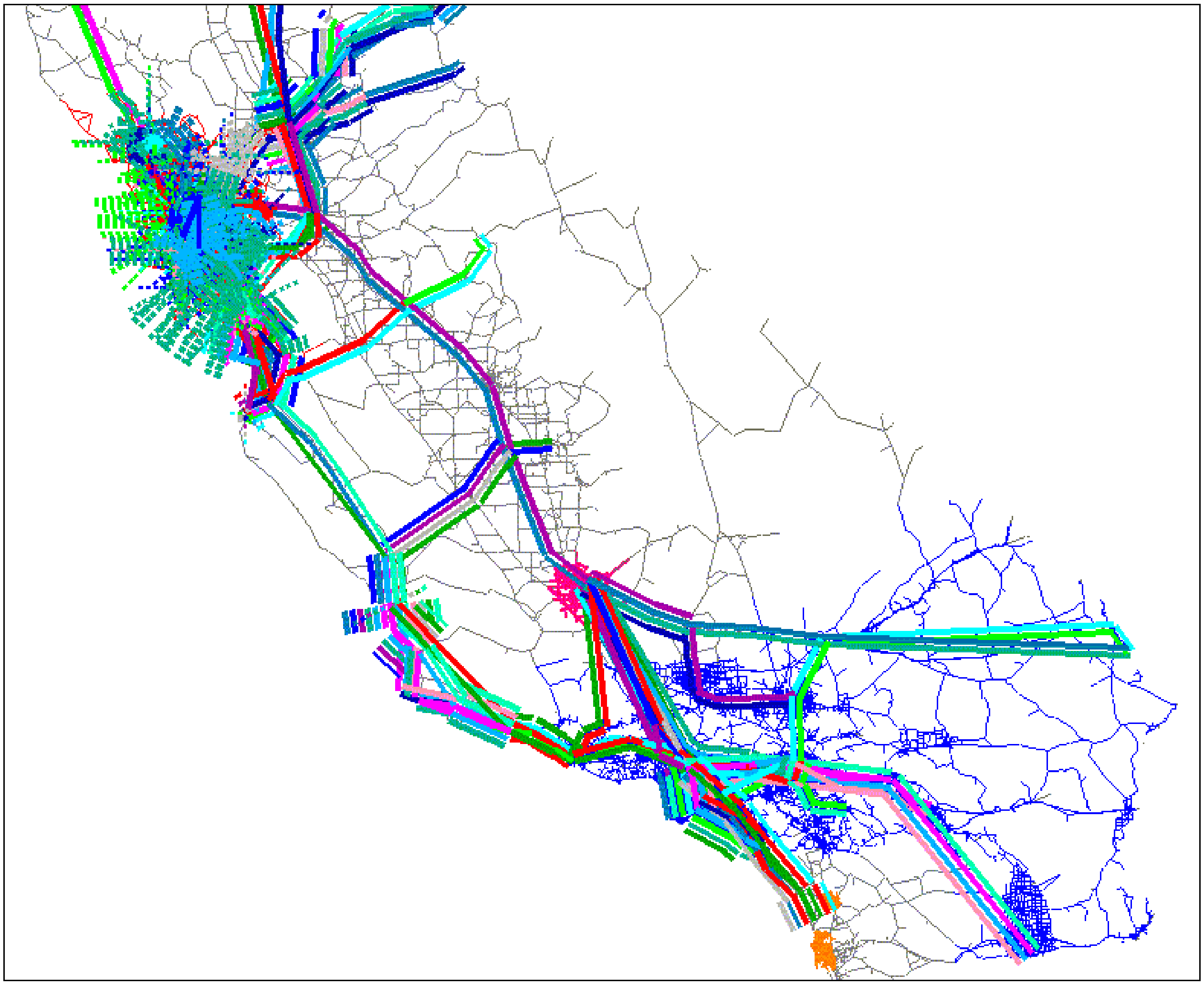
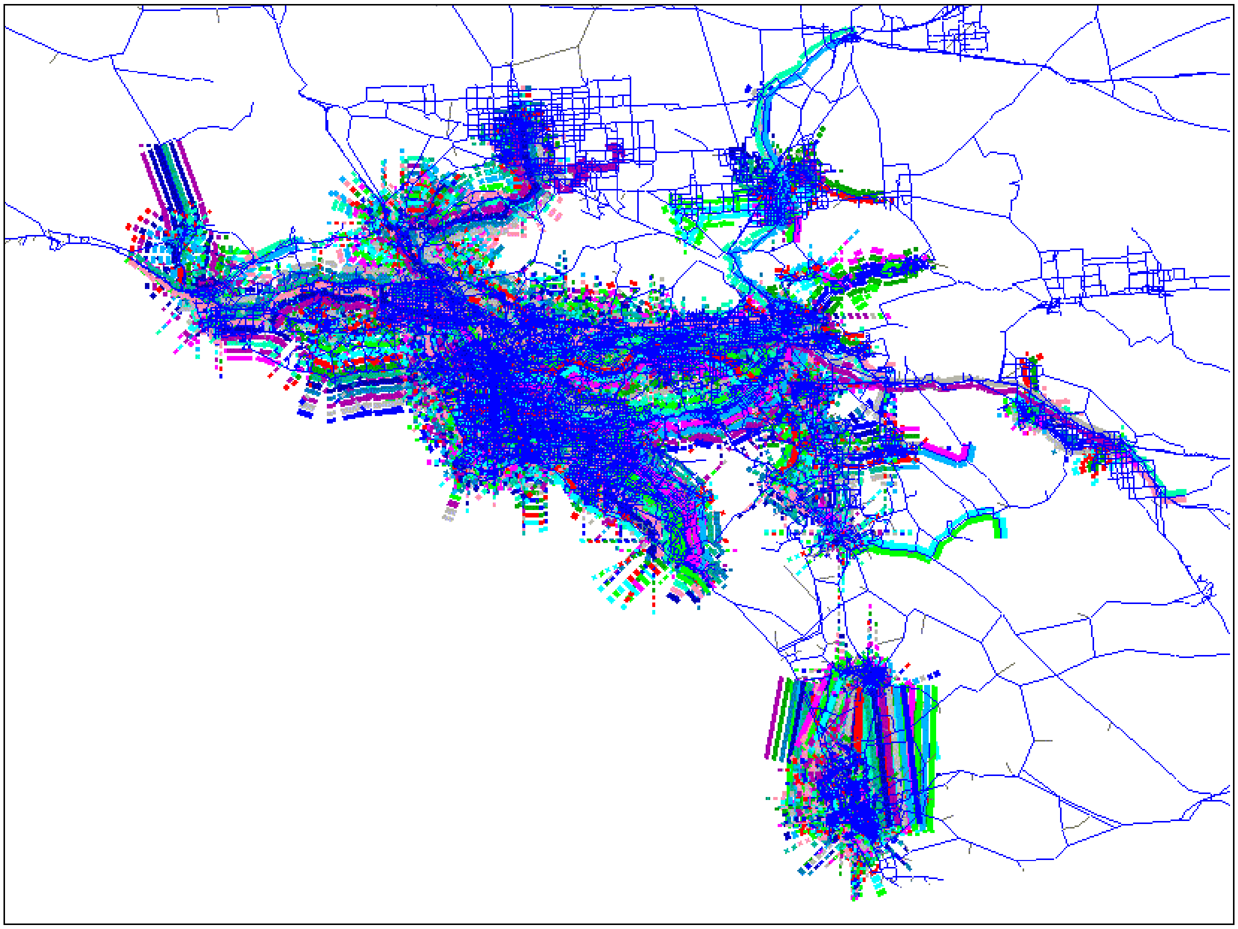


Figure 3-4: Transit Network in Southern California



3.8 Network Attributes

The development of networks includes not only coding the routes but also assigning attributes to those routes. Level-of-service (LOS) attributes were defined for the four inter-regional travel modes: auto, conventional rail, high-speed rail, and air based on published or observed data. The high-speed rail attributes were defined based on the initial service plan and fare structure. Level-of-service attributes covered three broad categories: costs, times and reliability, which taken together were called travel skims. Costs included line-haul fares, as well as access and egress charges. Times included line-haul times, frequencies (which define wait times), access/egress time, terminal times, and transfer times. Reliability was a newly developed measure for the new statewide model system. Reliability was included in the stated-preference (SP) survey choice experiment options, along with the more traditional time and cost variables. As discussed in Chapter 5, several of these attributes were varied during model application to see how ridership and revenue would be impacted. This chapter merely summarizes the data sources used to define the initial network values.

3.8.1 Costs

3.8.1.a Auto

Auto operating costs were prepared using data that MTC compiled on an ongoing basis (up to April 2006). The auto operating costs were comprised of gasoline and non-fuel-related costs. Gasoline operating costs were calculated on a per-mile basis from the price of average retail gasoline divided by the average fuel economy. A constant average fuel economy of 21.9 miles per gallon was assumed. Non-gasoline costs were fixed to 60 percent that of gasoline operating costs.

Table 3-13: 2005 Auto Operating Costs

Year	Retail Gas Price (Current $)	Annual Inflation	Gas Price	Gasoline Operating Cost (Cent/ Mile)	Non-Gas Operating Cost (Cent/ Mile)	Total Auto Operating Cost (Cent/ Mile)
1990	$1.241		$1.904	8.70	3.05	**11.75**
1991	$1.197	4.4%	$1.759	8.03	3.43	**11.46**
1992	$1.302	3.3%	$1.852	8.46	3.57	**12.03**
1993	$1.299	2.7%	$1.800	8.22	3.70	**11.92**
1994	$1.275	1.6%	$1.738	7.94	3.45	**11.39**
1995	$1.286	2.0%	$1.719	7.85	3.57	**11.42**
1996	$1.434	2.3%	$1.874	8.56	3.47	**12.03**
1997	$1.448	3.4%	$1.830	8.36	5.57	**13.93**
1998	$1.304	3.2%	$1.597	7.29	4.86	**12.15**
1999	$1.514	4.2%	$1.779	8.12	5.42	**13.54**
2000	$1.832	4.5%	$2.061	9.41	6.27	**15.68**
2001	$1.800	5.4%	$1.921	8.77	5.85	**14.62**
2002	$1.599	1.6%	$1.679	7.67	5.11	**12.78**
2003	$1.933	1.8%	$1.995	9.11	6.07	**15.18**
2004	$2.165	1.2%	$2.207	10.0	6.72	**16.80**
2005	$2.522	2.0%	$2.522	11.5	7.68	**19.19**
April 06	$2.933	2.3%	$2.868	13.11	8.73	**21.83**

Source: MTC 2005 Regional Transportation Plan Assumptions, Table 3, Historical and Projected Regional Auto Operating Costs, 1990 to 2030.

3.8.1.b Air

Line-haul airfares were obtained from the Federal Aviation Administration and supplemented with data from several web sites over several months to obtain data on airfares for origin-destination pairs in California. Business and non-business fares were queried and summarized separately, but there was no significant difference overall in these markets between business and non-business fares, so they were averaged for the purposes of this study.

3.8.1.c High Speed Rail

HST fares were set for the LA Basin to Bay area, at 50% of the 2005 air fares in that market, which was estimated at $99 (in 2005 dollars) from the data collected in the FAA 10% sample. This LA – SF fare was converted into a distance-based formula of $15 boarding charge (akin to a taxi flag drop) and 9 cents per mile for inter-regional trips. Intra-regional high speed rail fares were assumed to be on average 50 percent higher than corresponding conventional rail fares, with a $7.00 boarding fare and a per mile charge of $0.06 cents. Both the inter- and intra-regional per-mile high-speed rail charges were applied to the driving distance between stations.

3.8.2 Times

3.8.2.a Frequency & travel time

Observed air travel frequencies and gate to gate times were obtained from FAA reports for peak and off-peak conditions for 2000.

For high-speed rail, initial frequencies of service and station to station speeds were derived from previous operating plans developed in the CRA work, with increases to provide additional capacity to handle the additional traffic markets not included in the prior study. The current operating scenarios are presented below in Section 5.3.4, Revised Service Plan Scenarios.

Headways for the five conventional rail lines were coded as shown in Table 3-14 (services were in both directions), and station-to-station times were taken from existing schedules.

Future auto travel times were derived from forecast travel demand without high speed rail and the anticipated 2030 capacity of the highway system.

Table 3-14: Peak Period Conventional Rail Frequencies for North Alignments

Line	Year 2000		Year 2005	
	AM Peak	Off-Peak	AM Peak	Off-Peak
San Joaquin – Oakland	180	360	180	360
San Joaquin – Sacramento	–	–	360	360
Capitol Corridor – Auburn	120	180	90	150
Capitol Corridor – Sacramento	120	180	90	150
Altamont Commuter Express	60	–	60	–
Pacific Surfliner – San Luis Obispo	180	–	180	360
Pacific Surfliner – Santa Barbara	75	120	75	90
Metrolink – Orange County Line	60	120	60	120

3.8.2 b Access-Egress Times

Access and egress times were compiled for all mass transportation modes and covered the time required to travel from the origin activity location to the curb of the train station or airport terminal. The choice of mode included: drive and park, picked-up/dropped off, rental car, taxi, transit and walk.

3.8.3 Wait times

Wait time refers to the time between arriving at the airplane gate or train platform, and closing of the airplane or train door after everyone has boarded. The time spent prior to arriving at the airline gate or train platform is the terminal time and is discussed further below.

For air travel, the wait time included both the time spent waiting at the gate for the plane to arrive; the actual boarding time; and the time up until the plane, loaded with passengers, left the gate area. Once the plane leaves the gate, line-haul time begins. The wait time was set to 55 minutes and it was based on self-reported data from the travel surveys collected for this study.

For rail travel, the wait times were lower than air for a number of reasons. First, trains have numerous doors, making boarding a train a much faster proposition than boarding an airplane. In addition, the inconvenience and time variance of getting a boarding pass, checking luggage, and getting through security requires arrival at the airport earlier than at a train station without security checkpoints. Upon the Peer Review Panel's suggestion, inter-regional rail wait times were set to 15 minutes for both business and non-business travelers.

3.8.4 Terminal Times

Terminal time is the amount of time it takes someone to travel between the curb of the train station or airport terminal and the airport boarding area or train platform and for travellers driving an automobile and not taking a public mode, the time to walk from their car to their destination. Terminal times were defined for both access and egress ends.

Terminal times for drivers were estimated based on the degree of urbanization of each traffic zone.

Airport and station terminal times were determined from a combination of peer review recommendations and subsequent refinements made by Cambridge Systematics. The following terminal times were used:

- 12 minutes for downtown/terminal high-speed rail stations in San Diego, Irvine, Los Angeles, Sacramento, San Francisco, and Oakland
- 8 minutes for other high-speed rail stations
- 24 minutes for non-business/commute trips at Los Angeles And San Francisco Airports
- 20 minutes for non-business/commute trips at all other airports
- 22 minutes for business/commute trips at Los Angeles and San Francisco.
- 18 minutes for business/commute at all other airports

4.0 Model Calibration and Validation

4.1 Introduction

This chapter describes the development of data used for the calibration and validation of the interregional travel model and the results of the calibration and validation. The final interregional model coefficients and calibrated constants are documented in Chapter 2 and will not be repeated here. The calibration and validation of the interregional and intraregional models were completed using year 2000 data. The year 2000 was selected for the calibration and validation of the HSR R&R model because the observed data available for that year were more robust than for any other year.

In early 2010, refinements to the MTC intraregional component of the HSR R&R model were made based on 2007 refinements to the Bay Area's Baycast travel model performed by MTC. The refined MTC intraregional component of the HSR R&R model was recalibrated and revalidated to 2000 conditions. A discussion of the refinements to the MTC intraregional component is provided later in the chapter.

4.2 Calibration and Validation Data Sources

A variety of travel survey data sources, ridership, and traffic count data were used for the calibration and validation of the interregional travel models. In general, data from the various travel surveys were used to calibrate HSR R&R model components while transit ridership and traffic count data were used to validate the overall model performance. This section describes those sources and provides some basic summaries of the data.

4.2.1 American Traveler Survey (ATS)

This survey was used for the calibration and validation of the long distance business, recreation, and other trip purposes. The ATS was developed and conducted by the Bureau of Transportation Statistics (BTS) in 1995 to identify characteristics of current use of the nation's transportation system, forecast future demand, analyze alternatives for investment in and development of the system, and assess the effects of Federal legislation and Federal and state regulations on the transportation system and its use. It obtained information about long-distance travel of persons living in the United States. Intra-California trips over 100 miles in length (consistent with the long distance trip definition) were extracted from the ATS and factored to year 2000 daily trips using a growth factor of 6.9 percent (based on population growth in California during the 1995-2000 time period). An annualization factor of 365 days per year was used to estimate annual trips from the daily trips. The average daily trips were segmented by trip purpose and market as shown in Table 4-1. Commute trips from the ATS data were excluded since a more appropriate source for those trips was the year 2000 Census Transportation Planning Package (CTPP) data.

Table 4-1: Average Daily Interregional Trips in the American Traveler Survey Over 100 Miles (Long)

	Business	Recreation	Other	Total
LA to Sacramento	5,169	7,127	1,467	**13,764**
LA to San Diego	10,313	61,763	13,567	**85,642**
LA to SF	17,356	44,108	6,787	**68,251**
Sacramento to SF	5,645	21,443	7,306	**34,394**
Sacramento to San Diego	1,227	1,227	218	**2,672**
San Diego to SF	5,966	16,443	2,258	**24,667**
LA/SF to SJV	4,396	19,777	5,690	**29,863**
Other to SJV	12,538	12,886	4,725	**30,150**
To/from Monterey/ Central Coast	8,271	19,829	6,796	**34,895**
To/from Far North	3,129	12,359	2,366	**17,854**
To/from W. Sierra Nevada	531	7,528	1,510	**9,570**
Total	**74,540**	**224,491**	**52,691**	**351,722**

Source: U.S. Department of Transportation Bureau of Transportation Statistics, *1995 American Traveler Survey, Technical Documentation*, http://www.bts.gov/publications/1995_american_travel_survey/index.html.

The ATS data were also used to derive mode shares for the long distance business, recreation, and other trip purposes. These are presented in Table 4-2.

Table 4-2: Mode Shares in the American Traveler Survey Over 100 Miles (Long)

Mode	Business	Recreation	Other
Auto	76.13%	87.84%	87.98%
Rail	0.70%	2.32%	3.27%
Air	23.17%	9.85%	8.75%

Source: U.S. Department of Transportation Bureau of Transportation Statistics, *1995 American Traveler Survey, Technical Documentation*, http://www.bts.gov/publications/1995_american_travel_survey/index.html.

4.2.2 Caltrans Household Travel Survey

The California Statewide Travel Survey was used to calibrate and validate the short distance (100 miles or less) business, recreation, and other trip purposes. The survey, conducted in 2000 to 2001 by NuStats Research and Consulting for weekday travel, was an activity-based survey including all in-home activities and travel completed in accessing out-of-home activity locations over a 24-hour period. Each of the 58 counties throughout the State was represented in the survey; a grand total of 17,040 households were surveyed throughout the State.

The survey was conducted for randomly selected households using the telephone recruitment/diary mail-out/telephone trip retrieval method. The survey was conducted in waves, with the fall 2000 and spring 2001 waves completed before the 9/11 attacks on the World Trade Center and Pentagon. The fall 2001 wave was initiated prior to 9/11 and completed after 9/11. Expanded survey results include adjustment factors developed from Global Positioning System (GPS) surveys conducted to identify trip underreporting along with factors to account for changes in travel behavior due to the 9/11 attacks which severely disrupted travel throughout the U.S.

Table 4-3 presents a summary of the Caltrans household travel survey, weighted and summarized for interregional travel. Several of the markets shown in Table 4-3 are too distant from each other to have short trips. Only short trips are reported for markets with both short and long trips (such as Los Angeles to San Diego).

Table 4-3: Average Daily Interregional Trips Less Than 100 Miles from the 2000-2001 Caltrans Household Travel Survey

	Business	Other	Recreation	Total
LA to Sacramento		–	–	**–**
LA to San Diego	19,244	42,340	27,512	**89,095**
LA to SF				**–**
Sacramento to SF	17,805	17,383	12,394	**47,582**
Sacramento to San Diego	–	–	–	**–**
San Diego to SF	–	–	–	**–**
LA/SF to SJV	11,769	16,565	25,518	**53,852**
Other to SJV	20,223	24,382	8,341	**52,946**
To/from Monterey/ Central Coast	16,351	44,784	67,024	**128,159**
To/from Far North	15,626	47,494	89,480	**152,599**
To/from W. Sierra Nevada	2,421	10,566	6,840	**19,827**
Total	**103,439**	**203,514**	**237,108**	**544,061**

Source: State of California, Department of Transportation, Division of Transportation System Information, Office of Travel Forecasting and Analysis, Statewide Travel Analysis Branch, *2000-2001 California Statewide Travel Survey Weekday Travel Report*, June 2003.

Data from the California Statewide Travel Survey data was also used to derive mode shares for the short business, recreation, and other trip purposes. These shares are presented in Table 4-4.

Table 4-4: Mode Shares for Trips Less than 100 Miles from the 2000-2001 Caltrans Household Travel Survey

Mode	Business	Recreation	Other
Auto	92.89%	99.28%	89.60%
Rail	0.11%	0.72%	8.35%
Air	7.00%	0.00%	2.05%

Source: State of California, Department of Transportation, Division of Transportation System Information, Office of Travel Forecasting and Analysis, Statewide Travel Analysis Branch, *2000-2001 California Statewide Travel Survey Weekday Travel Report*, June 2003.

4.2.3 Census Transportation Planning Package (CTPP)

CTPP data were used to calibrate and validate the short and long distance commute trip purposes. The CTPP is a set of special tabulations from the 2000 decennial census designed for transportation planners. The CTPP contains tabulations by place of residence, place of work, and for flows between place of residence and place of work. The data were tabulated from answers to the Census 2000 long form questionnaire mailed to one in six U.S. households. Because of the large sample size, the data are reliable and have high levels of statistical accuracy.

The CTPP was collected in 2000 for the MPOs in the State of California and summarized for use in this project for commute travel, and for both long and short trips. Table 4-5 presents a summary of the CTPP data, weighted and summarized for both long and short interregional commute travel.

Table 4-5: Average Daily Interregional Commute Trips from the 2000 Census Transportation Planning Package

	Short Commute	Long Commute	Total
LA to Sacramento	–	5,103	**5,103**
LA to San Diego	69,728	29,665	**99,393**
LA to SF	–	22,124	**22,124**
Sacramento to SF	37,192	16,986	**54,178**
Sacramento to San Diego	–	886	**886**
San Diego to SF	–	4,840	**4,840**
LA/SF to SJV	77,112	53,741	**130,853**
Other to SJV	128,792	10,950	**139,743**
To/from Monterey/Central Coast	96,448	28,809	**125,257**
To/from Far North	36,658	16,982	**53,640**
To/from W. Sierra Nevada	17,672	9,730	**27,402**
Total	**463,603**	**199,817**	**663,420**

Source: U.S. Department of Transportation, Federal Highway Administration, Census Transportation Planning Package, September 11, 2006, http://www.fhwa.dot.gov/ctpp/.

The CTPP data were also used to derive mode shares for the long and short commute trip purposes. These are presented in Table 4-6. The CTPP included air, walk, bike, school bus, and other modes in an "other" category. The "other" mode category was assumed to be air travel for interregional trips.

Table 4-6: Mode Shares from the 2000 Census Transportation Planning Package

Mode	Commute Long	Commute Short
Auto	99.29%	99.52%
Rail	0.71%	0.48%
Air	0.00%	0.00%

Source: State of California, Department of Transportation, Division of Transportation System Information, Office of Travel Forecasting and Analysis, Statewide Travel Analysis Branch, *2000-2001 California Statewide Travel Survey Weekday Travel Report*, June 2003.

4.2.4 U.S. DOT Federal Aviation Administration (FAA) Origin-Destination (O&D) 10 Percent Ticket Sample Data

The U.S. DOT Federal Aviation Administration (FAA) origin-destination (O&D) 10 percent sample database includes actual ticket information for 10 percent of the tickets collected by large air carriers. While the

10-percent ticket sample data represents a robust data of airfares and travel times, these data are subject to sampling error. In addition, the O&D databases generally will not include tickets for passengers with itineraries that begin on airlines classified by the FAA as "Small Certificated Air Carriers," those airlines who do not fly any planes with more than 60 seats. Despite the limitations of the data, the O&D database is probably the most accurate single source for defining intrastate air markets. These data are more accurate for larger air markets, where there are few, if any, Small Certificated Air Carriers.

During model validation, a discrepancy between the air demand data in the ATS data and the air demand data in the FAA data for California was discovered. The ATS data for air travel in California reported 62,069 air trips and the FAA data reported only 48,246 for year 2000, as shown in Table 4-7. In addition, the FAA data for 2005 showed a significant decline in the observed volumes; these also are reported in Table 4-7. In an effort to accommodate the difference between the two observed data sources, a new validation target midway between the two estimates for 2000, or 55,158 air trips, was selected. The additional air trips required to raise the FAA estimate to 55,158 were allocated proportionally to each market that increased from 2000 to 2005. Markets that decreased from 2000 to 2005 were held constant in the new validation targets. Flights per day were also estimated from the FAA data, based on the amount of service reported in the FAA 10 percent ticket sample data.

Table 4-7: Air Passenger Boardings for 2000 by Market

	Observed Average Daily Volumes				Passengers per Flight
	2000	**2005**	**2000 Adjusted**	**Flights Per Day**	**2000 Adjusted**
LA to Sacramento	7,182	7,410	12,308	123	100
LA to San Diego	387	113	387	47	8
LA to SF	29,329	22,990	29,329	455	64
Sacramento to SF	5	8	8	15	1
Sacramento to San Diego	2,246	2,507	3,848	39	99
San Diego to SF	8,096	6,697	8,096	120	68
LA/SF to SJV	82	163	140	81	2
Other to SJV	64	54	64	32	2
To/from Monterey/ Central Coast	596	265	596	162	4
To/from Far North	170	221	292	56	5
To/from W. Sierra Nevada		-	-	–	
Intraregion	88	21	88	23	4
Total	**48,246**	**40,449**	**55,158**	**1,152**	**48**

Source: U.S. Department of Transportation O&D Market Database obtained from the Bureau of Transportation Statistics web site, accessed October 2005.

4.2.5 Rail Data

Rail passenger data were obtained from interregional rail operators in California and from MPOs in the State for intraregional area rail travel. The data were aggregated for each urban area and for each interregional rail market. These data were compiled for all rail operators in California, as shown in Table 4-8. The allocation of rail boardings to interregional and intraregional for the San Francisco Bay Area was based on estimates provided by the MTC. The interregional rail line in the Los Angeles region is the Metrolink Orange County line (from Los Angeles Union Station to Oceanside in San Diego County), and was estimated to have 600 interregional boardings out of a total of 5,600 boardings for the line.

Table 4-8: Rail Passengers in 2000 by Operator and Route

Operator/Route	Market Served	Boardings	Intraregional	Interregional
Amtrak Capital Corridor	Sacramento to San Francisco	3,300	1,000	2,300
Amtrak Surfliner	Santa Barbara to San Diego	5,100	2,800	2,300
Amtrak San Joaquin	San Joaquin Valley to San Francisco	2,110	100	2,010
Altamont Commuter Express (ACE)	Stockton to San Jose	3,100	700	2,400
Coaster, San Diego Trolley	San Diego region	97,400	97,400	
Metrolink, Metro Rail	Los Angeles region	236,500	235,900	600
BART, Caltrain, SF Muni, SCVTA	San Francisco region	555,900	555,900	
Regional Transit LRT	Sacramento region	37,600	37,600	
Total		**941,010**	**931,400**	**9,610**

Source: Individual rail operator and Metropolitan Planning Organization data sources reported in Cambridge Systematics, Bay Area/California High-Speed Rail Ridership and Revenue Forecasting Study, Socioeconomic Data, Transportation Supply, and Base Year Travel Patterns Data, December 2005.

4.2.6 Traffic Counts

Highway traffic counts were obtained primarily from the Caltrans traffic count database and supplemented with data from the MTC traffic count database. Comprehensive Sacramento and San Diego urban area traffic count databases were not required since the Caltrans traffic count data had sufficient count locations in these regions. A comprehensive SCAG traffic count database was not available at the time of the validation and was, therefore, not included in these summaries. Table 4-9 summarizes the highway traffic counts by facility type. Table 4-10 presents the same information by area type.

Table 4-9: Average Daily Traffic Count Miles Traveled by Facility Type in 2000

Facility Type	Number of Count Locations	Count Miles Traveled
Freeway	517	41,344,381
Expressway	638	14,322,157
Major Arterial	179	3,764,260
Minor Arterial	17	120,794
Collector	8	28,199
Total	**1,359**	**59,579,791**

Source: Caltrans Traffic Count Database – CA_ValVol(statewide model 2000 counts).dbf with 1,191 locations; Metropolitan Transportation Commission 2000 model validation counts with 175 locations; and Sacramento Area Council of Governments 2000 model validation counts with 4 locations.

Table 4-10: Average Daily Traffic Count Miles Traveled by Area Type in 2000

Facility Type	Number of Count Locations	Count Miles Traveled
Rural	836	28,096,076
Suburban	133	4,784,532
Urban	390	26,699,182
Total	1,359	59,579,791

Source: Caltrans Traffic Count Database – CA_ValVol(statewide model 2000 counts).dbf with 1,191 locations; Metropolitan Transportation Commission 2000 model validation counts with 175 locations; and Sacramento Area Council of Governments 2000 model validation counts with 4 locations.

The primary highway validation test was the comparison of traffic counts and modeled volumes at critical gateways in the system. The gateways corresponded to the air and rail markets of consideration. Table 4-11 presents a list of these gateways and the average daily traffic counts available for validation.

Table 4-11: Average Daily Traffic Counts for Gateways between California Cities in 2000

Gateway	Routes Included	Average Daily Traffic Count
Sacramento to San Francisco	I-80	115,536
Sacramento to San Joaquin Valley	I-5 SR 99	109,365
San Joaquin Valley to San Francisco (Altamont Pass)	I-580 SR 205	111,500
San Joaquin Valley to San Francisco (Pacheco Pass)	SR 152	20,728
San Joaquin Valley to Los Angeles (The Grapevine or Tejon Pass)	I-5 SR 14	78,927
Los Angeles to San Diego	I-5 I-15	442,951
Total		879,007

Source: Caltrans Traffic Count Database – CA_Screens.dbf with 76 locations.

4.3 Trip Frequency Model Calibration

4.3.1 Interregional trips

Interregional trips were calibrated by trip purpose (business, commute, recreation, and other); distance class (short and long); and by the regions covered by the major MPOs in the State (Sacramento Area Council of Governments [SACOG], MTC, SCAG, and San Diego Association of Governments [SANDAG]). This calibration approach provided the accuracy required by the subsequent models for trip purpose and distance class along with the assurance that interregional travel from the four major metropolitan areas was reasonably reproduced by the HSR R&R model. The observed trips for the trip frequency model were derived from a combination of the three surveys described earlier (the ATS, Caltrans Household Travel Survey, and CTPP).

Table 4-12 presents the results of the trip frequency model calibration effort for short trips, and Table 4-13 presents the results of the trip frequency model calibration effort for long trips. The majority of short interregional trips were generated outside of the four largest regions while the majority of long interregional trips were generated from within the four largest regions. This is largely due to the fact that the majority of short interregional trips were destined for the four largest regions while the majority of long interregional trips were traveling between major metropolitan regions.

Table 4-12: Trip Frequency Model Results for Short Trips

Region	Short				Total Daily Model Trips	Total Daily Observed Trips	Percent Difference
	Commute	Business	Recreation	Other			
Sacramento Region (SACOG)	43,450	11,108	11,124	17,864	83,546	83,075	1%
San Diego Region (SANDAG)	28,945	13,763	8,148	8,304	59,160	58,796	1%
San Francisco Region (MTC)	38,142	20,641	25,214	15,620	99,617	98,872	1%
Los Angeles Region (SCAG)	54,908	9,420	36,691	40,338	141,357	140,431	1%
Remainder of CA	298,252	48,577	122,876	154,689	624,394	627,536	-1%
Total	**463,697**	**103,509**	**204,053**	**236,815**	**1,008,074**	**1,008,710**	**0%**

Table 4-13: Trip Frequency Model Results for Long Trips

Region	Long				Total Daily Model Trips	Total Daily Observed Trips	Percent Difference
	Commute	Business	Recreation	Other			
Sacramento Region (SACOG)	18,192	6,204	15,784	5,050	45,230	44,271	2%
San Diego Region (SANDAG)	21,738	6,264	21,533	6,976	56,511	55,671	2%
San Francisco Region (MTC)	15,800	8,359	96,235	16,269	136,663	132,131	3%
Los Angeles Region (SCAG)	48,715	23,008	54,771	15,644	142,138	140,818	1%
Remainder of CA	82,925	19,530	15,217	1,202	118,874	131,937	-10%
Total	**187,370**	**63,365**	**203,540**	**45,141**	**499,416**	**504,828**	**-1%**

4.3.2 Intraregional Trips

The HSR R&R Model does not explicitly model intraregional trips within urban areas. Rather, it relies on existing MPO models for the two major metropolitan areas planned to have more than one HST station (MTC and SCAG) to provide intraregional trips. These trips were included in the model during trip assignment as either auto vehicle or transit person trips. As a result, tabulations of total person trips from the MPO models were not maintained. Nonetheless, it was useful to compare trip generation parameters from those MPO models and check for reasonableness. In addition, intraregional trips from the Caltrans Statewide Model were derived to represent all other regions in the State beyond the three largest MPO regions. This allowed the intraregional trip table to be more comprehensive statewide. Table 4-14 presents the auto vehicle trips (as the best proxy for total trips) from each of the three MPO models, and the resulting trips per person and trips per employee statistics from these. In general, these trip rates were consistent across the MPO regions, with one exception. SANDAG reported significantly higher trips per employee than other regions. Based on conversations with SANDAG staff, this was because they were accounting for significant under reporting evidenced on their household travel survey upon which the trip generation model was based. Overall, there were 65 million intraregional auto vehicle trips represented in the HSR R&R model for 2000.

Table 4-14: Intraregional Auto Vehicle Trips for 2000

Region	Daily Auto Vehicle Trips	Population	Auto Vehicle Trips Per Person	Employment	Trips Per Employee
SCAG	34,673,468	15,101,248	2.30	7,406,280	4.69
SANDAG	5,875,971	2,585,247	2.27	1,168,880	5.03
MTC	14,460,747	6,376,956	2.27	3,753,533	3.85
Remaining	13,045,337	6,717,328	1.94	3,107,079	4.20
Total	**68,055,523**	**30,780,779**	**2.21**	**15,435,772**	**4.41**

4.4 Destination Choice Model Calibration

4.4.1 Interregional trips

Interregional destination choice models were calibrated to both regions and to significant travel markets in the State. The observed dataset was developed from the three observed travel surveys presented in the previous section. The calibration process developed alternative-specific constants for each region in the State with additional constants for the largest travel markets. There were 25 regions included in the calibration and six major travel markets. Figure 4-1 shows the 25 regions. The six major travel markets were included by direction:

Los Angeles (SCAG) region to Sacramento (SACOG) region;

Los Angeles (SCAG) region to San Diego (SANDAG) region;

Los Angeles (SCAG) region to San Francisco (MTC) region;

Sacramento (SACOG) region to San Francisco (MTC) region;

Sacramento (SACOG) region to San Diego (SANDAG) region; and

San Diego (SANDAG) region to San Francisco (MTC) region.

In addition to the six major travel markets, the model calibration results were reported for the following five travel markets:

Los Angeles (SCAG) region and San Francisco (MTC) region to the San Joaquin Valley;

All other regions to the San Joaquin Valley;

To/from the Monterey (AMBAG) region and the Central Coast;

To/from the Far North region; and

To/from the W. Sierra Nevada region.

The first six travel markets in this list represent the primary travel markets of interest to the high-speed rail study. The additional travel markets are included to ensure that other regions in the State are attracting approximately the right numbers of trips. The San Francisco (MTC) region includes the nine counties: Napa, Sonoma, Marin, Solano, Contra Costa, Alameda, San Francisco, San Mateo, and Santa Clara. The Los Angeles (SCAG) region includes six counties: Ventura, Los Angeles, San Bernardino, Riverside, Orange, and Imperial.

Figure 4.1: Destination Choice Model Regions

The results of the destination choice model calibration are provided in Table 4-15. The destination choice model results in modeled trips in each market within +/-10 percent of observed, except for the Sacramento to San Diego market, which had a very small total number of observed trips per day (2,082).

4.4.2 Intraregional trips

Since the California Statewide High-Speed Rail Model does not explicitly model intraregional distribution of trips, no calibration (or validation) comparisons were made for the distribution models. Since each of the MPO models and the California Statewide Models was calibrated for trip distribution, the intraregional distribution models were assumed to suffice for the purposes of this project.

Table 4-15: Destination Choice Model Results for Short and Long Trips

	Short				Long				Total Daily Model Trips	Total Daily Observed Trips
Region	Commute	Business	Recreation	Other	Commute	Business	Recreation	Other		
LA to Sacramento	0	0	0	0	4,987	2,093	4,063	1,271	12,414	11,568
LA to San Diego	60,682	16,518	37,229	22,594	29,009	10,660	66,529	19,715	262,936	271,100
LA to SF	0	0	0	0	16,231	7,865	26,210	4,592	54,898	50,070
Sacramento to SF	34,908	18,494	14,734	9,990	16,299	6,775	31,373	7,007	139,580	143,563
Sacramento to San Diego	0	0	0	0	1,041	307	1,280	405	3,033	2,082
San Diego to SF	0	0	0	0	4,456	1,351	7,794	1,338	14,939	15,180
LA/SF to SJV	78,538	14,383	15,133	23,847	38,124	12,186	23,967	3,346	209,524	217,987
Other to SJV	119,756	21,268	55,760	69,307	12,860	3,290	57	39	282,337	228,384
To/From Monterey/ Central Coast	101,108	16,204	38,816	45,565	35,188	10,739	27,953	4,858	280,431	295,294
To/From Far North	45,520	12,941	33,172	56,011	22,659	6,143	9,289	1,792	187,527	222,350
To/From W. Sierra Nevada	23,185	3,701	9,209	9,501	6,516	1,956	5,025	778	59,871	55,962
Total	**463,697**	**103,509**	**204,053**	**236,815**	**187,370**	**63,365**	**203,540**	**45,141**	**1,507,490**	**1,513,540**

4.5 Mode Choice Calibration

4.5.1 Interregional trips

The interregional mode choice models were more complicated to calibrate, since there were conflicting observed data on boardings, highway volumes, and mode shares. The observed mode shares were derived from the same three observed data sources used for trip frequency and destination choice. These observed mode shares were translated into trips by mode and compared to observed boardings by mode for air and rail. The observed mode shares resulted in higher estimates of trips by mode than boardings for both air and rail. Table 4-16 presents a comparison of the observed datasets.

Table 4-16: Comparison of Observed Trips by Mode

	Air	Rail
Observed Trips from Travel Survey Data	61,327	16,006
Observed Boardings from Transit Operators	48,246	9,610
Difference	13,081	6,396
Adjusted Observed Boardings	55,156	
Source of Observed Boardings	FAA	Amtrak, ACE, Metrolink

Source: 20090403111741_StatewideModelValidationFRJuly2007.pdf

In the case of air boardings, an adjusted observed value was derived to account for the under-representation in the FAA dataset for smaller markets. The mode choice calibration targets were then adjusted to match the observed adjusted boardings for air and the observed boardings for rail. The final calibration targets for mode shares are reported in Table 4-17.

Table 4-17: Observed Main Mode Shares for Calibration

	Short Trips			Long Trips		
Mode	**Business**	**Commute**	**Recreation/ Other**	**Business/ Commute**	**Recreation/ Other**	**Total**
Trips by Mode						
Auto	102,086	461,293	441,190	223,786	220,419	1,448,774
Air	-	-	-	26,139	29,017	55,156
Rail	1,589	2,310	242	932	4,537	9,610
Total	**103,675**	**463,603**	**441,432**	**250,857**	**253,973**	**1,513,540**
Mode Shares						
Car	98.5%	99.5%	99.9%	89.2%	86.8%	95.7%
Air	0.0%	0.0%	0.0%	10.4%	11.4%	3.6%
Rail	1.5%	0.5%	0.1%	0.4%	1.8%	0.6%

Source: 20090403111741_StatewideModelValidationFRJuly2007.pdf

Mode shares for interregional trips were calibrated to match these observed mode shares by mode and trip purpose. Table 4-18 presents the results of the mode choice model calibration. Calibration was completed to match mode shares; trips were reported to provide information on these results. The final results are almost exact in total and quite close by mode and purpose.

Table 4-18: Main Mode Choice Model Results

	Short Trips			Long Trips		
Mode	**Business**	**Commute**	**Recreation/ Other**	**Business/ Commute**	**Recreation/ Other**	**Total**
Trips by Mode						
Auto	102,430	459,160	440,563	221,120	218,669	1,441,942
Air				28,754	27,181	55,935
Rail	1,079	4,537	305	861	2,831	9,613
Total	**103,509**	**463,697**	**440,868**	**250,735**	**248,681**	**1,507,490**
Mode Shares						
Car	99.0%	99.0%	99.9%	88.2%	87.9%	95.7%
Air	0.0%	0.0%	0.0%	11.5%	10.9%	3.7%
Rail	1.0%	1.0%	0.1%	0.3%	1.1%	0.6%

Source: 20090403111741_StatewideModelValidationFRJuly2007.pdf

The access and egress models were calibrated separately from the main mode choice models. The observed access and egress trips by mode are presented in Table 4-19. The access and egress mode choice models were calibrated based on mode shares. The access and egress trips were derived from the model estimation dataset and were, therefore, not as accurate in the aggregate as an independent validation data source of trips would be. Nonetheless, this was the only data source available for access and egress trips. The accuracy of the access and egress models is not as critical to the resulting ridership, because the access and egress models are used solely to provide logsums for access and egress to the main model choice models. As a result, the greater tolerance levels for accuracy are acceptable than for the main mode choice models. In addition, in the statewide model, levels of detail for certain variables, such as walk access times or transit access times for large zones, are not as accurate as would be necessary to accurately model travel by those access and egress modes.

Table 4-19: Observed Access and Egress Mode Shares by Mode and Purpose

		Short Trips			Long Trips	
		Business	**Commute**	**Recreation / Other**	**Business/ Commute**	**Recreation / Other**
Drive and park	Access	80.7%	81.8%	52.0%	59.7%	24.1%
	Egress	14.6%	25.9%	33.8%	12.6%	2.3%
Rental car	Access	0.0%	0.0%	0.0%	2.6%	1.3%
	Egress	11.6%	3.2%	33.8%	47.6%	34.4%
Drop off	Access	12.1%	14.8%	38.5%	20.2%	57.4%
	Egress	22.1%	36.8%	0.8%	22.4%	33.1%
Taxi	Access	3.0%	1.8%	5.3%	6.8%	7.9%
	Egress	48.8%	26.4%	26.4%	16.6%	26.3%
Subtotal Auto	**Access**	**95.9%**	**98.4%**	**95.9%**	**89.3%**	**90.7%**
	Egress	**4.1%**	**1.6%**	**4.1%**	**10.7%**	**9.3%**
Transit	Access	3.4%	1.3%	2.9%	8.2%	5.6%
	Egress	2.9%	7.3%	5.2%	0.8%	3.6%
Walk/bike	Access	0.8%	0.3%	1.2%	2.5%	3.7%
	Egress	0.1%	0.5%	0.0%	0.0%	0.3%
Subtotal Non-Auto	**Access**	**97.1%**	**92.3%**	**94.8%**	**99.2%**	**96.1%**
	Egress	**2.9%**	**7.7%**	**5.2%**	**0.8%**	**3.9%**

Source: 20090403111741_StatewideModelValidationFRJuly2007.pdf

Table 4-20 presents the model results for the access and egress models. The aggregated auto and non-auto access and egress modes are all within +/-14 percent of the observed mode shares. The final calibration was reasonable based on these aggregated comparisons.

Table 4-20: Estimated Access and Egress Mode Shares by Mode and Purpose

		Short Trips			Long Trips	
		Business	Commute	Recreation / Other	Business/ Commute	Recreation Other
Drive and park	Access	80.3%	60.6%	68.6%	59.5%	52.6%
	Egress	14.6%	25.9%	33.8%	12.6%	2.3%
Rental car	Access	0.0%	0.0%	0.0%	3.4%	3.0%
	Egress	11.6%	3.2%	33.8%	47.6%	34.4%
Drop off	Access	9.0%	22.4%	9.0%	20.0%	28.9%
	Egress	22.1%	36.8%	0.8%	22.4%	33.1%
Taxi	Access	1.8%	1.7%	8.9%	11.2%	7.2%
	Egress	48.8%	26.4%	26.4%	16.6%	26.3%
Subtotal Auto	**Access**	**91.1%**	**84.7%**	**86.5%**	**94.1%**	**91.6%**
	Egress	**8.9%**	**15.3%**	**13.5%**	**5.9%**	**8.4%**
Transit	Access	8.4%	12.9%	13.4%	5.8%	7.4%
	Egress	2.9%	7.3%	5.2%	0.8%	3.6%
Walk/bike	Access	0.5%	2.4%	0.1%	0.0%	1.0%
	Egress	0.1%	0.5%	0.0%	0.0%	0.3%
Subtotal Non-Auto	**Access**	**97.1%**	**92.3%**	**94.8%**	**99.2%**	**96.1%**
	Egress	**2.9%**	**7.7%**	**5.2%**	**0.8%**	**3.9%**

Source: 20090403111741_StatewideModelValidationFRJuly2007.pdf

4.5.2 Intraregional Trips

Intraregional mode choice models were required for the three regions that have more than one planned HST station – MTC, SCAG, and SANDAG.

MTC Intraregional model

The MTC intraregional model component for the HSR R&R model was originally developed in 2007. The model was adapted from the MTC Baycast travel model. The intraregional model, while suitable for the first generation HSR R&R model, proved cumbersome to use and produced results that, at times, appeared to not change consistently with input parameters. A primary cause of these issues seemed to be the off-peak-period transit path skimming procedure used in the original Baycast model and thereby adopted in the first generation HSR R&R model. Prior to 2010, the issues were addressed using off-model adjustments.

The MTC completed a revalidation of the Baycast model in late 2004 based on updated demographic, economic, and land use forecasts from the Association of Bay Area Governments' (ABAG) Projections 2003 series and updated 2030 regional forecasts as part of their 2035 transportation plan update. The refinements made to the first generation HSR R&R model focused on more closely reproducing MTC's updated 2000 and 2030 results while continuing to provide the additional modeling detail required from the HSR R&R model.

The MTC intraregional model was carefully reviewed and updated to ensure that the peak period and off-peak-period models implementing the planned model updates for transit path-building were consistently applied. In addition, the model implementation procedures were reviewed to ensure that they properly processed data for scenarios that were not contemplated at the time that the HSR R&R model was originally developed (e.g., varying parking costs for HSR and commuter rail stations).

Model calibration consisted of adjusting mode-specific constants until the modeled mode shares matched observed targets. Model constants were specified in a manner similar to those used for the original MTC Baycast model with the exception that constants were applied for transit submodes rather than just for total transit. In effect, constants were specified by purpose, (production) county, time of day, and sub-mode.

Table 4-21 shows the validation results by submode. These results show that the MTC intraregional model reasonably reproduces the MTC Baycast model results.

Table 4-21: Year 2000 Daily Trips by Submode

	San Francisco	San Mateo	Santa Clara	Alameda	Rest of Region	Total Region
Target						
BART	135,341	12,823	2,404	97,563	52,797	300,929
Commuter Rail	5,590	8,811	12,044	1,919	532	28,896
LRT	77,768	0	11,356	0	0	89,124
Bus	218,084	48,233	93,943	111,481	89,015	560,755
Ferry	11,611	0	0	3,877	4,976	20,464
Transit	448,394	69,867	119,747	214,840	147,320	1,000,168
Modeled						
BART	136,521	12,841	2,059	97,516	52,773	301,709
Commuter Rail	5,603	8,594	11,969	1,931	533	28,630
LRT	77,894	9	11,459	9	10	89,381
Bus	218,554	48,234	93,345	111,597	88,964	560,694
Ferry	11,609	0	0	3,594	4,916	20,120
Transit	450,181	69,678	118,832	214,646	147,196	1,000,533
Difference						
BART	1,180	18	-345	-47	-24	780
Commuter Rail	13	-217	-75	12	1	-266
LRT	126	9	103	9	10	257
Bus	470	1	-598	116	-51	-61
Ferry	-2	0	0	-283	-60	-344
Transit	1,787	-189	-915	-194	-124	365
Percent Difference						
BART	0.9%	0.1%	-14.4%	0.0%	0.0%	0.3%
Commuter Rail	0.2%	-2.5%	-0.6%	0.6%	0.2%	-0.9%
LRT	0.2%	–	0.9%	–	–	0.3%
Bus	0.2%	0.0%	-0.6%	0.1%	-0.1%	0.0%
Ferry	0.0%	–	–	-7.3%	-1.2%	-1.7%
Transit	0.4%	-0.3%	-0.8%	-0.1%	-0.1%	0.0%

SCAG Intraregional model

The SCAG intraregional mode choice model uses SCAG trip tables and skims and a recalibrated version of the MTC mode choice model to produce peak and off-peak trips by mode and purpose for the SCAG region. This model was calibrated to match observed SCAG trips by mode and purpose. The results of this calibration are provided in Table 4-22. They show a close fit to observed trips by mode overall and for transit modes, but an underestimation of the Shared Ride 2 trips and an overestimation of drive-alone trips.

Table 4-22: Intraregional Trips by Mode from SCAG Model

Mode	Observed Mode Share	Observed Trips	2000 Model Mode Share	Model Trips
Drive Alone	46.2%	18,039,255	54.9%	21,466,448
Shared Ride 2	21.6%	8,423,944	11.8%	4,593,150
Shared Ride 3+	21.3%	8,332,239	22.5%	8,792,319
Urban Rail	0.3%	104,394	0.3%	104,201
Commuter Rail	0.1%	34,227	0.1%	34,819
Express Bus	0.2%	95,496	0.2%	96,266
Local Bus	1.6%	634,142	1.7%	664,577
Walk/Bike	8.8%	3,422,911	8.5%	3,335,080
Total	**100.0%**	**39,086,607**	**100.0%**	**39,086,859**

Source: 20090403111741_StatewideModelValidationFRJuly2007.pdf

In early 2008, the SCAG intraregional models were refined for use in the HSR R&R model. The refinements addressed issues identified after completion of model runs for the Program EIR/EIS. The issues had been included in model files that were provided by public agencies for use in creating the ridership and revenue model. The following is a summary of the issues and the modifications to address those issues:

- Systemic errors were found to exist in the original SCAG transit skims used in the mode choice and assignment algorithms for the SCAG intraregional model. Updated base year transit skims were successfully integrated into the model and the transit mode choice and assignment models were recalibrated.
- Several refinements were made to the HSR skimming process and input fare matrices to correct inconsistencies. A set of quality control heuristics was developed for each HSR skim to test for reasonableness. Specifically, HSR paths between TAZ pairs were not allowed if any of the following conditions were present:
    1. The HSR path had HSR in-vehicle travel time of zero
    2. The trip required more than one transfer for drive access skims, or two transfers for walk access skims
    3. The time required to access HSR was greater than the time spent on HSR
    4. The total access distance was greater than 15 miles
    5. The walk access or egress time was greater than one-half of the time spent on HSR

- Due to software limitations, reasonable walk and drive access links could not be generated for the SCAG intraregional model. Instead, a procedure was developed to integrate the walk and drive access links generated for the interregional travel model into the SCAG intraregional model for HSR.
- The SCAG intraregional model used the basic mode choice model structure from the MTC model, adapted to include HSR as a separate mode. Modifications to model coefficients and utility equations were made for internal consistency. Parking cost at HSR stations was added to the fare in the HSR utility equations.
- After making the changes to the mode choice model structure and coefficients, the modal constants were recalibrated to reproduce observed base year ridership shown in Table 4-22.

SANDAG Intraregional model

The SANDAG trips by mode were not available from existing sources, but the highway and transit assignment validations were available from the Addendum to the Transportation Model Documentation (June 2005). These are presented in Table 4-23.

Table 4-23: Intraregional Volumes by Mode from SANDAG Model

Volume	Mode	Observed	2000 Model	Difference	Percent Difference
Vehicle Miles Traveled	Highway	70,789,214	70,266,732	(522,482)	-1%
Boardings	Rail	99,906	102,052	2,146	2%
Boardings	Bus	229,369	224,161	(5,208)	-2%

Source: 20090403111741_StatewideModelValidationFRJuly2007.pdf

4.6 Trip Assignment Validation

Three individual trip assignments by mode completed the statewide model validation effort for year 2000. Each assignment was compared to the observed data sources described earlier. The highway and rail assignments included interregional and intraregional trips; the air assignment included only interregional trips because there were no intraregional air trips.

4.6.1 2000 Trip Tables

Trips by mode from the interregional models were combined with intraregional trips by mode to assign to the highway, air, and rail networks. Table 4-24 presents a summary of the modeled 2000 interregional trips by mode and market.

Table 4-24: 2000 Daily Interregional Trips by Mode

Market	Auto	Air	Rail	Total
LA to Sacramento	7,479	4,935	–	**12,414**
LA to San Diego	257,441	100	5,395	**262,936**
LA to SF	28,031	26,867	–	**54,898**
Sacramento to SF	137,739	25	1,816	**139,580**
Sacramento to San Diego	175	2,858	–	**3,033**
San Diego to SF	4,630	10,309	–	**14,939**
LA/SF to SJV	205,205	3,393	926	**209,524**
Other to SJV	281,750	243	344	**282,337**
To/From Monterey/Central Coast	275,794	3,532	1,105	**280,431**
To/From Far North	184,506	3,005	16	**187,527**
To/From W. Sierra Nevada	59,192	668	11	**59,871**
Intraregion	–	–	–	**–**
Total	**1,441,942**	**55,935**	**9,613**	**1,507,490**

Source: California Statewide High-Speed Rail Forecasting Model run for 2000 "base year" conditions.

The air trips in Table 4-24 were assigned to direct flights within the State of California. It was assumed that transferring to travel within the State was negligible, so the total boardings on air were equal to the total air trips. For rail, an option to transfer from one rail line to another existed so the resulting boardings reflected the number of transfers (1.3 boardings per trip).

4.6.2 Air

Even though the air and rail assignments were very small compared to auto, these were critical to the evaluation of high-speed rail, so the validation of these modes was important. Assigned air trips compared very well with observed numbers for the major markets and operators. The air passenger boarding validation, presented in Table 4-25, showed a reasonable comparison of observed to estimated air passengers in all except two markets. The Sacramento to San Diego market was overestimated and the "other" market was underestimated; modeled boardings for all remaining markets matched observed boardings quite closely. For the three largest markets, modeled boardings matched observed boardings within ±2 percent and the overall total air boardings matched observed boardings within ±1 percent.

Table 4-25: 2000 Air Passenger Boarding Validation

Market	Observed Adjusted	Model	Difference
LA to Sacramento	12,308	12,170	(138)
LA to San Diego	387	70	(317)
LA to SF	29,329	28,890	(439)
Sacramento to SF	8	22	14
Sacramento to San Diego	3,848	5,030	1,182
San Diego to SF	8,096	8,263	167
LA/SF to SJV	140	137	(3)
Other	1,040	294	(746)
Total	**55,156**	**54,876**	**(280)**

4.6.3 Rail

The rail passenger boarding validation, presented in Table 4-26, shows a comparison of modeled to observed rail passengers by operator. These include all conventional rail operators that serve interregional passengers except the Metrolink Orange line, which travels from Los Angeles Union Station to Sierra Madre Villa in the San Diego region. The Metrolink Orange line was modeled as an interregional service, but not validated separately since the majority of the service was intraregional. The Altamont Commuter Express market was slightly underestimated and the Amtrak Surfliner was slightly overestimated. The other rail markets were reasonable. The overall conventional rail assignments were within +/- 11 percent of observed.

Table 4-26: 2000 Rail Passenger Boarding Validation

Market	Observed	Intraregional Models	Interregional Model	20000 Model Total	Difference
Altamont Commuter Express (ACE)	3,100	836	451	1,287	(1,813)
Amtrak Surfliner	5,100	2,966	5,122	8,088	2,988
Amtrak San Joaquin	2,110	452	2,350	2,802	692
Amtrak Capital Corridor	3,300	1,094	1,872	2,966	(334)
Total	**13,610**	**5,348**	**9,795**	**15,143**	**1,533**

Source: 20090403111741_StatewideModelValidationFRJuly2007.pdf

4.6.4 Auto

Auto assignments were primarily validated based on gateways along the high-speed rail corridors. These compared very well to observed traffic counts. Highway trips were converted from person trips to vehicle trips using vehicle occupancy factors derived from the Caltrans Statewide Travel Survey as shown in Table 4-27.

Table 4-27: 2000 Interregional Vehicle Occupancy (Persons per Vehicle)

Trip Type	Business	Commute	Recreation	Other
Long	1.1872	1.1118	1.7304	1.3107
Short	1.1807	1.1872	1.4946	1.536

Source: 20090403111741_StatewideModelValidationFRJuly2007.pdf

In addition, highway trips were separated into peak and off-peak time periods so that peak and off-peak trip tables could be assigned separately to the highway network. This ensured that peak-period travel times more accurately reflected congestion that occurred in the peak-period. Table 4-28 shows the time period factors applied by trip purpose.

Table 4-28: 2000 Interregional Peaking Factors

Trip Type	Business	Commute	Recreation	Other
Peak from Home	46%	49%	39%	43%
Peak to Home	34%	34%	39%	39%
Offpeak from Home	4%	1%	12%	7%
Offpeak to Home	16%	17%	11%	12%

Source: 20090403111741_StatewideModelValidationFRJuly2007.pdf

The peak and off-peak interregional auto vehicle trips were combined with the intraregional auto vehicle trips. These intraregional trips came from four sources: MTC, SANDAG, SCAG, and Caltrans. The Caltrans Statewide Model was used to estimate intraregional trips for all regions other than the MTC, SANDAG, and SCAG regions. Thus, the auto trip table represented all statewide travel. This ensured that congestion within smaller urban areas was adequately represented. Table 4-29 summarizes the auto vehicle trips from each source and provides the resulting total peak and off-peak auto vehicle trips that were assigned to the highway network.

Table 4-29: Auto Vehicle Trips by Mode and Source

Region and Mode	Vehicle Trips
MTC Drive Alone	9,173,350
MTC Shared Ride 2	2,799,465
MTC Shared Ride 3	2,487,932
MTC Trucks	252,577
SANDAG Peak	2,852,350
SANDAG Offpeak	3,023,621
SCAG Drive Alone Peak	12,568,822
SCAG Shared Ride 2 Peak	3,118,167
SCAG Shared Ride 3 Peak	1,922,152
SCAG Drive Alone Offpeak	11,399,239
SCAG Shared Ride 2 Offpeak	2,971,802
SCAG Shared Ride 3 Offpeak	1,509,108
SCAG Trucks	1,184,178
Caltrans Statewide (Remaining Urban Areas)	13,045,337
Interregional	1,049,247
Total Daily	69,357,348

Source: 20090403111741_StatewideModelValidationFRJuly2007.pdf

Table 4-30 presents the highway assignment validation results with the results aggregated by four different grouping schemes: facility type, area type, region, and gateway. For the facility type grouping, freeways and expressways reflect the vast majority of vehicle miles traveled on statewide facilities (95 percent) and modeled volumes were within two percent of observed volumes on those facilities. The arterials were overestimated but were not the focus of the study given their limited use for interregional travel. Additional network review and highway validation could improve these results. The highway assignment compared well to observed volumes by area type. Modeled volumes were within ±14 percent of observed volumes for all categories.

The highway assignment summarized by region shows that the regions of significance to the high-speed rail study are all within ±20 percent of observed volumes, except for the SCAG region, which does not reflect the full set of counts in the region. The Central Coast and Far North regions are outside this target, but are well outside the proposed high-speed rail corridor so this was not a concern. In addition, these regions are not congested, so this underestimation of volumes does not significantly affect travel times across the State.

The gateways established for this study were located in key corridors for high-speed rail and were consistent with the previous set of travel markets evaluated for the trip tables. Six gateways were established and all had assigned volumes within ±15 percent of observed volumes. Although both the Altamont and Pacheco passes were underestimated slightly, they were well balanced so there was no concern of a bias towards one pass over the other for the highway validation.

Table 4-30: 2000 Highway Assignment Validation

Classification	Locations	Modeled	Observed	Difference	Percent Difference
Vehicle Miles Traveled By Facility Type					
Freeways/Expressways	1,155	54,807,094	55,666,538	-859,443	-2%
Major Arterials	179	2,760,912	3,764,260	-1,003,348	-36%
Minor Arterials/Collectors	25	144,513	148,993	-4,422	3%
Total	**1,359**	**57,712,519**	**59,579,791**	**-1,867,213**	**3%**
Vehicle Miles Traveled By Area Type					
Rural	836	29,959,583	28,096,076	1,863,506	6%
Suburban	133	4,321,742	4,784,532	-462,790	-11%
Urban	390	23,431,194	26,699,182	-3,267,987	-14%
Total	**1,359**	**57,712,519**	**59,579,791**	**-1,867,271**	**-3%**
Vehicle Miles Traveled By Region					
AMBAG	39	2,166,435	1,572,883	593,552	27%
Central Coast	70	1,756,734	3,054,418	-1,297,684	-74%
Far North	258	4,684,264	6,763,302	-2,079,038	-44%
Fresno	46	2,470,711	2,150,050	320,661	13%
Kern	83	3,731,189	3,342,222	388,967	10%
Merced	64	2,092,094	1,717,837	374,257	18%
MTC	176	7,975,231	7,653,524	321,707	4%
SACOG	150	8,416,323	8,495,630	-79,308	-1%
San Joaquin	90	3,328,091	3,997,801	-669,710	-20%
SANDAG	141	15,417,924	15,186,348	231,576	2%
SCAG	16	638,858	466,960	171,898	27%
South San Joaquin	20	778,733	697,951	80,782	10%
Stanislaus	44	1,423,711	1,690,356	-266,645	-19%
W. Sierra Nevada	162	2,832,222	2,790,509	41,713	1%
Total	**1,359**	**57,712,519**	**59,579,791**	**-1,867,271**	**-3%**
Volumes By Gateway					
SAC to SF on I-80	4	127,788	115,536	12,252	11%
SAC to SJV on I-5 and SR-99	4	112,105	109,365	2,740	3%
SJV to SF on I-580 (Altamont Pass)	4	95,831	111,500	-15,669	-14%
SJV to SF on SR-152 (Pacheco Pass)	2	17,705	20,728	-3,023	-15%
SJV to LA on I-5 and SR-14	4	86,910	78,927	7,983	10%
LA to SD on I-5 and I-15	4	451,154	442,951	8,203	2%
Total	**22**	891,493	879,007	12,486	1%

Source: 20090403111741_StatewideModelValidationFRJuly2007.pdf

4.7 Sensitivity Analysis

A series of sensitivity tests were conducted to test the impacts of changes in level of service on high-speed rail ridership and revenue. These tests were designed to assist in developing an improved operating plan and optimum fares, and to understand the impacts of potential changes in assumptions to the air and auto modes. The results of the sensitivity tests are provided in Table 4-31.

Table 4-31: Sensitivity Tests for High-Speed Rail

		Percent Change from Base	
Sensitivity Test	**Change in Level of Service**	**Boardings**	**Revenues**
High-speed rail level of service tests			
Higher high-speed rail fares	25% increase	-13%	2%
Average daily headways	High-speed rail headways*	-15%	-14%
Higher high-speed rail freq	100% increase	15%	16%
Express service SF/LA	Double freq SF/LA to SJV, SD/SF to SAC	22%	24%
Air and auto level of service tests			
Higher air/auto times	6% increase**	6%	6%
Higher air/auto costs	50% increase	46%	53%
Combined level of service tests			
Higher high-speed rail fares and higher air/auto costs	25% increase in fares, 50% increase in costs	13%	19%
Higher high-speed rail fares and higher air/auto costs	50% increase in both	31%	40%
Higher high-speed rail fares and higher air/auto costs	100% increase in fares, 50% increase in costs	-6%	1%

* Average daily headways assume that the headways in the peak and off-peak periods are equal. This effectively increases peak headways and decreases off-peak headways.

** The 6-percent increase in travel time was based on a 30-minute increase in travel time from San Francisco to Los Angeles by car.

The results show that improvements in high-speed rail frequencies can be used to support higher HSR ridership. Increased HSR frequencies in the major corridors (San Francisco to Los Angeles, Los Angeles to San Joaquin Valley, San Diego to Sacramento, and San Francisco to Sacramento) have been retained planning purposes. These results also show that raising high-speed rail fares will not significantly increase revenues, unless this is combined with different assumptions of air and auto costs. Assumptions regarding air and auto cost increases remain a difficult issue, given the volatility in these costs in the past 5 years alone. The sensitivity tests did show that high-speed rail ridership was highly sensitive to the assumptions of air and auto costs, and could increase as much as 46 percent with a 50-percent increase in air and auto costs.

4.8 External Review

The purpose of the peer review panel was to provide technical guidance in the model design, model development, and forecasting of ridership and revenue for a statewide and Bay Area high-speed rail system. The panel provided comments on the development and application of the models to the evaluation of high-speed rail, suggested areas in which additional analyses were required, provided a review of basic assumptions and the design of alternatives to be tested, and commented on the interim and final results. The peer review panel enhanced the credibility of the process by providing an objective and independent review of the models, assumptions, methodologies, and results.

The peer review panel members included several members from the private sector, affected public agencies, and academia, as follows:

Ayalew Adamu (Caltrans HQ)

Jean-Pierre Arduin (Independent)

Mike Bitner (Fresno Council of Governments)

Chris Brittle (MTC)

Tim Byrne (OCTA)

Billy Charlton (SFCTA)

Gordon Garry (SACOG)

Kostas Goulias (University of California, Santa Barbara)

Keith Killough (SCAG)

Frank Koppelman (Northwestern University)

Bill McFarland (SANDAG)

Brad McAllester (LAMTA)

Kazem Oryani (URS)

David Valenstein (FRA)

A number of observers were invited to the peer review panel meetings, including Malcolm Quint (BART), Carl Schiermeyer (Riverside County Transportation Commission), Jay Kim (LADOT), Laura Biery (City of Palmdale), and Beth Thomas (Caltrain).

There were two meetings of the peer review panel and a final review by e-mail.

- First peer review meeting in June 2005 was to review the model system design (Task 3), data collection plan (Task 4), and development of performance measures (Task 8);
- Second peer review meeting in June 2006 was to review the models developed (Task 5) and the network alternatives (Task 6); and
- Final peer review was conducted to review the ridership and revenue forecasts (Task 8).

The peer review summaries are described below.

4.8.1 First Peer Review

The first peer review panel meeting was held on June 8, 2005, in Oakland, California. Four primary technical areas of work were covered in the first peer review: study work plan, model design, survey data collection, and performance measures. There were many discussions of the proposed approach to model design and data collection and development of performance measures during the course of the peer review panel meeting. In addition, there were a number of suggestions from peer review panel members that resulted in a change in the proposed approach or an agreement that further information was warranted before proceeding. These are summarized below:

- Urban mode choice models were reviewed to consider using existing models adapted to include a high-speed rail mode, rather than developing a generic mode choice model for all urban areas in the State. The peer review panel's recommendation on using the existing urban mode choice models was implemented rather than developing a separate generic mode choice model.
- The panel suggested that the study team consider a minimum travel time parameter (like 15 minutes) for high-speed rail to preclude short trips on this mode. However, this parameter could cause unintended results when modeling urban high-speed rail trips, and therefore was carefully reviewed. This recommendation was not implemented as there were no issues with short, illogical high-speed rail trips.
- Urban area household travel surveys were reviewed to identify potential intercity trips that could be used to expand the California Household Travel Survey sample size. In addition, the household survey data collection could be used to supplement these surveys. This recommendation was implemented and increased the overall survey sample size from 2,678 to 6,882 surveys.
- The proposed model validation year was 2005, but since some significant data sources were from the year 2000, changes between these years would need to be studied and understood. The study team conducted separate validation tests for the year 2000 and 2005 data, rather than combining these datasets and tests. Both the 2005 and 2000 data were prepared and reviewed, but there was not enough data for 2005 conduct a comprehensive model validation.
- The study team should reallocate resources to increase the sample size of the new survey data collection to 2,500 samples for mode choice model development. The increase in survey sample size was to be achieved by expanding the household auto travel survey to 1,450 surveys. Air surveys would continue to have a sample size of 600 and rail surveys would have 450 samples. This recommendation was implemented and the final number of completed surveys (2,678) exceeded the target of 2,500.
- Survey questionnaires should be revised and resubmitted to the peer review panel working group. In addition, the household pretest should be delayed to test these changes in the field. Both of these recommendations were completed. The survey questionnaires went through extensive review and revisions with the peer review panel members and other members of the consulting team.
- The study team should reconsider allocation of resources for the 2040 and 2050 forecasts for the third peer review panel meeting. This recommendation was implemented. The sources of data for 2040 and 2050 were not detailed and the level of effort to develop 2040 and 2050 models was quite high, so it was felt that these forecasts could be reasonably generated using trend analysis, rather than implementing a full set of models for these forecast years.
- Performance measures should be reduced to provide a more limited set of robust measures for consideration. SUMMIT analyses would not be used to estimate performance measures due to its limitations. This recommendation was implemented and the performance measures were limited to those required for environmental documentation.

The majority of the recommendations from the first peer review panel meeting were implemented and provided useful direction for the model development and forecasting activities.

4.8.2 Second Peer Review

The second peer review panel meeting was held on June 2, 2006 in Oakland, California.

The purpose of the second peer review panel meeting was to provide technical guidance in the model specification and estimation, and on the forecasting assumptions. The elements of the model reviewed at this meeting included the following: review of model design, interregional travel models, forecast assumptions, and summary. The list of peer review members who attended the 2nd peer review panel meeting is:

Ayalew Adamu (California Department of Transportation (Caltrans) Headquarters);

Jean-Pierre Arduin (independent consultant)

Chris Brittle (independent consultant representing MTC)

Billy Charlton (San Francisco County Transportation Authority (SFCTA))

Chausie Chu (Los Angeles County Metropolitan Transportation Authority (Metro))

Kostas Goulias (University of California at Santa Barbara)

Keith Killough (Southern California Association of Governments (SCAG))

Frank Koppelman (Northwestern University)

Kazem Oryani (URS Corporation)

In addition, a number of observers were invited to the peer review panel meetings, including the following:

Malcolm Quint (Bay Area Rapid Transit District (BART))

Carl Schiermeyer (Riverside County Transportation Commission)

Tom Matoff (LTK Engineering)

Joe Castiglione (Parsons Brinckerhoff)

The following representatives from MTC (Chuck Purvis) and CHSRA (Dan Leavitt) and consultant team members were present at the meeting:

Maren Outwater (Project Manager)	Arun Kuppam	George Mazur
Ron West	Elizabeth Sall	Mark Bradley
Vamsee Modugula	Chris Wornum	Nick Brand

There were a series of recommendations mentioned for consideration or inclusion into the modeling or forecasting approach. These are described below with additional notes on the implementation of these recommendations.

Model Development

- A recommendation was made to estimate nonresident, high-speed rail travel by separating current air demand into resident and nonresident segments, and then assuming that nonresident mode shares for air and high-speed rail will mimic resident mode shares for air and high-speed rail. This approach would serve to include nonresident demand for high-speed rail directly and assists in the calibration of air demand by including only resident air demand. Available data sources were reviewed to estimate the resident/nonresident air demand shares to support this analysis; however, this recommendation was not implemented due to time and resources constraints.
- It was noted that the original model design did not include any information on visitors that might use the system. A suggestion was made to include estimates of visitors derived from available air demand data sources and then apply the same resident modal shares between air and high-speed rail to

these non-residents. The panel agreed that it was better to include these estimates than to produce ridership for only residents. This recommendation was not implemented.

- It was suggested that some issues might exist with using the statewide model as the source for the mode choice model logsums for this initial destination choice model estimation and the panel suggested testing the models with and without the distance variables when re-estimated with the final logsums. The final destination choice models incorporated the distance variables.
- It was pointed out that households were not considered as a size variable for the destination end of the trip in any of the destination choice models in the initial model estimation. Households can be attractors for recreation and other trips, in addition to employment. As a result, the study team recommended to the panel that this be considered in the final round of model estimation for recreation and other destination choice models and they agreed. Households were included in the final recreation and destination choice models as the "base" size variables.
- It was suggested that annualization factors should be developed from an evaluation of the high-speed rail systems in operation around the world. These annualization factors would allow prediction of annual ridership from our modeled estimates of average weekday ridership. Overseas experience and California travel patterns were examined, and the annualization factor was discussed again during the third peer review meeting and was set to 365.
- The panel and study team discussed finalizing the trip frequency, destination, and mode choice models. For the trip frequency and destination choice model, it was decided to calculate the actual logsums from each lower-level model and using them to re-estimate the logsum variable in the upper-level model. It also involved reviewing statistically insignificant variables in each of the three models to determine if they should be dropped from the model specification, or if they added value to the models (and were logical) indicating that they should be retained. Chapter 2 documented which of those coefficients were retained in the final models.
- A discussion of the initial estimation of the trip frequency model, which used accessibility measures as a weighted sum of the travel time to all potential destinations in the system, based on population and employment in each traffic analysis zone, and travel times at peak or off-peak to support the business/commute or recreation/other trip purposes, respectively, resulted in the decision to use the actual logsum value from the destination choice models in the final estimation of the model. These accessibility measures were calculated separately for within each region and outside the region; the within region accessibility measures were retained in the final models because the within region (or urban area) models are not destination choice models and are not able to produce logsums for this purpose.
- One peer review panel member requested that we consider replacing mode choice logsums in the urban distribution models to estimate the impacts of high-speed rail travel on urban trip lengths. This request was considered, but would result in a high level of effort and was not expected to result in any significant differences in high-speed rail ridership, so it was not pursue. This option can be pursued by MPOs wishing to evaluate this impact on their own urban models for those purposes (such as work) that are currently already incorporating mode choice logsums.
- There was also discussion regarding the inclusion of a reliability measure in the mode choice models. The initial models indicated that reliability does not have a significant impact on modal choices, but this may be due to the definition of the reliability measure in the survey regarding on-time performance within 15 minutes of scheduled arrival (for auto, air and conventional rail) and within 5 minutes for high-speed rail. This measure, taken in the context of a longer interregional trip, is probably too narrow to adequately differentiate reliability among modes. In addition, the peer review panel felt that the measures needed to be consistent across modes. So the reliability measure was modified to reflect arrival within 60 minutes of scheduled (or expected) time. This was be modified in model calibration to the new measure. The specifications of the reliability measure are described more fully in the next section on level-of-service assumptions.

- There was a substantive discussion about the need to include some measure of a reservation system or the convenience/inconvenience of having to make reservations ahead of time or at the station. There were some responses that this type of information would not significantly influence travel behavior, and therefore would not warrant inclusion in the models. In addition, these data were not collected in our surveys, so it would not be possible to include in the estimated models.

Level of Service (LOS) Assumptions

- Items included in the auto operating cost and whether it should include insurance to better represent federal reimbursement policies were discussed. The panel agreed that this was probably too high and we should retain the proposed auto operating costs developed by MTC.
- Whether to use the same cost inputs for urban and interregional models or vary them by region was also discussed. The panel felt that auto operating cost was not significantly different by region and this was supported by the research completed by MTC on auto operating cost.
- There was also debate among the panel about the high-speed rail fares, especially for short trips. Previous high-speed rail fares for longer trips were set at 50 percent of air fares and this assumption is proposed again. The panel felt that these fares were reasonable. The panel felt that the proposed fare of $5 for short high-speed rail trips was too low and that it should be at least 20 percent higher than fares for conventional rail in the same corridor. The revised proposed high-speed rail fare for shorter trips starts at $7.50 compared to similar conventional rail service ranging from $3 to $7 in most corridors.

Frequency and Wait Time

- For all modes, service must first be assumed, and then supplied to the models to produce demand from that service. Service can be adjusted to better match demand after initial ridership is produced; this is typically referred to as an equilibration process. Since this study is focused on high-speed rail demand, we propose to assume air and conventional rail service will be set at 2005 service levels for future forecasts. The peer review panel concurred that we keep the frequencies for air and conventional rail supply constant over time and review the calculation of demand relative to supply.
- Frequency is included in the mode choice models directly rather than the traditional wait times, calculated as half the headway, because frequency has a different impact on interregional travel than it does on urban travel. Wait times were estimated separately based direction from the peer review panel (see next point).
- An initial review of wait times for air travelers in the surveys collected for this project revealed no significant difference between wait times for business and non-business travelers. In addition, it appeared that air traveler wait times are not a function of the air service frequencies, as recommended by the peer review panel. The rationale for using set wait times is each seat must be reserved in advance, so the presence of more or less frequent service between airport pairs does not influence the wait times. As a result, air wait times for air passengers will be set based on a review of the surveys reported wait times at 55 minutes. The air wait times are derived from self-reported data on arrival time before departure in the air passenger travel surveys collected for this study, which includes both wait and terminal times.
- For rail travel, the wait times are lower than air for a number of reasons. First, trains will have numerous doors, making boarding a train a much faster proposition than boarding an airplane. In addition, the hassle and time variance of getting a boarding pass, checking luggage, and getting through security requires arrival at the airport earlier than at a train station without security checkpoints. It is explicitly assumed that high-speed rail will not have the elaborate security check-in procedures, boarding passes will not be required to wait for a train, seats are not assigned, and that luggage is typically self-carried on the train. The peer review panel recommended that interregional rail travel wait times be in the range of 10 minutes to 20 minutes, with higher values for non-

business travel. Since the air passenger surveys did not support separate wait times for business and non-business travelers, we propose to use a single wait time value for rail passengers as well. The rail wait time is set at 15 minutes for both high-speed and conventional rail travelers. All of these factors combine to make train wait times much shorter than for air travel. During model calibration, we will separate terminal and wait times from the modal constant in the mode choice models so these can be included for policy testing.

Terminal Time

Terminal times are defined as the walk travel time between curbside and waiting areas. There was considerable discussion about the expected security measures that would be in place for each mode and how this would affect the terminal times.

The panel felt that the proposed 5 minute terminal time for high-speed rail was too low. The following revised terminal times were used:

- 12 minutes for downtown/terminal high-speed rail stations in San Diego, Irvine, Los Angeles, Sacramento, San Francisco, and Oakland. (These are the larger proposed high-speed rail stations, with more distant parking and longer walk times to local ground transportation);
- 8 minutes for other high-speed rail stations;
- 24 minutes for non-business/commute trips at Los Angeles and San Francisco Airports;
- 20 minutes for non-business/commute trips at other airports;
- 22 minutes for business/commute trips at Los Angeles and San Francisco Airports; and
- 18 minutes for business/commute trips at other airports.

These values average out to the 10 minute high-speed rail and 20 minute air terminal time recommendations of the peer group, but provide more differentiation that travelers generally encounter at larger airports and (presumably) high-speed rail stations.

Transfer Times

Transfer times were discussed by the peer review panel and proposed to be calculated as 50 percent of the headway for all modes, with a maximum of 15 minutes for relevant transfers. For interregional travel, transfer times are somewhat more complicated because local transit access/egress to/from the high-speed rail modes is part of the access/egress time. Because the interregional travel mode will be the primary mode of travel, it is assumed the traveler will know the schedule of the interregional mode, and will plan their trip accordingly. As a result, no time will be assessed for trips that include using local transit to access the interregional mode.

For example, consider a traveler living in San Francisco and traveling to Southern California. This traveler will take BART to San Francisco Airport, followed by a flight to a Southern California airport. The notion of assessing a transfer time of half the airline headway (or some similar such measure) does not make sense since the traveler will obviously take a BART train that gets him/her to the airport on time for their flight. In this case, all of the relevant access travel time components are applied – a walk to the BART station, a wait for the BART train to arrive, and the actual BART ride. From there, the traveler will walk from the BART platform to the San Francisco Airport entrance. The times, in total, comprise the access time. This traveler will have the airport terminal and wait times, as well as the airline flight time, for their trip, so an assessment of a transfer time for this trip would be redundant and unrealistic.

However, the egress mode for the return trip would assess the typical transfer time – for the airline to BART connection. In this case, the traveler will have flown back to San Francisco airport and will need to transfer to BART. Coming off a relatively long flight and egress terminal time, the traveler will likely to have to wait half the BART headway. The peer review panel suggested that the transfer egress time be capped at 15 minutes, and that recommendation has been implemented.

Reliability

As mentioned in the mode choice model discussion, there was agreement among the peer review panel that the reliability measure should be consistent among modes. In addition, there was agreement that a measure of on-time performance within 60 minutes of scheduled arrival was a reasonable measure for interregional travel. There was considerable discussion about the difference between minor delays and significant or catastrophic delays, which can cause service to be hours behind schedule. The panel felt that both should be incorporated if possible, based on available data. The following measures of reliability by mode were developed based on the peer review panel's guidance:

The auto measure of reliability that has been used on a series of studies by Cambridge Systematics is the freeway vehicle hours of delay. This measure indicates that as delay on the freeway increases, the overall reliability of the system would tend to decrease. The probability, expressed in decimal terms, of an auto traveler arriving within 60 minutes of the congested travel time can be found with the following function:

$$P = \left(\left(\frac{TC+60}{TC} \right) - \left[\frac{TC + \left(\mathbf{60} \times \mathbf{TO} \times \left[0.0073 \times \frac{\left(\frac{TC}{TO} - 1 \right)^{1/8.5}}{0.18} \right]^{5.2695} \right)}{TC} \right] \right)$$

Source: 20090403112828_R2b_Findings from 2nd Peer Review Meeting_FINAL.pdf

where: TO = Freeflow travel time in minutes

TC = Congested travel time in minutes

The prior equation uses the concept of "travel time index", and essentially looks at the likelihood that someone's trip will be delayed by 60 minutes or more by non-recurring incident delay. The probability is referenced against congested travel time, since auto travelers presumably already account for the effects of recurring congestion in their mode choice decisions. The portion of the equation shown in bold represents the estimate of incident delay, measured in minutes. There are a number of major simplifications and limitations with the preceding equation including, but not limited to, the following:

- The equation uses the freeway volume delay function for all origin destination pairs. This function says that TC = TO (1+0.18(Volume/Capacity)$^{8.5}$.
- Travel distance is estimated using free-flow travel time and an assumed free-flow speed of 60 mph for all origin-destination pairs.
- The equation uses an incident delay function development for the FHWA IDAS software package for 6-lane freeways (3 lanes per direction). Linear regression was used to approximate a continuous function from the discrete look-up table in the IDAS User's Manual1. The IDAS "rates for off-peak or daily" reliability were used, with an additional assumption that the "1-hour level of service capacity" was equal to 1/14th of the link capacities in the high-speed rail model.
- The equation estimates incident delay uses average V/C ratio over the entire length of the trip. This is a limitation, as IDAS estimates incident delay from the V/C ratio on each individual link, but the equation has been scaled to account for this.

This auto reliability measure relies on existing research to define the function for determining auto reliability, but is applied on an origin-destination basis rather than a link basis for the purposes of this study. The resulting percent reliability estimates for a trip from Los Angeles to San Francisco are in the range of 67 percent to 92 percent, depending on the specific details of a trip. Trips with no congestion will have 100 percent reliability.

Airline reliability data for 2000 and 2005, as well as forecasts for 2025 were compiled from FAA data. Table 4-32 shows airport-to-airport reliability statistics for airports with the largest numbers of flights in 2000 and 2005. Airline travel shows reliability improvements since 2000, probably due to the airline practice of increasing scheduled air times to allow for better on-time performance.

To gather conventional rail data, e-mails were sent to Henning Eichler (Metrolink), Brian Schmidt (ACE), and Steve Roberts (Amtrak). There was no available on-time performance data for rail services arriving within 60 minutes of the scheduled time. The proposed measurement takes into account the same relationship that air performance has between 5 and 60 minutes, and assesses individual performance for each service. The following reliability measures were obtained and estimated:

- ACE – Reliability for ACE was measured within 5 minutes in the "Low 90s" through 1995. Since last year, ACE has had a number of reliability issues due to sharing track with freight rail. On-time performance within 60 minutes was estimated at 97 percent.
- Metrolink – Metrolink reliability is tracked monthly route. Year 2000 reliability averaged 95 percent in 2000 and 94 percent in 2005. Metrolink reliability is measured as the percentage of trains arriving within 5 minutes of scheduled time. On-time performance within 60 minutes was estimated at 98 percent.
- San Joaquins – The 5-year on-time performance within 5 minutes is 70 percent. On-time performance within 60 minutes was estimated at 89 percent.
- Capitol Corridor – The 5-year on-time performance within 5 minutes is 82 percent. On-time performance within 60 minutes was estimated at 94 percent.
- Surfliners – The 5-year on-time performance within 5 minutes is 83 percent. On-time performance within 60 minutes was estimated at 94 percent.

Table 4-32: Airline Reliability

ORIGIN	DEST	Percent More than 60 Minutes late (including canceled and diverted) 2000	2005	2025	Flights 2000	2005
Los Angeles	San Francisco	12.1%	6.1%	7.7%	16,021	8,427
San Francisco	Los Angeles	11.9%	5.0%	6.3%	15,967	8,503
Oakland	Los Angeles	9.2%	5.8%	7.4%	11,944	9,646
Los Angeles	Oakland	7.7%	4.7%	6.1%	11,861	9,665
Los Angeles	San Jose	7.9%	5.3%	6.3%	10,911	10,234
San Jose	Los Angeles	10.3%	4.2%	5.5%	10,861	10,237
San Diego	San Francisco	11.1%	5.0%	6.3%	7,320	3,332
San Francisco	San Diego	10.0%	4.2%	5.3%	7,288	3,090
San Jose	Santa Ana	6.3%	3.4%	4.2%	5,450	5,290
Santa Ana	San Jose	6.1%	4.0%	4.7%	5,435	5,457
San Jose	San Diego	7.7%	4.7%	5.8%	5,253	6,588
San Diego	San Jose	9.0%	4.2%	5.0%	5,231	6,603
Sacramento	Los Angeles	10.0%	5.0%	6.1%	5,229	5,608
Los Angeles	Sacramento	8.4%	5.5%	6.9%	5,181	5,627
Burbank	Oakland	6.1%	4.7%	5.8%	5,152	4,894
Oakland	Burbank	7.7%	5.5%	6.6%	5,124	4,906

- Typical high-speed rail reliability for European and Japanese systems was analyzed by Systra staff. On dedicated high-speed rail track, even with express and local trains, both the French and Japanese have reported average delays of 29 to 40 seconds per train (including weather and earthquake delays), which basically is more than 99 percent on time (within 10 minutes of schedule in European practice). This is possible since the dispatching and signal/control environment are managed as a consistent centralized unit with very few opportunities for delay. The ensemble of TGVs have been running at around 90 percent on time, because they also operate on conventional lines with different types of equipment, grade crossings, and other opportunities for slow down. About one-half of the operating mileage is on conventional lines. In Japan, almost all the mileage is on dedicated right-of-way (ROW).
- In California, there will be origin-destination pairs that will have 100 percent dedicated rights-of-way (ROW), where a very high on-time performance (OTP) could be expected. This would include any origin-destination for San Diego-Los Angeles-Central Valley-Sacramento. Trains running into the Bay Area and Orange County would have more interaction with other operators, although there would be no grade crossings. An assumed 95 percent OTP on time performance within 5 minutes would represent a reasonable high-speed rail service assumption. Obviously, OTP depends a lot on the schedule pad that is used, and the above assumes that a 5 percent pad in the times is included. This translates to 99 percent reliability for the defined criteria of on-time performance within 60 minutes.

Forecast Assumptions

- Financially constrained and unconstrained plans for inclusion into the future baseline were discussed statewide. There was consensus that financially constrained plans should be used, that the unconstrained plans were not necessary to incorporate, and that all the projects identified were from financially unconstrained plans, except for SCAG. The SCAG's financially constrained plans were obtained and incorporated into the model. Sensitivity tests were proposed and discussed by the panel.

- Two other tests were suggested (socioeconomic data and value of time), but were not considered to be necessary by the panel. One test for more or less expensive electricity was eliminated, because it is not a significant portion of the operating cost for high-speed rail.
- As of the second peer review, there was no plan to model the phasing plans for high-speed rail. The current project alternatives are focused on long-term (2030) ridership and revenue potential. There are also some longer-term forecast alternatives for 2040 and 2050 and shorter term forecasts for 2020.
- Sensitivity tests will be performed for a series of various cost assumptions. The evaluation of different project alternatives will effectively test changes in travel time assumptions. We considered testing changes in socioeconomic data, based on the peer review panel suggestion, but this test would require extensive additional data processing and does not support the overall forecasting efforts for the CHSRA or MTC. Another suggestion by the peer review panel was to test changes in value of time. This test was to be completed by the Regional Rail Study and is therefore not considered as a sensitivity study for this project.

4.8.3 Third Peer Review

While the reports and requests for their review were sent to the members of the panel who participated in the previous two peer review panel meetings, this peer review had a relatively smaller response. The panelists that participated in the third peer review meeting were:

Jean-Pierre Arduin (independent consultant)

Kostas Goulias (University of California at Santa Barbara)

Chris Brittle (independent consultant representing Metropolitan Transportation Commission (MTC)

The third peer review took place via e-mail exchange.

Model Validation

- Panelists had several questions about the source and validity of the observed data sources that were used to calibrate and validate the interregional model. The panel suggested that additional surveys be performed to better understand the situation; however, this was outside the scope of this study.
- A panelist suggested that the year 2000 validation targets for air passenger trips should have relied to a greater degree on the year 2000 and year 2005 DOT ticket samples and to a lesser degree on American Travel Survey (ATS) results. In order to develop purpose-specific estimates for validation purposes, it was necessary to rely on a combination of the DOT ticket sample data and the ATS, which included trip characteristics information. The two sources disagree to some extent about the amount of true intrastate origin-destination air travel. Both sources are subject to sampling errors, since neither is a census of travelers, and both sources are subject to nonrandom biases. The ATS survey required participants to recall trips they had made in the recent past, so some inaccuracies and misreporting would be expected. The 10 percent ticket sample is required of all large carriers, but the level of reporting by smaller carriers varies, depending on the ticketing relationship with other carriers and on the ticket purchase channel. The targets that were used represent somewhat of a compromise between the alternative sources. The significant changes in air passenger demand between 2000 and 2005 (when air passenger choice data were collected) affected both the amount of air travel and the composition of the air travel market, so the market segment-specific validation targets for air passenger trips try to reflect these composition changes. As the panelist notes the

forecast growth rate in interregional air trips is lower than for other available forecasts, so the higher validation targets for the base year help to mediate the differences between these other forecasts.

- A panelist pointed out that there were no "short" (less than 100 miles) air trips in the observed air data, and wondered where trips to/from SFO/SMF and several other airport pairs were accounted for. All observed air trips are assumed to be "long" or over 100 miles.
- There was general agreement that the calibration of the interregional models was acceptable. However, there was concern that the LA to and from SF market was not going up enough between 2000 and 2030. This market has a great deal of congestion and suffers from a lack of accessibility, which suppresses the growth of travel between these regions.

Ridership and Revenue Forecasts

- Panelists observed that there was no documentation about the forecast demographics and future network and transportation supply for the future year. The socioeconomic forecasts are consistent with the metropolitan planning organization (MPO) and the State of California forecasts and, therefore, assume all of their caveats and assumptions. The future year transportation supply for 2030 was defined by financially-constrained long-range plans, and was documented in the report, LOS and Forecast Assumptions, Cambridge Systematics, Inc., August, 2006.
- One reviewer pointed out the relatively low number of interregional trips that are forecast compared to several other forecasts done for aviation purposes by MTC and the Federal Aviation Administration (FAA). In particular, the growth rate of interregional air trips forecasts has roughly one-half the growth rate as the FAA's latest forecast, and slightly lower than the "low-forecast" range in the MTC's 2000 Regional Airport System Plan. The forecasts of air passenger growth were constrained in part by the input assumption that airline scheduled flight frequencies would remain the same as in 2005. While this assumption may be over simplistic, we believe it is more rational than assuming some arbitrary increase in these frequencies. The reviewer suggested the development of a separate air travel forecast to check the reasonableness of the California Statewide Model for High-Speed Rail using cost per passenger mile as one of the key variables. We agree that this would be a useful extension to the model system; it was outside the scope of this study. Reviewers requested more comparisons and summaries of the level-of-service assumptions for all modes.
- Several suggestions for further sensitivity tests were made. There were concerns about the relatively low high-speed rail fares compared to airfares.Subsequent work tested different high-speed rail fare strategies, as well as a variety of future year airfare and auto cost situations.
- Further explanation was requested for the results of Sensitivity Tests 3 and 5 in Table 3.2 of the report, where the HSR, Air, and Auto costs were all increased by the same percentage (35 percent for Test 3, and 75 percent for Test 5). The result in both cases was a 35 percent increase in the HSR ridership. This indicates that the higher fares do not have as much impact on the utility of high-speed rail compared to other modes.
- It was pointed out that the projected diversion of air travel to high-speed rail (36 percent) assumed very favorable assumptions about high-speed rail fares. However, this diversion was less than that of the previous study's air diversion rate of 56 percent. The reviewer also pointed out that they would expect the Pacheco Pass alternative to divert more air trips due to its superior connection between SF and LA markets (a large air market). One reviewer expected the diversion from Conventional Rail (CVR) to HSR to be higher, but agreed with the overall results.
- One reviewer asked about what annualization factor was used to get annual boardings and revenue. A value of 365 was used because the base year intercity travel volume estimates do not distinguish by weekday and weekend, and because intercity travel service is generally not reduced during holiday periods.

- The average fare per passenger was thought to be quite low. This is due to the high level of intraregional trips projected to use the HSR system, and their relatively lower pricing structure for fares.
- One panel member commented that proportion of business trips and overall forecast levels of the forecasts have a great level of credibility in comparison with other similar forecasts. They further mentioned that they accepted these results as credible, because they are based on cautious and prudent assumptions and used proven methods.

5.0 Forecasts for Project-Level EIR/EIS Work

This chapter presents

- the scenarios for which the HSR R&R model was used to produce 2030 forecasts during the period of 2008 – 2010, and their summary results
- the method for factoring 2030 forecasts to 2035 for use in the EIR/EIS work, and the results for various scenarios in 2035.

5.1 Overview of 2030 Forecasts and Process

The 2030 forecasts of high-speed rail (HSR) ridership and revenue were developed for a variety of scenarios. Initial forecasts for the project level work started with the input assumptions developed for the HSR service in the Program Bay Area-Central Valley EIR/EIS work for the full system. A new set of HSR network and cost related inputs was developed in early 2008 for an initial phase of service from Anaheim to San Francisco and Merced. Travel and parking costs were adjusted later in 2008, a new operating pattern was prepared for the full system, and the initial phase pattern was modified to include non-stop express service LA – SF. These operating patterns were used for all subsequent forecasts. Parking costs assumed at HST stations were further increased in late 2009 and used for all subsequent forecasts.

The inter-regional model as finalized in February 2007 and described in earlier sections of this report was used throughout this process. In early 2008, the SCAG intra-regional models were refined and used throughout all of the forecasts herein. At the beginning of 2010, the MTC intra-regional models were refined as described above, and used for the last of the forecasts made for the EIR/EIS project level work presented below. For each scenario, the HSR R&R model was used to predict the number of travelers that would use high-speed rail on an average weekday in 2030 and annual ridership and revenue were calculated using annualization factors based on California intercity and local traffic patterns.

5.2 Process for Factoring 2030 Forecasts to 2035

Since most metropolitan planning entities in the state had not yet completed updating their long-term transportation plan from 2030 to 2035, and some had not yet completed population and employment forecasting updates to 2035, the statewide model could not be used for a 2035 forecast. Instead a region-by-region forecast of growth was made from available government and private forecasts and applied to the model forecasts of 2030. Notably growth from 2030 to 2035 was forecasted to slow to below 1 percent per annum compared to 1.5 percent forecast for the prior decade.

The 2035 forecasts were developed as follows:

1. Projected changes in population and employment between 2030 and 2035 were assembled for each of the 14 regions identified for the high-speed rail ridership and revenue model: AMBAG, Central Coast, Far North, Fresno/Madera, Kern, South SJ Valley, Merced, SACOG, SANDAG, San Joaquin, Stanislaus, W. Sierra Nevada, MTC, and SCAG. The SCAG region was subdivided into SCAG North and SCAG South for ridership summaries, Table 5-1 shows the population and employment forecasts for 2030 and 2035, along with the percent growth assumed from 2030 to 2035 for each of the 14 regions. For AMBAG, MTC, Kern, and SCAG, forecasts of regional population, total employment, and households were obtained from the respective MPOs. Since 2035 MPO forecasts had either not been produced or adopted for the remaining regions, 2035 regional forecasts for those regions were developed using information from Woods and Poole Economics, Inc.

Table 5-1: Population and Employment by Region for 2030 and 2035

Region	Source for 2035 Forecast	2030		2035		Percent Change	
		Population	Total Employment	Population	Total Employment	Population	Total Employment
AMBAG	AMBAG	895,577	387,920	920,713	404,620	2.8%	4.3%
Central Coast	Woods & Poole	799,563	540,392	829,800	569,233	3.8%	5.3%
Far North	Woods & Poole	1,307,895	699,537	1,367,929	742,367	4.6%	6.1%
Fresno/Madera	Woods & Poole	1,359,119	672,339	1,429,346	714,055	5.2%	6.2%
Kern	Kern	1,156,938	426,924	1,264,200	460,385	9.3%	7.8%
Merced	Woods & Poole	331,378	126,061	350,230	134,348	5.7%	6.6%
MTC	MTC	8,712,800	4,921,680	9,031,500	5,247,780	3.7%	6.6%
SACOG	Woods & Poole	2,257,887	1,338,726	2,372,541	1,422,813	5.1%	6.3%
San Joaquin	Woods & Poole	905,658	394,570	957,178	420,428	5.7%	6.6%
SANDAG	Woods & Poole	3,926,855	2,628,192	4,140,035	2,819,077	5.4%	7.3%
SCAG	SCAG	23,255,380	9,913,335	24,057,301	10,287,127	3.4%	3.8%
South SJ Valley	Woods & Poole	713,456	319,386	745,713	335,736	4.5%	5.1%
Stanislaus	Woods & Poole	688,307	298,413	727,194	316,346	5.6%	6.0%
W. Sierra Nevada	Woods & Poole	256,685	134,549	271,280	144,236	5.7%	7.2%

Source: 01S_Results Memorandum_2009-08-14_FINAL.doc available on PS2:
https://ww3.projectsolve2.com/eRoomReq/Files/SFOF/CAHSRProgramMgmt/0_b0719/01S_Results%20Memorandum_2009-08-14_FINAL.doc

Trip production and attraction growth factors were developed for each of the regions. The full model estimated business and commute trip frequency for residents based on accessibility to employment throughout the rest of the state. Recreational and other trip frequency for residents in the full model was based on accessibility to retail and service employment and accessibility to households. Accessibility was based on travel times between resident zones and all other zones via auto, air, conventional rail, and high speed rail. Since the initial 2035 forecasts did not include detailed network analysis, growth factors for regional trip productions for each of the trip purposes were based on the percent changes in population in each of the 14 regions. The growth in business and commute trip attractions was based on the percent changes in employment in each of the 14 regions and the growth in recreational and other trip attractions was based on the percent growth in the sums of households, service employment and retail employment for each of the 14 regions. The growth in households closely paralleled the growth in population in the regions and growth in retail and service employment closely paralleled the growth in total employment.

Table 5-2 shows the growth factors by production and attraction for each purpose for the 15 regions and sub-regions. The SCAG region was subdivided into SCAG North and SCAG South for ridership summaries. The growth factors estimated for the entire SCAG region were applied to both the SCAG North and SCAG South sub-regions.

Table 5-2: Growth Factors by Production and Attraction and Purpose

Region	Business/Commute		Recreation/Other	
	Production	Attraction	Production	Attraction
AMBAG	1.028	1.043	1.028	1.040
Central Coast	1.038	1.053	1.038	1.052
Far North	1.046	1.061	1.046	1.054
Fresno/Madera	1.052	1.062	1.052	1.062
Kern	1.093	1.078	1.093	1.086
South SJ Valley	1.045	1.051	1.045	1.054
Merced	1.057	1.066	1.057	1.056
SACOG	1.051	1.063	1.051	1.060
SANDAG	1.054	1.073	1.054	1.065
San Joaquin	1.057	1.066	1.057	1.056
Stanislaus	1.056	1.060	1.056	1.054
W. Sierra Nevada	1.057	1.072	1.057	1.064
MTC	1.037	1.066	1.037	1.056
SCAG-North	1.034	1.038	1.034	1.042
SCAG-South	1.034	1.038	1.034	1.042

Source: 01S_Results Memorandum_2009-08-14_FINAL.doc available on PS2 at: https://ww3.projectsolve2.com/eRoomReq/Files/SFOF/CAHSRProgramMgmt/0_b0719/01S_Results%20Memorandum_2009-08-14_FINAL.doc

The factoring approach used for the initial 2035 forecasts assumed that the operating plans, travel times, fares, station locations, and competing mode information for 2035 will be identical to those for the 2030 forecasts described above. Thus, these forecasts did not consider changes in competitiveness among the different modes that might occur between forecasts in 2030 and 2035 and did not fully account for possible future changes in accessibility among the different regions.

2. An iterative proportional fitting (IPF) growth factor process was applied to the 2030 region-to-region high-speed rail ridership forecasts described above to produce initial estimates of 2035 high-speed rail region-to-region trips. (IPF growth factoring ensures that the sums of trip interchanges from or to any region match the estimated trips produced or attracted by the region within a specified tolerance.) Table 5-2 above, shows the specific growth factors used for productions and attractions for the business/commute and recreation/other trip purposes.

3. Changes in region-to-region high-speed rail trips were allocated to the 2030 station boardings and segment ridership results to produce initial estimates of 2035 station boardings, segment volumes, and revenues. Average high-speed rail fares for 2035 were assumed to be equal to the 2030 values for estimations of annual revenues.

5.3 Scenario Definitions, Key Assumptions and Forecast Results

Four sets of scenarios analyzed over the last few years are presented and discussed below:

- The first set relied on a set of baseline assumptions and analyzed various air and HST fare structures and auto-operating costs; these resulted in figures used in the 2008 business plan;
- the second set used one of the fare structures analyzed in the initial set of scenarios, increased the air and auto costs by 8% and used a revised service plan;
- the third set of scenarios used the assumptions of the second set of scenarios but increased the HST station parking costs; and,
- the final set of scenarios included the previous service plan, the fare structure, and the increased costs but used a revised intraregional model as described in Chapter 4. This set of assumptions was used in the EIR/EIS overall forecast of riders and revenue.

5.3.1 Baseline Scenario

5.3.1.a Baseline Cost Assumptions

The baseline year 2030 air, auto, and conventional rail costs were developed based on the relative competitive situation of 2005, and assumptions about future trends as summarized below. This baseline uses the same inputs as the Program Bay Area-Central Valley except for the new initial phase service pattern Anaheim – SF & Merced.

- The cost of driving was assumed to increase in line with general inflation, but to remain at 2005/6 levels in real terms, or 22 cents per mile for each auto traveler (2005$$). Based on MTC methodology, gasoline at $2.93 per gallon in 2006 constitutes about half of this cost. Similarly, bridge tolls were assumed to remain at 2005 real levels. Auto trips were assumed to pay market based parking charges ranging from $0 to $35 per trip, depending on employment density at the destination. These driving and parking costs also applied to air, conventional rail and high-speed train travelers who drove a private vehicle or rental car from the station to/from their final destination.
- Airfares were obtained for 2005 from the Federal Aviation Administration 10 percent sample of collected tickets for each of the airport pairs in California. Parking costs at airports were assumed to remain at their 2005 levels in real terms.
- Conventional rail fares for the baseline in 2030 were assumed to be equal to the per-ride cost of a current multi-ride ticket, except for the Amtrak San Joaquin and Pacific Surfliner Routes, for which full one-way ticket costs were assumed. Parking costs at stations were assumed to be similar to 2005, in real terms.
- Baseline high-speed train fares for trips between regions were set so that the LA to San Francisco fare would be half of the average air fare from the LA Basin airports to Bay Area airports, or $55 in 2005 dollars. Fares for other trips between regions were then calculated using a formula derived from this fare, with a fixed boarding charge of $15 plus a per-mile cost of 9 cents. For trips wholly within the Los Angeles Basin, San Diego County, or Bay Area, a lower fare was set with a $7 boarding fee plus 6 cents per mile.
- The cost of parking at the proposed stations was assumed to be $3 (2005$$) per trip for all stations, except at San Francisco, Sacramento, Los Angeles, Ontario, and San Diego, where the assumptions were $25, $6, $6, $10, and $12, respectively.

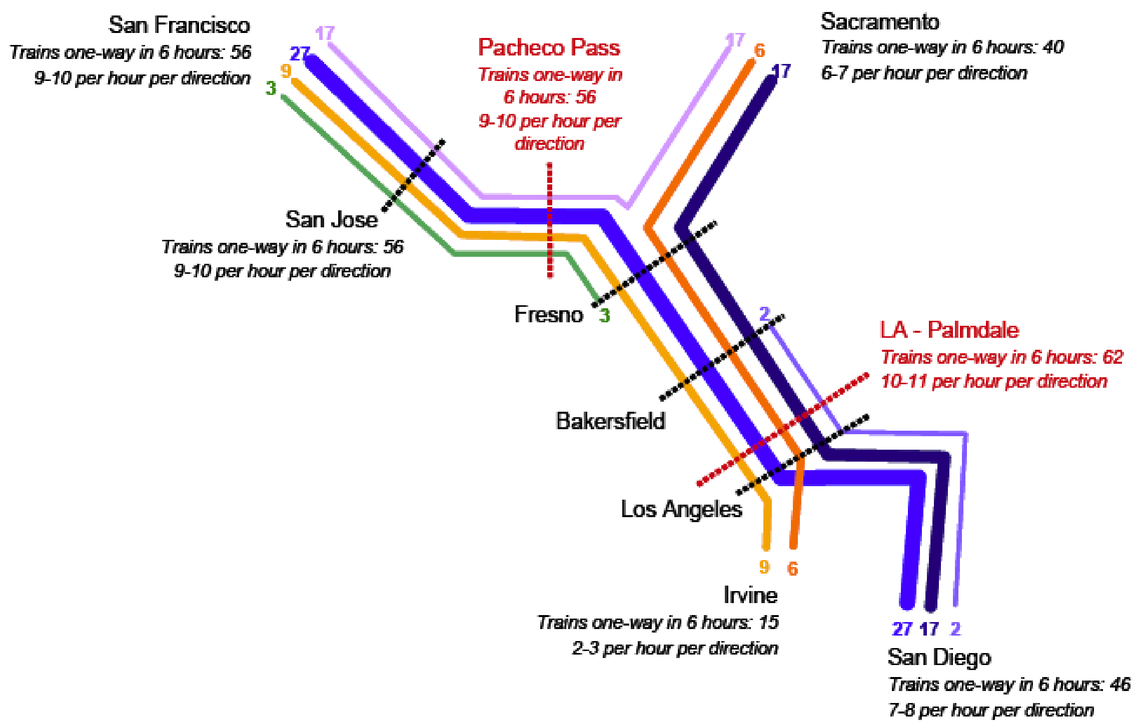
5.3.1.b Baseline Travel Time Assumptions

Air travelers were assumed to continue to arrive at the terminal approximately 55 minutes before scheduled closing of airplane cabin doors as indicated in the 2005 air traveler surveys. Flight reliability will also remain at 2005 levels, with about 95 percent of flights arriving within an hour of schedule. The forecasts assume that high-speed train travelers will not face airport-style security checks and processing time, in line with practice in the Washington-New York-Boston 150-mph Acela train services, and all but one of the high-speed train services overseas. In 2030, Amtrak and other conventional rail trips between regions will take the same time as in 2005. The wait time for conventional trains will be in line with the current 15 minutes, with no airport-style security measures. For rail service within regions, future running times and frequencies will be improved to the levels in each region's long-range transportation plan.

5.3.1.c Baseline Service Pattern

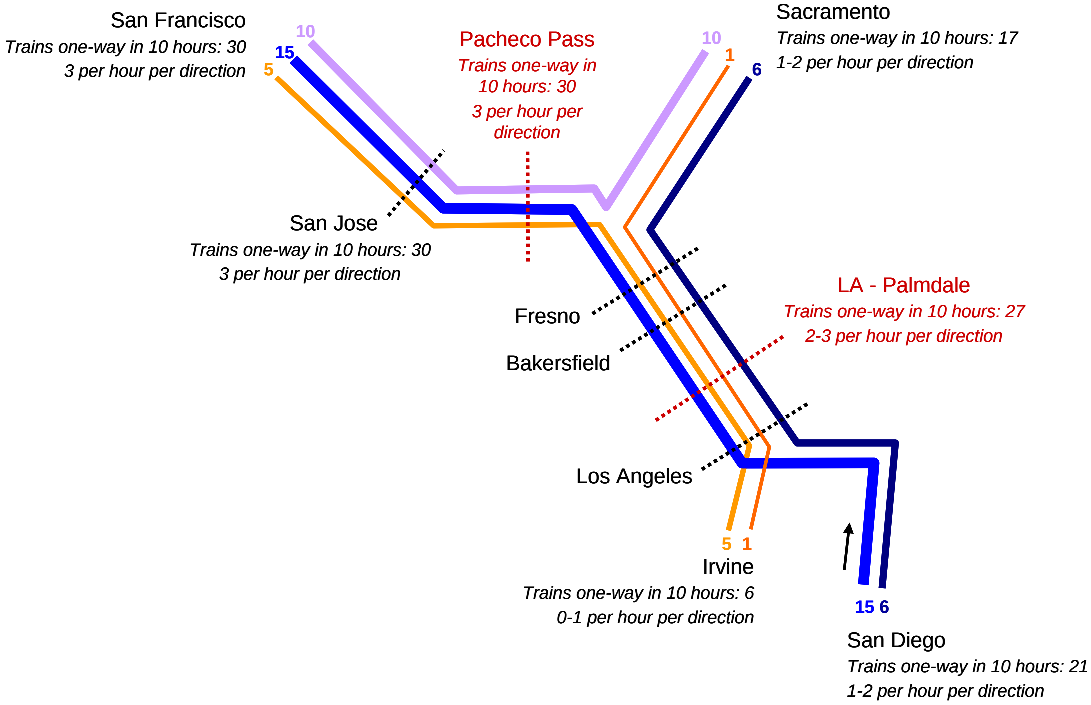
For the full system, the operating pattern of the program EIR/EIS analysis was used as shown below.

Figure 5-1a: Full System Baseline -- Number of Trains One-Way in Peak 6 Hours



For the newly-defined Phase 1, high-speed trains would run from San Francisco to Los Angeles Union Station and Anaheim, and from Merced to Anaheim and San Francisco. In the peak hours (6 am to 9 am, and 4 pm to 7 pm) trains would operate, on average, every 9 minutes in each direction between San Francisco and the Los Angeles Basin, every 20 minutes from Merced, and every 15 minutes between Anaheim and Los Angeles. In the off-peak (5am to 6am, 9am to 4pm, and 4pm to midnight) departures were less frequent: 11 minutes apart between Los Angeles and San Francisco, every 33 minutes between Merced and Los Angeles or San Francisco, and 26 minutes apart between Anaheim and Los Angeles.

Figure 5-1b: Full System Baseline -- Number of Trains One-Way in Off-Peak 10 Hours



Phase 1 included a total of 57 trains in each direction during the peak periods, and 71 trains per direction during the remaining 10 hours of off-peak service, for a total of 256 trains daily. These are shown in Tables 5-1c & d below.

Figure 5-1c: Phase 1 Baseline -- Train Patterns One-Way in Peak 6 Hours

Pattern#	1	2	3	4	5	6	7	8
Frequency of service (mins)	120	60	120	30	30	120	40	40
	Run times from start in minutes							
San Francisco	0	0	0	0	0	0	0	
Milbrae	|	|	13	13	|	|	13	
Redwood City / Palo Alto	20	|	23	|	20	20	23	
San Jose	34	30	38	34	34	34	38	
Gilroy	51	|	55	|	51	|	55	
Merced	|	|	|	|	|	|	89	0
Fresno	|	|	95	86	|	|		21
Bakersfield	|	|	133	124	|	|		59
Palmdale	|	|	|	|	147	139		92
Sylmar	|	|	|	171	|	159		112
Burbank	|	|	|	|	171	168		121
Los Angeles Union Station	170	161	188	185	181	177		130
Norwalk	182		201			189		143
Anaheim	195		213			202		155
# of trains	3	6	3	12	12	3	9	9

Figure 5-1d: Phase 1 Baseline Train Patterns One-Way During Off-Peak 10 Hours

Pattern#	1	9	3	4	5	7	8
Frequency of service (mins)	120	120	120	30	30	75	75
	Run times from start in minutes						
San Francisco	0	0	0	0	0	0	
Milbrae	|	13	13	13	|	13	
Redwood City / Palo Alto	20	23	23	|	20	23	
San Jose	34	38	38	34	34	38	
Gilroy	51	55	55	|	51	55	
Merced	|	|	|	|	|	89	0
Fresno	|	95	95	86	|		21
Bakersfield	|	132	133	124	|		59
Palmdale	|	165	|	|	147		92
Sylmar	|	185	|	171	|		112
Burbank	|	194	|	|	171		121
Los Angeles Union Station	170	203	188	185	181		130
Norwalk	182	215	201				143
Anaheim	195	228	213				155
# of trains	5	5	5	20	20	8	8

5.3.1.d 2030 Baseline Scenario Forecast Results & Various Sensitivity Tests

Baseline Results 2030

The baseline results for the year 2030 are shown in Table 5-3-a and 5.3-b below.

Table 5-3-a: 2030 Phase 1 Baseline

Market	HST Ridership (millions)	HST Mode Share	HST Average Fare (2008 $$)	HST Revenue (2008$$ in millions)
LA basin - Sacramento	1.8	25%	$63	$116
LA basin - San Diego	0.1	0%	$13	$2
LA basin- Bay Area	10.6	51%	$62	$650
Sacramento - Bay Area	0.0	0%	$11	$0
San Diego- Sacramento	0.0	1%	$63	$2
San Diego- Bay Area	3.2	35%	$64	$201
Bay Area - San Joaquin Valley	7.4	10%	$43	$318
San Joaquin Valley - LA basin	8.3	12%	$39	$322
Sacramento - San Joaquin Valley	0.6	3%	$49	$29
San Diego - San Joaquin Valley	0.1	24%	$43	$3
within Bay Area Peninsula	4.8	0.1%	$10	$50
within North LA basin	4.8	0.1%	$11	$53
within South LA basin	1.3	0.0%	$9	$12
North LA - South LA	3.9	0.1%	$10	$40
within San Diego region	0.0	0.0%		$0
within San Joaquin Valley	0.9	0.0%	$29	$27
Other	6.4	0.1%	$44	$284
Total	**54.2**		**$39**	**$2,108**
within San Diego region				$0
within entire LA basin	9.9		$11	$106
within entire MTC	4.8		$10	$50
total between regions	39.5		$49	$1,953

Table 5-3-b: 2030 Full System Baseline

Market	HST Ridership (millions)	HST Mode Share	HST Average Fare (2008 $$)	HST Revenue (2008$$ in millions)
LA basin - Sacramento	3.2	43%	$58	$202
LA basin - San Diego	21.0	15%	$27	$614
LA basin- Bay Area	9.3	45%	$59	$599
Sacramento - Bay Area	3.3	5%	$39	$141
San Diego- Sacramento	0.1	5%	$68	$7
San Diego- Bay Area	3.6	41%	$70	$277
Bay Area - San Joaquin Valley	7.2	10%	$39	$309
San Joaquin Valley - LA basin	5.6	8%	$38	$233
Sacramento - San Joaquin Valley	2.3	10%	$38	$95
San Diego - San Joaquin Valley	0.1	32%	$48	$5
within Bay Area Peninsula	4.5	0.1%	$10	$46
within North LA basin	6.7	0.1%	$11	$81
within South LA basin	4.1	0.0%	$9	$42
North LA - South LA	8.8	0.3%	$14	$130
within San Diego region	0.4	0.0%	$9	$4
within San Joaquin Valley	2.0	0.0%	$26	$58
Other	9.1	0.1%	$45	$445
Total	**91.4**			**$3,288**
within San Diego region	0.4		$9	$4
within entire LA basin	19.6		$12	$253
within entire MTC	4.5		$10	$46
total between regions	66.9		$41	$2,984

Phase 1 Sensitivity to HST Fares and Air and Auto Travel Costs

After the Phase 1 baseline forecast was completed, a run was made assuming 4 trains per hour between Anaheim and Los Angeles in the peak in place of the three per hour in the baseline, and three per hour in the off-peak in place of 1.5 per hour, in order to provide the capacity needed to handle the forecast level of service. This raised revenue to $2,202 million, and riders to 55.1 million, an increase of 2-4%.

Several runs were also made to test different HST fares and auto/air costs. Initially, three runs were made assuming the levels of higher HST fares in Scenarios 2-4 in Table 5-3-c (below) using the baseline as point of departure. The sensitivities to these higher fares were then applied to the results from the modified baseline with 4 trains per hour to Anaheim, and are shown in Scenarios 2-4 in the same table. The effect of two additional levels of air and auto cost on these scenarios were estimated from other cost sensitivity runs, and constitute Scenarios 5 to12 of Table 5-3-c below. Revenues increased as high-speed train fares were raised, however revenues in several markets showed a decline at the highest fares, compared to the next highest fare levels, suggesting that HST fares at the 83% of air fare level could be in the neighborhood of point of revenue-maximization.

Table 5-3-c: 2030 Phase 1 with Various HST Fare Levels & Air/Auto Cost

Future Scenarios Tested		Year 2030 (millions)	
#	Phase 1, Air & Auto Baseline Cost 2005/6 Levels	Riders	2008 $$
1	HST fares 50% of air	55.1	$2,202
2	HST fares 66% of air	46.3	$2,369
3	HST fares 83% of air	38.8	$2,490
4	HST fares 83% of air & $25 minimum	33.5	$2,542
#	Phase 1, Air & Auto 2008 Cost, +8% over 2005/6 Levels		
5	HST fares 50% of air	54.6	$2,355
6	HST fares 62% of air	47.7	$2,437
7	HST fares 83% of air	39.9	$2,562
8	HST fares 77% of air & $25 minimum	34.4	$2,615
#	Phase 1, Air & Auto Cost, +50% over 2005/6 Levels		
9	HST fares 33% of air	71.0	$2,978
10	HST fares 44% of air	57.8	$3,075
11	HST fares 55% of air	48.5	$3,638
12	HST fares 55% of air & $25 minimum	42.4	$3,713

SOURCE: High-Speed Rail Authority Program Management Team, 2008

2030 Forecasts for Higher and Air and Auto Costs – Full System

The baseline forecasts of riders and revenue for the full system were similarly adjusted to reflect higher service LA-Anaheim, 8% higher air and auto costs of 2008, and inflation to $2008. The base with fares at 50% of air fare increased to 93.1million, and revenues to $3.6 billion in 2030. With high-speed train fares at 83% of air, riders drop to 74 million, but revenue increases to $4.3 billion. Table 5-4-a on the following page shows the results by major market.

Table 5-4-a: 2030 Full System with Various Fare and Higher Air/Auto Cost

RIDERS AND REVENUE FOR HIGH-SPEED TRAIN FULL SYSTEM, YEAR 2030 2008 AIR & AUTO CONDITIONS (+8% OVER 2005/6)				
(figures in millions, 2008$$)	HSR fares at 50% of air fare levels		HSR fares at 83% of air fare levels	
Market Pairs (Ultimate trip ends)	Riders	Revenue	Riders	Revenue
LA Basin – Bay Area, with intermediate markets	28.9	$1,503	21.1	$1,678
LA Basin- Bay Area	*9.5*	*$659*	*6.7*	*$720*
Bay Area - San Joaquin Valley	*7.3*	*$339*	*5.6*	*$402*
San Joaquin Valley - LA Basin	*5.7*	*$256*	*4.3*	*$296*
Monterey Bay/Central Coast regions – Bay Area	*2.9*	*$99*	*1.9*	*$105*
Monterey Bay /Central Coast regions – LA Basin	*1.4*	*$86*	*1.4*	*$98*
Within San Joaquin Valley	*2.1*	*$64*	*1.2*	*$57*
LA basin - San Diego region	21.4	$675	19.1	$927
San Diego region – Bay Area	3.7	$305	2.4	$309
LA Basin – Sacramento region	3.3	$222	2.3	$239
Northern CA & Sierras regions – LA Basin	2.7	$182	2.0	$221
Sacramento region – Bay Area	3.4	$155	2.7	$188
Other interregional markets	2.2	$122	1.6	$148
Sacramento region – San Joaquin Valley	2.4	$105	1.9	$132
San Diego – Sacramento region	0.1	$7	0.1	$3
San Diego region – San Joaquin Valley	0.1	$6	0.1	$7
Sub-total interregional	***68.2***	***$3,282***	***53.3***	***$3,852***
North LA Basin – South LA Basin	9.0	$144	7.7	$188
within North LA Basin	6.8	$89	5.4	$109
within Bay Area Peninsula	4.6	$51	3.5	$60
within South LA Basin	4.1	$46	3.7	$64
within San Diego region	0.4	$5	0.4	$6
Sub-total within-region	***24.9***	***$335***	***20.7***	***$427***
Total 2030	**93.1**	**$3,617**	**74.0**	**$4,279**

SOURCE: High-Speed Rail Authority Program Management Team, 2008

2030 Station Boardings for Full System with Baseline Service Plan

Table 5-4B shows the station boardings with the boardings for this service plan. It is the scenario from which the reasonable maximum impact parking and boardings were calculated for three stations (Bakersfield, Temecula, and Burbank) as described in Chapter 6. Although at other stations later scenarios had higher boarding, at these three stations more trains stopped in this scenario than in later ones, producing the highest boardings.

Table 5-4-b: Daily Station Boardings for Full System Baseline 2030

HSR Station	Full System (P1)
San Francisco (Transbay)	26,540
Millbrae	2,936
Redwood City	4,603
San Jose	11,789
Morgan Hill	955
Gilroy	4,816
Sacramento	18,699
Stockton	5,064
Modesto	3,671
Merced	1,558
Fresno	6,841
Bakersfield	8,672
Palmdale	19,639
Sylmar	12,990
Burbank	7,403
Los Angeles Union Station	31,432
Norwalk	3,456
Anaheim	12,535
Irvine	5,671
City of Industry	4,313
Ontario	4,893
Riverside	9,116
Temecula	5,058
Escondido	8,575
University City	5,558
San Diego	18,441
Subtotal (common stations)	***155,209***
Total	**269,732**

Source: Ridership and Revenue Forecasting for the Finance Plan available on PS2 at https://ww3.projectsolve2.com/eRoomReq/Files/SFOF/CAHSRProgramMgmt/0_6a945/TM1_CAHSRA_RidershipRevenueForecasting_Text.pdf

5.3.4 Revised Service Plan Scenarios

The second set of scenarios was based on revised service plans shown in Figures 5-2-a to 5-2-d. The 8% increased air and auto costs were used, the HSR fare was set at 50% of the air far level, and the air and auto travel time assumptions remained the same. The revised service plan for Phase I included:

- The conversion of one limited multi-stop train per hour in the peak periods to a non-stop train between San Francisco Transbay and Los Angeles Union Station. This provided faster service for these major markets, while reducing by one the number of stops at Redwood City, San Jose, Gilroy, Palmdale, and Burbank.
- The addition of one train per hour in the off-peak from Anaheim to San Francisco Transbay, slightly increasing frequency of service to these endpoints and Norwalk, Los Angeles Union Station, Bakersfield, Fresno, and all stations from Gilroy north.
- The slowing of run times by several minutes for many line segments.

In addition a new operating plan for the Full System for both the peak and off-peak periods was tested. The new Full System operating plan is significantly different from the baseline plan. The new plan incorporates features of the Phase 1 operating plan, which improved service and generated greater ridership, as well as patterns of operation emerging from the development of a detailed operating schedule. Major changes include:

- A regular "clock-face" hourly schedule, in which each train type leaves at the same time each hour.
- More than three times the number of trains to Norwalk and Anaheim in the off-peak, and nearly twice as many in the peak.
- Addition in the peak of two Los Angeles Union Station – San Diego trains per hour per direction to handle the volume of ridership, especially between Los Angeles and Riverside.
- Conversion of one limited stop train per hour to non-stop between San Francisco Transbay – Los Angeles Union Station, Norwalk, and Anaheim, resulting in faster running times for this major market.
- In all, an increase of nine trains per direction in the six-hour peak period to 90 trains.
- An increase of 43 trains per direction in the ten hour off-peak period, to 80, increasing service for all stations.
- Run times slowed by several minutes for many line segments.
- No service to the Irvine and Morgan Hill stations.

Compared to the Phase 1 service, the full system shows some operating plan differences that help explain detailed differences in the forecasts:

- Decreased frequency of service during the peak period for most stations.
- Increased frequency of service for some station-to-station pairs, decrease of frequency of service for other pairs.
- Decreased frequency of service between Bakersfield and Southern California stations.

The results presented for all scenarios from this point forward incorporate the refinements to the MTC model and the resulting changes in intra-regional MTC riders and revenue.

Figure 5-2-a: Phase 1 – 2030 Train Patterns One-Way During Peak 6 Hours – May 2009 Revised Service Plan

Pattern#	0	1	2	3	4	5	6	7	8
Frequency of service (mins)	60	120	60	120	30	60	120	60	60
	Run times from start in minutes								
San Francisco	0	0	0	0	0	0	0	0	
Milbrae	│	│	│	15	15	│	│	15	
Redwood City / Palo Alto	│	20	│	25	│	20	20	25	
San Jose	│	35	30	40	35	35	35	40	
Gilroy	│	51	│	56	│	51	│	56	
Merced								91	0
Fresno	│	│	│	97	87	│	│		22
Bakersfield	│	│	│	136	126	│	│		61
Palmdale	│	│	│	│	│	151	145		95
Sylmar	│	│	│	│	175	│	167		117
Burbank	│	│	│	│	│	179	176		126
Los Angeles Union Station	160	175	163	194	189	188	185		135
Norwalk		188	│	207			198		148
Anaheim		200	184	219			210		160
# of trains	6	3	6	3	12	6	3	6	6

Figure 5-2-b: Phase 1 – 2030 Train Patterns One-Way During Off-Peak 10 Hours – May 2009 Revised Service Plan

Pattern#	1	9	3	4	5	7	8
Frequency of service (mins)	60	60	30	0	30	60	60
	Run times from start in minutes						
San Francisco	0	0	0	0	0	0	
Milbrae	│	15	15	15	│	15	
Redwood City / Palo Alto	20	25	25	│	20	25	
San Jose	35	40	40	35	35	40	
Gilroy	51	56	56	│	51	56	
Merced						91	0
Fresno	│	97	97	87	│		22
Bakersfield	│	136	136	126	│		61
Palmdale	│	170	│	│	151		95
Sylmar	│	192	│	175	│		117
Burbank	│	201	│	│	179		126
Los Angeles Union Station	175	210	194	189	188		135
Norwalk	188	223	207				148
Anaheim	200	235	219				160
# of trains	10	10	20	0	20	10	10

Figure 5-2-c: Full System – 2030 Train Patterns One-Way During Peak 6 Hours – May 2009 Revised Service Plan

Pattern#	0	1	2	29	28	4	20	41	42	14	39	25	15	35
Frequency of service (mins)	60	30	60	60	60	60	60	60	60	60	60	60	60	60
	Run times from start in minutes													
San Francisco	0	0	0	0	0	0	0			0	0			
Milbrae	|	|	|	|	15	15	15			15	|			
Redwood City / Palo Alto	|	20	|	20	25	25	25			25	20			
San Jose	|	35	30	35	40	40	40			40	35			
Gilroy	|	51	|	51	56	56	|			56	|			
Merced										91	|			
Modesto										108	|			
Stockton										124	104			
Sacramento										146	126	0	0	0
Stockton												22	22	22
Modesto												|	38	|
Merced												|	55	|
Fresno	|	|	|	|	97	97	93					68	78	68
Bakersfield	|	|	|	|	|	138	134					|	119	|
Palmdale	|	|	|	151	164	172	|					135	153	|
Sylmar	|	|	|	173	|	194	183					157	175	|
Burbank	|	|	|	|	|	203	|					166	184	|
Los Angeles Union Station	160	175	163	188	198	213	198	0	0			176	194	154
City of Industry		|		208	218	|		19	|					174
Ontario		203		220	230	241		31	|					186
Riverside		216		233	243	254		44	35					199
Murrieta		|		250	260	|		61	|					216
Escondido		|		268	278	|		79	|					234
University City		258		283	293	296		94	|					249
San Diego		270		295	305	308		106	85					261
Norwalk	173		176				211					189	207	
Anaheim	184		187				222					200	218	
# of trains	6	12	6	6	6	6	6	6	6	6	6	6	6	6

Figure 5-2-d: Full System – 2030 Train Patterns One-Way During Off-Peak 10 Hours – May 2009 Revised Service Plan

Pattern#	1	27	26	15	17	4	16	14
Frequency of service (mins)	60	60	60	60	60	60	60	60
	Run times from start in minutes							
San Francisco	0	0	0		0	0	0	0
Milbrae	|	|	15		|	15	15	15
Redwood City / Palo Alto	20	20	25		20	25	25	25
San Jose	35	35	40		35	40	40	40
Gilroy	51	51	56		51	56	56	56
Merced								91
Modesto								108
Stockton								124
Sacramento				0				146
Stockton				22				
Modesto				38				
Merced				55				
Fresno	|	|	97	78	|	97	97	
Bakersfield	|	|	138	119	|	138	138	
Palmdale	|	151	|	153	151	172	|	
Sylmar	|	173	|	175	173	194	|	
Burbank	|	182	|	184	182	203	|	
Los Angeles Union Station	175	192	194	194	192	213	194	
City of Industry	|	212	214			|		
Ontario	203	224	226			241		
Riverside	216	237	239			254		
Murrieta	|	254	256			|		
Escondido	|	272	274			|		
University City	258	287	289			296		
San Diego	270	299	301			308		
Norwalk				207	205		207	
Anaheim				218	216		218	
# of trains	10	10	10	10	10	10	10	10

Results of 2030 Revised Service Plan– Phase I

The results, shown in Table 5-5, show a total high speed rail annual ridership of 55.8 million in the year 2030, a small increase of 0.7 million, or one percent, from the baseline plan. Revenue increased approximately 7 percent over the baseline in the 2008 business plan to $2,362 million annually. The faster Los Angeles – San Francisco Transbay express train and the higher off-peak frequency to Anaheim increased travel between the LA Basin and the Bay Area, and between San Diego / Orange Counties and LA Basin. The additional off-peak train contributes to increases in other markets served – intra Bay Area, San Joaquin Valley to Los Angeles and the Bay Area. On the down side, the intra-North Los Angeles traffic dropped slightly largely because the peak-period Los Angeles – San Francisco Bay Area express train replaced one that provided local service to Palmdale and Burbank, and the additional off-peak train did not stop at these stations.

Table 5-5: Phase 1 Annual Region to Region Ridership and Revenue – Revised Service Plan May 2009

Market	Ridership (millions)	Mode Share	Average Fare (2008$$)	HSR Revenue (2008$$ in millions)
LA Basin – Sacramento	1.9	25%	$68	$125
LA Basin – San Diego	0.2	0%	$14	$2
LA Basin – Bay Area	11.9	57%	$67	$790
Sacramento – Bay Area	0.0	0%	$11	$0
San Diego-Sacramento	0.0	2%	$69	$2
San Diego-Bay Area	3.2	36%	$69	$221
Bay Area – San Joaquin Valley	7.6	11%	$46	$346
San Joaquin Valley – LA Basin	8.5	12%	$42	$352
Sacramento – San Joaquin Valley	0.6	3%	$52	$29
San Diego – San Joaquin Valley	0.1	25%	$46	$3
Within Bay Area Peninsula	5.1	0.1%	$11	$57
Within North LA Basin	4.3	0.0%	$12	$52
Within South LA Basin	1.6	0.0%	$10	$16
North LA - South LA	3.8	0.1%	$11	$42
Within San Diego region	0.0	0.0%	$0	$0
Within San Joaquin Valley	1.0	0.0%	$31	$30
Other	6.2	0.1%	$47	$293
Total	**55.8**	**0%**	**$42**	**$2,362**
Within San Diego region	0.0	0.0%	$0	$0
Within entire LA Basin	9.7	0.0%	$11	$110
Within entire MTC	5.1	0.1%	$11	$57
Total between regions	**41.1**	**0%**	**$53**	**$2,195**

Source: 01S_Results Memorandum_2009-08-14_FINAL.doc available on PS2 at: https://ww3.projectsolve2.com/eRoomReq/Files/SFOF/CAHSRProgramMgmt/0_b0719/01S_Results%20Memorandum_2009-08-14_FINAL.doc

2030 Revised May 2009 Service Plan – Full System

The revised service plan for the Full System and the local traffic changes from the MTC model refinement produced a forecast 2030 high speed rail ridership of 98.3 million and revenue of $3,863 million.

The increase in train frequency for both the peak and off-peak periods, especially for the Norwalk and Anaheim stations, increased ridership between San Joaquin Valley and the Los Angeles basin and within the Bay Area. The faster Los Angeles – San Francisco express train and increased service to the LA Basin and Bay Area stations contributed to an increase of three million riders between the LA Basin and the Bay Area. On the down side, similar to the Phase 1 results, ridership between the North LA Basin stations dropped slightly because of the fewer trains stopping at these stations as did ridership between Sacramento and the Bay Area, because of fewer assumed trains.

Table 5-6: Full System Annual Region to Region Ridership and Revenue

	Revised Service Plan			
Market	Ridership (millions)	Mode Share	Average Fare (2008$$)	HSR Revenue (2008$$ in millions)
LA Basin – Sacramento	3.8	51%	$66	$254
LA Basin – San Diego	21.4	15%	$31	$659
LA Basin- Bay Area	12.3	59%	$68	$836
Sacramento – Bay Area	3.0	4%	$45	$132
San Diego- Sacramento	0.1	5%	$78	$7
San Diego- Bay Area	3.5	39%	$81	$280
Bay Area – San Joaquin Valley	8.0	11%	$45	$359
San Joaquin Valley – LA Basin	8.4	12%	$44	$367
Sacramento – San Joaquin Valley	2.1	9%	$42	$87
San Diego – San Joaquin Valley	0.1	26%	$55	$4
Within Bay Area Peninsula	6.2	0.1%	$11	$68
Within North LA Basin	6.0	0.1%	$12	$75
Within South LA Basin	3.5	0.0%	$10	$36
North LA – South LA	6.8	0.2%	$11	$76
Within San Diego region	0.4	0.0%	$11	$4
Within San Joaquin Valley	2.3	0.0%	$29	$65
Other	10.5	0.1%	$53	$554
Total	**98.3**	**0%**	**$39**	**$3,863**
Within San Diego region	0.4	0.0%	$11	$4
Within Entire LA Basin	16.3	0.1%	$11	$187
Within entire MTC	6.2	0.1%	$11	$68
Total between regions	**75.3**	**1%**	**$48**	**$3,608**

Source: 01S_Results Memorandum_2009-08-14_FINAL.doc available on PS2 at: https://ww3.projectsolve2.com/eRoomReq/Files/SFOF/CAHSRProgramMgmt/0_b0719/01S_Results%20Memorandum_2009-08-14_FINAL.doc

2035 Revised Service Plan– Phase I and Full System

The 2035 forecasts, factored from the model runs for 2030 as described earlier result in Phase 1 riders up by about 2.4 million riders, or 4.3 percent. Revenues increase by $103 million, which is also over a 4 percent increase. The Full System results for 2035 showed similar increases in ridership and revenue over 2030. Ridership increased by 4.1 million riders, and revenue increased by $158 million from 2030 to 2035. For both Phase 1 and the Full System the largest ridership growth occurred between San Diego and the Bay Area and between the Bay Area and San Joaquin Valley. Tables 5-7 and 5-8 show the ridership and revenue forecasts for the 2035 scenarios.

Table 5-7: 2035 Phase 1 Annual Region to Region Ridership and Revenue

Market	HSR Ridership (millions)	HSR Mode Share	HSR Average Fare (2008 $$)	Revenue (2008 $$ in millions)
LA Basin – Sacramento	1.9	26%	$68	$131
LA Basin – San Diego	0.2	0%	$14	$2
LA Basin- Bay Area	12.2	47%	$67	$811
Sacramento – Bay Area	0.0	0%	$11	$0
San Diego- Sacramento	0.0	2%	$69	$3
San Diego- Bay Area	3.4	37%	$69	$233
Bay Area – San Joaquin Valley	8.1	9%	$46	$371
San Joaquin Valley – LA Basin	8.9	11%	$42	$371
Sacramento – San Joaquin Valley	0.6	3%	$52	$32
San Diego – San Joaquin Valley	0.1	27%	$46	$4
Within Bay Area Peninsula	5.3	0.1%	$11	$59
Within North LA Basin	4.5	0.0%	$12	$54
Within South LA Basin	1.6	0.0%	$10	$16
North LA – South LA	3.9	0.1%	$11	$43
Within San Diego region	0.0	0.0%	$0	$0
Within San Joaquin Valley	1.1	0.0%	$31	$33
Other	6.5	0.1%	$47	$303
Total	**58.2**	**0%**	**$42**	**$2,465**
Within San Diego region	0.0	0.0%	$0	$0
Within entire LA Basin	9.9	0.0%	$11	$113
Within entire MTC	5.3	0.1%	$11	$59
Total between regions	**43.0**	**0%**	**$53**	**$2,293**

*Note: These initial 2035 forecasts are based on a factoring of the results of the model runs for 2030.

Source: 01S_Results Memorandum_2009-08-14_FINAL.doc available on PS2 at:
https://ww3.projectsolve2.com/eRoomReq/Files/SFOF/CAHSRProgramMgmt/0_b0719/01S_Results%20Memorandum_2009-08-14_FINAL.doc

Table 5-8: 2035 Full System Annual Region to Region Ridership and Revenue

Market	HSR Ridership (millions)	HSR Mode Share	HSR Average Fare (2008$$)	Revenue (2008$$ in millions)
LA Basin – Sacramento	3.9	50%	$66	$261
LA Basin – San Diego	22.5	14%	$31	$692
LA Basin- Bay Area	12.4	48%	$68	$838
Sacramento – Bay Area	3.1	4%	$45	$140
San Diego- Sacramento	0.1	5%	$78	$8
San Diego- Bay Area	3.8	41%	$81	$304
Bay Area – San Joaquin Valley	8.6	10%	$45	$387
San Joaquin Valley – LA Basin	8.7	11%	$44	$380
Sacramento – San Joaquin Valley	2.2	9%	$42	$94
San Diego – San Joaquin Valley	0.1	27%	$55	$5
Within Bay Area Peninsula	6.5	0.1%	$11	$71
Within North LA Basin	6.3	0.1%	$12	$77
Within South LA Basin	3.6	0.0%	$10	$38
North LA – South LA	7.0	0.2%	$11	$78
Within San Diego region	0.4	0.0%	$9	$3
Within San Joaquin Valley	2.4	0.0%	$29	$70
Other	10.9	0.1%	$53	$576
Total	**102.4**	**0%**	**$39**	**$4,021**
Within San Diego region	0.4	0.0%	$9	$3
Within entire LA Basin	16.9	0.1%	$11	$193
Within entire MTC	6.5	0.1%	$11	$71
Total between regions	**78.7**	**0%**	**$48**	**$3,758**

*Note: These initial 2035 forecasts are based on a factoring of the results of the model runs for 2030.

Source: 01S_Results Memorandum_2009-08-14_FINAL.doc available on PS2 at: https://ww3.projectsolve2.com/eRoomReq/Files/SFOF/CAHSRProgramMgmt/0_b0719/01S_Results%20Memorandum_2009-08-14_FINAL.doc

5.3.5 Increased Parking Cost Scenarios

The final set of scenarios tested the effects of higher market-based parking costs on ridership and revenue for the high-speed rail system. Table 5-9 shows the parking costs used in all prior scenarios above compared to the increased parking costs used in the EIR/EIS forecasts following.

Table 5-9: HST Station Parking Cost Comparison

Station		Increased Parking Cost Scenario	Nearest Airport
San Francisco (Transbay)	$25	$36	$25.50
Millbrae	$3	$16	$25.50
Redwood City	$3	$16	$25.50
San Jose	$3	$21	$25.50
Gilroy	$3	$11	$22.50
Sacramento	$6	$16	$9.50
Stockton	$3	$11	$3.00
Modesto/SP Downtown	$3	$11	$3.00
Merced	$3	$11	$3.00
Fresno	$3	$16	$10.00
Bakersfield	$3	$16	$7.50
Palmdale	$3	$11	$18.50
Sylmar	$3	$16	$18.50
Burbank	$3	$21	$18.50
Los Angeles (Union)	$6	$32	$19.00
Norwalk	$3	$16	$10.50
Anaheim	$3	$21	$17.00
City of Industry	$3	$11	$10.00
Ontario	$10	$16	$10.00
Riverside	$3	$11	$10.00
Temecula/Murrieta	$3	$11	$17.00
Escondido	$3	$11	$18.00
University City	$3	$16	$18.00
San Diego	$12	$27	$18.00
Average Daily Cost	$5	$17	$15

Source: M_HSR_IncreasedParkingCostScenario-FINAL.pdf available on PS2 at: https://ww3.projectsolve2.com/eRoomReq/Files/SFOF/CAHSRProgramMgmt/0_9c30b/M_HSR_IncreasedParkingCostScenario-FINAL%20(2).pdf

Phase 1 -- 2030 and 2035 Ridership and Revenue Results with Increased Parking Costs

The increased parking costs for Phase 1 result in a forecast of 2030 high-speed rail ridership of 54.4 million with HST fares at the 50% of air fare level, a decrease of 4.4 million, or 7.5 percent, compared to the prior runs with lower parking costs. As expected, shorter distance riders are more sensitive to increases in parking cost than longer distance riders. This sensitivity is particularly the case for HSR because fares are distance-based and parking costs are fixed, thus as distance decreases the share of total trip cost attributable to parking increases.

The results in Table 5-10 indicate that intra-regional riders decrease far more significantly than interregional riders. Within the LA Basin and the MTC region riders drop by 21 percent compared to 2 percent for inter-regional trips. Of the 4.4 million ridership decrease, 82% is attributable to intraregional travel and 18% is attributable to interregional travel.

On the other hand, the interregional revenue loss accounts for half of the total $76 million drop since long-distance interregional trips have higher fares. (The average fare is $54 for interregional trips compared to $11 for intraregional travel).

Table 5-10: Phase 1 2030 with Increased Parking Cost - Annual Region-to-Region Ridership and Revenue

	Increased Parking Cost Scenario			
Market	HSR Ridership (Millions)	HSR Mode Share	HSR Average Fare (2008 Dollars)	Revenue (2008 Dollars in Millions)
LA Basin – Sacramento	1.8	24%	$68	$124
LA Basin – San Diego	0.2	0%	$14	$2
LA Basin – Bay Area	11.7	56%	$67	$777
Sacramento – Bay Area	0.0	0%	$12	$0
San Diego – Sacramento	0.0	2%	$69	$2
San Diego – Bay Area	3.2	35%	$69	$219
Bay Area – San Joaquin Valley	7.4	10%	$46	$340
San Joaquin Valley – LA Basin	8.3	12%	$42	$340
Sacramento – San Joaquin Valley	0.6	3%	$52	$29
San Diego – San Joaquin Valley	0.1	26%	$46	$3
Within Bay Area Peninsula	6.4	0.1%	$11	$70
Within North LA Basin	3.6	0.0%	$12	$43
Within South LA Basin	1.2	0.0%	$10	$12
North LA – South LA	3.0	0.1%	$11	$33
Within San Diego Region	-	-	-	-
Within San Joaquin Valley	0.9	0.0%	$31	$29
Other	6.1	0.1%	$47	$288
Total	**54.4**	**0.1%**	**$43**	**$2,316**
Within San Diego Region	-	-	-	-
Within Entire LA Basin	7.7	0.0%	$11	$88
Within Entire MTC[a]	6.4	0.1%	$11	$70
Total between Regions	**40.3**	**0.2%**	**$54**	**$2,158**

[a] Reflects results from February 2010 revised MTC Intraregional model.

Source: M_HSR_IncreasedParkingCostScenario-FINAL.pdf available on PS2at: https://ww3.projectsolve2.com/eRoomReq/Files/SFOF/CAHSRProgramMgmt/0_9c30b/M_HSR_IncreasedParkingCostScenario-FINAL%20(2).pdf

The ridership and revenue changes in Table 5-11 for 2035 follow a similar pattern. Total ridership drops 7.5 percent and revenue 3 percent.

Table 5-11: Phase 1 2035 with Increased Parking Cost - Annual Region-to-Region Ridership and Revenue

	Increased Parking Cost Scenario			
Market	HSR Ridership (Millions)	HSR Mode Share	HSR Average Fare (2008 Dollars)	Revenue (2008 Dollars in Millions)
LA Basin – Sacramento	1.9	24%	$68	$129
LA Basin – San Diego	0.2	0%	$14	$2
LA Basin – Bay Area	12.0	56%	$67	$797
Sacramento – Bay Area	0.0	0%	$12	$0
San Diego – Sacramento	0.0	2%	$69	$2
San Diego – Bay Area	3.4	35%	$69	$232
Bay Area – San Joaquin Valley	8.0	14%	$46	$368
San Joaquin Valley – LA Basin	8.7	11%	$42	$362
Sacramento – San Joaquin Valley	0.6	8%	$52	$32
San Diego – San Joaquin Valley	0.1	25%	$46	$4
Within Bay Area Peninsula	6.7	0.1%	$11	$73
Within North LA Basin	3.7	0.0%	$12	$45
Within South LA Basin	1.2	0.0%	$10	$13
North LA – South LA	3.1	0.1%	$11	$34
Within San Diego Region	-	-	-	-
Within San Joaquin Valley	1.0	0.0%	$31	$32
Other	6.4	0.1%	$47	$299
Total	**57.0**	**0.1%**	**$43**	**$2,424**
Within San Diego Region	-	-	-	-
Within Entire LA Basin	8.0	0.0%	$11	$91
Within Entire MTC[a]	6.7	0.1%	$11	$73
Total between Regions	**42.3**	**0.2%**	**$54**	**$2,260**

[a] Reflects results from February 2010 revised MTC Intraregional model.

Source: M_HSR_IncreasedParkingCostScenario-FINAL.pdf available on PS2 at: https://ww3.projectsolve2.com/eRoomReq/Files/SFOF/CAHSRProgramMgmt/0_9c30b/M_HSR_IncreasedParkingCostScenario-FINAL%20(2).pdf

Full System – 2030 & 2035 Ridership & Revenue Results with Increased Parking Cost

The increased parking cost resulted in ridership of 93.7 in 2030 (see Table 5-12), a decrease of 6.4 million, or 7 percent, compared to the May 2009 Operating Plan runs. Similar to Phase 1 results, shorter distance riders are more sensitive to increases in parking cost than longer distance riders.

Intraregional ridership decreases far more absolutely and in percentage terms than interregional ridership. Within the Los Angeles, San Diego, and San Francisco regions ridership decreases by 4.7 million compared to a 1.7 million drop between regions, although total interregional HST travel is twice as big as local HST travel.

Table 5-12: Full System 2030 Increased Parking Cost -- Annual Region-to-Region Ridership and Revenue

Increased Parking Cost Scenario				
Market	**HSR Ridership (Millions)**	**HSR Mode Share**	**HSR Average Fare (2008 Dollars)**	**Revenue (2008 Dollars in Millions)**
LA Basin – Sacramento	3.8	50%	$66	$249
LA Basin – San Diego	20.8	15%	$31	$637
LA Basin – Bay Area	12.2	59%	$68	$827
Sacramento – Bay Area	2.8	4%	$45	$127
San Diego – Sacramento	0.1	4%	$77	$7
San Diego – Bay Area	3.4	38%	$81	$274
Bay Area – San Joaquin Valley	7.8	11%	$45	$354
San Joaquin Valley – LA Basin	8.2	11%	$44	$360
Sacramento – San Joaquin Valley	2	9%	$43	$86
San Diego – San Joaquin Valley	0.1	27%	$56	$5
Within Bay Area Peninsula	6.5	0.10%	$11	$71
Within North LA Basin	5	0.10%	$12	$61
Within South LA Basin	2.9	0.00%	$10	$30
North LA – South LA	5.5	0.20%	$11	$61
Within San Diego Region	0.3	0.00%	$11	$3
Within San Joaquin Valley	2.1	0.00%	$29	$62
Other	10.3	0.10%	$53	$547
Total	**93.7**	**0.20%**		**$3,763**
Within San Diego Region	0.3	0.00%	$11	$3
Within Entire LA Basin	13.3	0.00%	$11	$153
Within Entire MTC[a]	6.5	0.00%	$11	$71
Total between Regions	**73.6**	**1%**	**$48**	**$3,536**

Source: M_HSR_IncreasedParkingCostScenario-FINAL.pdf available on PS2 at:
https://ww3.projectsolve2.com/eRoomReq/Files/SFOF/CAHSRProgramMgmt/0_9c30b/M_HSR_IncreasedParkingCostScenario-FINAL%20(2).pdf

The ridership and revenue changes in Table 5-13 for 2035 follow a similar pattern. The percent reduction in ridership (6 percent) and the percent reduction in revenue (3 percent) are comparable to the 2030 analysis. Fares and parking costs in 2035 are assumed equal to 2030 in the factoring process.

Table 5-13: Full System 2035 Increased Parking Cost Scenario -- Annual Region-to-Region Ridership and Revenue

	Increased Parking Cost Scenario			
Market	**HSR Ridership (Millions)**	**HSR Mode Share**	**HSR Average Fare (2008 Dollars)**	**Revenue (2008 Dollars in Millions)**
LA Basin – Sacramento	3.9	50%	$66	$258
LA Basin – San Diego	21.9	15%	$31	$672
LA Basin – Bay Area	12.3	59%	$68	$836
Sacramento – Bay Area	3	4%	$45	$135
San Diego – Sacramento	0.1	4%	$78	$8
San Diego – Bay Area	3.7	38%	$81	$299
Bay Area – San Joaquin Valley	8.5	11%	$45	$383
San Joaquin Valley – LA Basin	8.5	11%	$44	$374
Sacramento – San Joaquin Valley	2.2	9%	$43	$93
San Diego – San Joaquin Valley	0.1	27%	$56	$6
Within Bay Area Peninsula	6.8	0.10%	$11	$74
Within North LA Basin	5.1	0.10%	$12	$64
Within South LA Basin	3	0.00%	$10	$31
North LA – South LA	5.7	0.20%	$11	$64
Within San Diego Region	0.3	0.00%	$11	$4
Within San Joaquin Valley	2.3	0.00%	$29	$68
Other	10.8	0.10%	$53	$570
Total	**98.2**	**0.20%**	**$40**	**$3,938**
Within San Diego Region	0.3	0.00%	$11	$4
Within Entire LA Basin	13.8	0.00%	$11	$158
Within Entire MTC	6.8	0.00%	$11	$74
Total between Regions	**77.3**	**1%**	**$48**	**$3,702**

Source: M_HSR_IncreasedParkingCostScenario-FINAL.pdf available on PS2 at: https://ww3.projectsolve2.com/eRoomReq/Files/SFOF/CAHSRProgramMgmt/0_9c30b/M_HSR_IncreasedParkingCostScenario-FINAL%20(2).pdf

Station Boardings 2035 Full System and Phase 1 with Increased Parking Cost

Tables 5-14 and 5-15 show the forecast boardings for the May 2009 revised service plan with increased parking cost at HST stations.

In comparison to the Phase 1 results, Full System station boardings decreased in San Francisco, Merced, and Anaheim. The decrease in boardings is due to the shifts of riders from San Francisco Transbay Terminal and Merced to high speed rail stations in Sacramento and Stockton. In particular, almost all of the high speed rail users from Yolo and Sacramento Counties switch to the Sacramento station, and about half of the Solano County riders do the same. In addition, about ten percent of the Contra Costa high speed rail riders switch to the Stockton station. The decrease in ridership at the Anaheim station is due to the new line to the San Diego region which adds seven stations between Los Angeles Union Station and San Diego. The final five stations on that line, Riverside, Temecula/Murrieta, Escondido, University City, and San Diego all primarily accessed Anaheim for Phase 1.

Table 5-14: Daily Station Boardings for Phase 1 2035, Increased Parking Cost Scenario

Origin Station	Boardings
	Total
San Francisco (Transbay)	40,400
Millbrae	5,600
Redw ood City	6,500
San Jose	10,700
Gilroy	6,200
Merced	7,800
Fresno	6,800
Bakersfield	7,900
Palmdale	15,300
Sylmar	7,000
Burbank	3,400
Los Angeles Union Station	15,000
Norw alk	5,600
Anaheim	30,500
Daily	168,700

Source: M_HSR_IncreasedParkingCostScenario-FINAL.pdf available on PS2 at: https://ww3.projectsolve2.com/eRoomReq/Files/SFOF/CAHSRProgramMgmt/0_9c30b/M_HSR_IncreasedParkingCostScenario-FINAL%20(2).pdf

Table 5-15: Daily Station Boardings for Full System 2035, Increased Parking Cost Scenario

Origin Station	Boardings
	Total
San Francisco (Transbay)	36,200
Millbrae	6,000
Redw ood City	7,800
San Jose	12,600
Gilroy	6,700
Sacramento	19,100
Stockton	6,700
Merced	2,600
Fresno	8,400
Bakersfield	8,800
Palmdale	17,300
Sylmar	13,400
Burbank	4,300
Los Angeles Union Station	29,100
Norw alk	7,000
Anaheim	22,400
Ontario	11,000
Riverside	14,300
Temecula / Murrieta	7,400
Escondido	8,300
University City	6,200
San Diego	20,300
City of Industry	6,700
Modesto/SP Dow ntow n	4,600
Daily	287,131

Source: M_HSR_IncreasedParkingCostScenario-FINAL.pdf available on PS2 at: https://ww3.projectsolve2.com/eRoomReq/Files/SFOF/CAHSRProgramMgmt/0_9c30b/M_HSR_IncreasedParkingCostScenario-FINAL%20(2).pdf

6.0 Station Area Parking

6.1 Station Boardings and Access Modes With Higher Parking Cost

In order to assess environmental impacts around high-speed train (HST) stations, reasonable maximum forecasts of ridership have been compiled. In these forecasts, HST fares are set at "50% of air fare"[7], and costs of parking at HST stations are set similar to or higher than nearby airports and downtown area parking. The proportion of passengers at each station using various modes of access have also been estimated as a function of future patterns of development and transportation options at each of the 24 stations in the Full System forecasts[8].

The most discussed access issue to date has been the extent of parking needed at and around the stations. Unconstrained parking demand ranges from 1,000 spaces in Millbrae to 13,700 in Anaheim. While large compared to current rail station parking, the requirements reflect that at least half of HST passengers are expected to arrive by some other mode than driving and parking, and in urban station areas such as LA and San Francisco 85% are expected to not be arriving in a car to park. (In Anaheim, the percentage is 75% not driving to the station and parking.)

The parking demands at stations are also less than the airport-oriented supply at five California airports, which are estimated to range from 8,100 spaces at San Diego Lindbergh to 30,300 at LAX. These figures include at-terminal parking, remote airport-provided parking, and off-site private operator provided parking. Table 6- 1 shows the number of spaces in each category, as well as how far they are from the terminals. For the five California airports two-thirds of the supply is remote from the terminals.

Table 6- 1: Parking Supply and Distance to Terminal at Selected US Airports

	Total Estimated Parking Supply	Distribution of Supply			Avg Wtd Distance to Terminal (miles)	
		At Terminal	On-Airport Remote	Off-Airport	On-Airport Remote	Off-Airport
San Francisco International	15,600	18%	39%	43%	1.80	3.20
San Jose Minetta	8,515	33%	48%	19%	3.30	2.83
Los Angeles International	30,355	26%	38%	36%	2.05	2.19
Ontario	10,410	68%	18%	14%	1.50	1.80
San Diego Lindbergh	8,149	38%	6%	56%	2.07	1.85
Chicago Midway	11,210	20%	61%	19%	0.80	1.26
Boston Logan	14,000	81%	5%	14%	1.80	2.44
NYC Laguardia	5,360	92%	0%	8%	-	0.60
Weighted Averages						
California Airports		33%	33%	34%	2.16	2.41
All Airports		41%	30%	29%	1.86	2.31

Source: Cambridge Systematics

The distribution of off-site airport parking by distance from the terminals at the five California airports is shown in Table 6- 2. More than 80% of off-site parking supply is within 3 miles of the terminals.

[7] HST fares were set for LA-SF at 50% of the air fare from MTC to SCAG airports, and a distance-based formula created to scale HST fares to other markets.
[8] The process and results are described in Section 6.2

Table 6- 2: Off-Site Parking Supply by Distance from Terminal at Five California Airports[9]

	Parking Supply within Distance Band	
Distance from Terminal	Spaces	Percent of Total Off-Site
Less than 1 mile	-	0%
1.00 to 1.99 miles	7,331	29%
2.00 to 2.49 miles	7,567	30%
2.50 to 2.99 miles	5,564	22%
3.00 to 3.99 miles	3,247	13%
4.00 miles or more	1,485	6%
Total Off-Airport Supply	25,194	

Source: Cambridge Systematics

Table 6- 3 shows the factors influencing the number of spaces demanded at each station, developed from over 2,500 California travelers surveyed in 2004 and 2005. These factors have already been used in the calculations of parking volume presented in Table 6- 4 to Table 6- 8 at the end of this report.
The average days parked is based on the mix at each station of inter-regional travellers, who leave their car on average 3.36 days, and local travellers, who on average stay less than 24 hours.

The average party size is based on the mix of inter-regional commute and business trips, at 1.2 and 1.5 persons per car respectively, recreation and other inter-regional trips at 2.5 persons per vehicle, and local trips at 1.64 persons per vehicle.

The parking demand figures do not include allowances for additional spaces that are normally provided in large parking facilities to account for searching for spots to park. With driver signage systems, this allowance may be as low as five (5) percent.

The unconstrained parking demand may exceed the feasible or desirable parking capacity at the station itself. In such cases, it should be assumed that the demand for parking will be accommodated at remote lots or off-site structures as occurs around US airports. Access to the station by shuttle service should be assumed, and the impacts included in the station design and environmental analyses. It should be assumed that within a 3-mile radius, there will not be an appreciable effect on ridership.

If there is still unmet parking demand, the remaining passengers should be assumed to switch to being driven to the station and dropped off, in order to evaluate the reasonable maximum impact scenario.

No allowance is made for fluctuations in demand by day of the week and season of the year. While unconstrained daily demand would be higher than the average weekday demand, use of demand management techniques, such as varying the ticket and parking prices as a function of projected peaks, is assumed to be capable of constraining demand to the averages shown.

The boardings and modes of access to assume in the environmental analysis are shown in Table 6-4 to Table 6- 6 in the following pages. Each table shows the forecast of daily boardings for inter-regional and local[10] trips, and the total daily access activity.

---

[9] San Francisco (SFO), San Jose (SJC), Los Angeles (LAX), Ontario (ONT), San Diego (SAN)
[10] Local trips are those entirely within either the MTC region, the SCAG region, or the SANDAG region. All others are inter-regional.

The highest boardings at each station from among three forecasts are used[11]:

- For Anaheim, Merced, and San Francisco, Phase 1 in year 2035, since during that phase they attract many passengers who will use other stations when the Full System is completed.
- For most stations, the Full System in the year 2035 with either the operating pattern of August 2008 (Escondido, Burbank, and Bakersfield) or of May 2009 (all other stations), depending on which pattern generated more boardings at each station.

Table 6-4 shows boardings and access activity for 2035. Table 6-5 and Table 6-6 show boardings and access activity for 2030 and 2025, in order to help in staging the project and any mitigation that might be needed.

The Access Activity columns contain the following information:

- Autos Dropping off Passengers – Number of daily arrivals at stations, taking into account average passenger occupancy for each station.
- Motorized Vehicles Arriving to Park - Number of daily arrivals of cars, trucks, motorcycles and other private motorized vehicles, taking into account average passenger occupancy for each station.
- Cumulative Parking Space Demand - Number of parking spaces needed to accommodate the parking demand, taking into account the average passenger occupancy and the length of stay of the station's specific mix of trips.
- Rental Cars Brought Back – Number of rental returns taking into account the party size of the station's specific mix of trips.
- Taxis Dropping Off Passengers – Number of taxis arriving to drop off passengers, taking into account the party size of the station's specific mix of trips.
- Transit / Shuttle Alightings – Number of passenger arrivals by public transit, conventional rail, private shuttle vans and similar vehicles. Does not include rental or remote parking shuttles.

Table 6-3: Drive and Park Factors by Station

Origin Station	Average days parked	Average party size
San Francisco **	2.90	1.81
4th and King***	2.47	1.28
Millbrae	2.03	1.89
Redw ood City	2.52	1.90
San Jose	2.62	1.89
Gilroy	3.08	1.57
Sacramento	3.36	1.60
Stockton	3.36	1.47
Merced **	3.36	1.48
Fresno	3.36	1.59
Kings-Tulare ***	3.36	1.61
Bakersfield	3.36	1.64
Palmdale	2.18	1.64
Sylmar	2.82	1.84
San Fernando***	2.88	1.57
Burbank Airport ***	2.90	1.87
Burbank	2.43	2.08
Los Angeles	2.14	1.94
Norw alk	2.35	1.66
Fullerton ***	1.81	1.62
Anaheim **	2.75	1.55
Ontario	2.19	1.85
Riverside	2.75	1.85
Temecula / Murrieta	2.74	1.86
Escondido	3.28	1.89
University City	3.27	1.82
San Diego	3.31	2.01
City of Industry	2.44	1.75
Modesto	3.36	1.51

* 12/2009 Full System for all stations exept as noted
** 12/2009 Phase 1
*** New Alternative Station Location
Source : Calculated from Cambridge Systematics data

[11] 2035 access activity calculated by PB increasing the 2030 CS forecast details by the ratio of each station's 2035 boardings to those of 2030. For the August 2008 forecasts PB also made adjustments for the impact of higher parking costs to ensure compatibility with the 2009 forecasts. See Section 6.3.

In Table 6-7, 2030 forecast boardings and access activity are presented for station parking in Merced, Anaheim, and San Francisco assuming the Full System to help in staging parking and other station functions.

Table 6-8 represents forecasted boardings for 2035, 2030, and 2025 for proposed station location alternatives at 4th and King Streets in San Francisco, in Kings-Tulare, Fullerton, and at the Burbank Airport. At the 4th and King station, the parking demand and auto activity forecasts have been increased by 15% to account for the possibility that it will be a more attractive alternative to driving and parking at Transbay Terminal than suggested by the access egress model. This does not reduce the maximum impact scenario at Transbay, which is based on not having a 4th & King station.

Table 6- 4: Highest Station Boardings and Access Activity, 2035

Average Weekday*

Origin Station	2035 Boardings			2035 Access Activity†						
	Inter-regional	Local	Total	Autos Dropping Off Psgrs	Motorized Vehicles Arriving to Park	Cumulative Parking Space Demand	Rental Cars Brought Back	Taxis Dropping Off Psgrs	Transit / Shuttle Alightings	Walkers Bicyclists Other Non-Motorized
San Francisco**	29,400	11,000	40,400	3,300	2,900	9,800	1,800	2,300	10,300	11,200
Millbrae	1,600	4,400	6,000	700	700	1,100	300	300	1,300	1,200
Redw ood City	4,700	3,100	7,800	1,100	1,200	3,000	400	400	800	1,000
San Jose	8,700	3,900	12,600	1,200	1,400	3,800	600	600	2,800	2,600
Gilroy	5,700	1,000	6,700	1,200	2,100	6,400	200	300	200	200
Sacramento	19,100	0	19,100	1,600	2,700	9,000	900	1,100	4,400	4,000
Stockton	6,700	0	6,700	1,000	1,900	6,600	300	400	600	400
Merced **	7,600	0	7,600	1,200	2,300	7,700	400	400	600	300
Fresno	8,400	0	8,400	1,300	2,200	7,400	400	400	700	400
Bakersfield ***	9,200	0	9,200	1,400	2,300	8,100	400	400	900	500
Palmdale	8,600	8,700	17,300	3,400	5,200	11,300	400	700	600	400
Sylmar	10,300	3,100	13,400	2,600	3,400	9,700	200	400	500	400
Burbank****	2,500	4,300	6,800	1,000	900	1,900	400	300	700	800
Los Angeles	14,100	15,000	29,100	2,300	2,300	4,800	1,200	1,400	7,500	8,300
Norw alk	4,000	3,000	7,000	900	1,300	3,100	400	400	800	900
Anaheim **	25,400	5,100	30,500	2,900	5,000	13,700	1,600	1,700	6,200	5,500
Ontario	5,600	5,400	11,000	1,600	1,800	3,900	700	600	1,100	1,300
Riverside	10,600	3,700	14,300	2,500	3,100	8,500	700	400	1,000	500
Temecula / Murrieta	5,400	2,000	7,400	1,500	2,000	5,500	100	200	100	200
Escondido***	9,000	300	9,300	1,200	1,500	5,000	500	500	1,100	1,200
University City	6,000	200	6,200	1,200	1,700	5,600	100	200	100	200
San Diego	19,900	400	20,300	1,800	2,200	7,200	1,000	900	4,300	4,000
City of Industry	4,100	2,600	6,700	1,400	1,800	4,500	100	200	300	200
Modesto	4,600	0	4,600	700	1,300	4,300	200	300	400	200
Total Daily	231,200	77,200	308,400							
Annualization Factor	365	292	346							
Annual (millions)	84.4	22.5	106.7							

Forecast base

† Egress is mirror of access

* 12/2009 Full System for all stations exept as noted

** 12/2009 Phase 1

*** Interregional from EIR/S Full System (08/2008) with changes due to parking cost estimated

**** EIR/S Full System (08/2008) with changes due to parking cost estimated

Table 6- 5: Highest Station Boardings and Access Activity, 2030

Average Weekday*

Origin Station	2030 Boardings			2030 Access Activity†						
	Inter-regional	Local	Total	Autos Dropping Off Psgrs	Motorized Vehicles Arriving to Park	Cumulative Parking Space Demand	Rental Cars Brought Back	Taxis Dropping Off Psgrs	Transit / Shuttle Alightings	Walkers Bicyclists Other Non-Motorized
San Francisco**	28,000	10,500	38,500	3,200	2,800	9,300	1,700	2,200	9,800	10,700
Millbrae	1,500	4,200	5,700	600	600	1,100	300	300	1,300	1,200
Redw ood City	4,500	3,000	7,500	1,100	1,200	2,900	400	400	800	900
San Jose	8,400	3,700	12,100	1,100	1,400	3,600	600	600	2,700	2,500
Gilroy	5,400	1,100	6,500	1,200	2,100	6,100	200	300	200	200
Sacramento	18,100	0	18,100	1,500	2,600	8,600	900	1,100	4,200	3,800
Stockton	6,300	0	6,300	1,000	1,800	6,200	300	400	600	400
Merced **	7,200	0	7,200	1,200	2,200	7,300	300	400	600	300
Fresno	8,000	0	8,000	1,200	2,100	7,000	400	400	700	400
Bakersfield ***	8,500	0	8,500	1,300	2,100	7,500	400	400	800	500
Palmdale	8,200	8,200	16,400	3,300	4,900	10,700	400	700	600	400
Sylmar	9,900	3,000	12,900	2,500	3,300	9,300	200	400	500	300
Burbank****	2,400	4,000	6,400	1,000	900	1,800	400	300	700	800
Los Angeles	13,600	14,500	28,100	2,200	2,200	4,600	1,200	1,300	7,300	8,000
Norw alk	3,900	2,900	6,800	900	1,300	3,000	400	400	800	900
Anaheim **	24,400	4,900	29,300	2,800	4,800	13,200	1,500	1,600	6,000	5,300
Ontario	5,300	5,300	10,600	1,500	1,700	3,800	700	600	1,000	1,300
Riverside	10,200	3,500	13,700	2,400	3,000	8,200	700	400	900	500
Temecula / Murrieta	5,200	1,900	7,100	1,400	1,900	5,200	100	200	100	200
Escondido***	8,400	300	8,700	1,100	1,400	4,700	500	500	1,000	1,100
University City	5,600	300	5,900	1,100	1,600	5,300	100	200	100	200
San Diego	18,800	400	19,200	1,700	2,000	6,800	900	900	4,100	3,800
City of Industry	3,900	2,500	6,400	1,300	1,700	4,300	100	200	200	200
Modesto	4,400	0	4,400	700	1,200	4,100	200	200	400	200
Total Daily	220,100	74,200	294,300							
Annualization Factor	365	292	346							
Annual (millions)	80.3	21.7	101.8							

Forecast base

† Egress is mirror of access

* 12/2009 Full System for all stations exept as noted
** 12/2009 Phase 1
*** Interregional from EIR/S Full System (08/2008) with changes due to parking cost estimated
**** EIR/S Full System (08/2008) with changes due to parking cost estimated

Table 6- 6: Highest Station Boardings and Access Activity, 2025

Average Weekday*

Origin Station	2025 Boardings			2025 Access Activity†						
	Inter-regional	Local	Total	Autos Dropping Off Psgrs	Motorized Vehicles Arriving to Park	Cumulative Parking Space Demand	Rental Cars Brought Back	Taxis Dropping Off Psgrs	Transit / Shuttle Alightings	Walkers Bicyclists Other Non-Motorized
San Francisco**	26,000	9,700	35,700	3,000	2,600	8,700	1,600	2,100	9,100	9,900
Millbrae	1,400	3,900	5,300	600	600	1,000	300	300	1,200	1,100
Redw ood City	4,200	2,700	6,900	1,000	1,100	2,700	400	300	700	900
San Jose	7,800	3,400	11,200	1,000	1,300	3,400	500	500	2,500	2,300
Gilroy	5,100	900	6,000	1,100	1,900	5,700	200	300	200	200
Sacramento	16,800	0	16,800	1,400	2,400	8,000	800	1,000	3,900	3,500
Stockton	5,900	0	5,900	900	1,700	5,700	300	300	600	300
Merced **	6,700	0	6,700	1,100	2,000	6,800	300	400	500	300
Fresno	7,400	0	7,400	1,100	1,900	6,500	400	400	700	400
Bakersfield ***	7,900	0	7,900	1,200	1,900	7,000	400	400	700	500
Palmdale	7,600	7,600	15,200	3,000	4,600	9,900	400	600	600	400
Sylmar	9,200	2,700	11,900	2,300	3,100	8,600	200	400	500	300
Burbank****	2,200	3,800	6,000	900	800	1,700	400	300	600	700
Los Angeles	12,600	13,400	26,000	2,000	2,000	4,300	1,100	1,200	6,800	7,400
Norw alk	3,600	2,700	6,300	800	1,200	2,800	400	400	700	800
Anaheim **	22,600	4,600	27,200	2,600	4,500	12,200	1,400	1,500	5,600	4,900
Ontario	5,000	4,800	9,800	1,400	1,600	3,500	600	500	1,000	1,200
Riverside	9,500	3,300	12,800	2,300	2,800	7,600	700	400	900	500
Temecula / Murrieta	4,900	1,700	6,600	1,300	1,800	4,900	100	200	100	200
Escondido***	7,800	300	8,100	1,000	1,300	4,400	500	500	900	1,000
University City	5,200	200	5,400	1,000	1,500	4,900	100	200	100	100
San Diego	17,400	400	17,800	1,500	1,900	6,300	900	800	3,800	3,500
City of Industry	3,600	2,400	6,000	1,200	1,600	4,000	100	200	200	200
Modesto	4,100	0	4,100	600	1,100	3,800	200	200	400	200
Total Daily	204,500	68,500	273,000							
Annualization Factor	365	292	346							
Annual (millions)	74.7	20.0	94.5							

Forecast base

† Egress is mirror of access

* 12/2009 Full System for all stations exept as noted

** 12/2009 Phase 1

*** Interregional from EIR/S Full System (08/2008) with changes due to parking cost estimated

**** EIR/S Full System (08/2008) with changes due to parking cost estimated

Table 6- 7: Phase 1 Terminal Stations Boardings and Access, Full System 2030

Average Weekday*

Origin Station	2030 Boardings			2030 Access Activity†						
	Inter-regional	Local	Total	Autos Dropping Off Psgrs	Motorized Vehicles Arriving to Park	Cumulative Parking Space Demand	Rental Cars Brought Back	Taxis Dropping Off Psgrs	Transit / Shuttle Alightings	Walkers Bicyclists Other Non-Motorized
San Francisco*	23,900	10,600	34,500	2,500	2,000	6,500	1,500	1,900	9,500	10,500
Merced *	7,200	0	7,200	400	700	2,000	100	100	200	100
Anaheim *	16,100	5,600	21,700	1,700	3,300	9,700	1,300	1,600	5,000	4,500

Forecast base † Egress is mirror of access

* 12/2009 Full System for all stations

Table 6- 8: Highest Station Boardings and Access Activity for Alternative Stations - 2035, 2030, and 2025

Average Weekday*

	Inter-regional	Local	Total	Autos Dropping Off Psgrs	Motorized Vehicles Arriving to Park	Cumulative Parking Space Demand	Rental Cars Brought Back	Taxis Dropping Off Psgrs	Transit / Shuttle Alightings	Walkers Bicyclists Other Non-Motorized
	2035 Boardings			**2035 Access Activity†**						
4th & King	3,900	2,400	6,300	600	800**	1900**	400	400	1,600	1,500
Kings-Tulare	3,300	0	3,300	500	800	2,800	200	200	300	200
San Fernando	11,900	3,000	14,900	2,900	5,100	12,400	300	400	600	400
Burbank Airport	11,800	2,800	14,600	2,000	2,500	7,100	700	700	1,500	1,800
Fullerton	3,900	7,500	11,400	1,700	2,000	3,600	700	600	1,500	1,500
	2030 Boardings			**2030 Access Activity†**						
4th & King	3,600	2,200	5,800	600	700**	1700**	300	300	1,500	1,300
Kings-Tulare	3,100	0	3,100	500	800	2,700	200	200	300	200
San Fernando	11,000	2,900	13,900	2,700	4,100	10,100	200	400	500	400
Burbank Airport	10,900	2,700	13,600	1,900	2,300	6,600	700	600	1,400	1,600
Fullerton	3,800	7,200	11,000	1,600	1,900	3,500	700	600	1,400	1,400
	2025 Boardings			**2025 Access Activity†**						
4th & King	3,400	2,000	5,400	500	700**	1600**	300	300	1,300	1,200
Kings-Tulare	2,900	0	2,900	400	700	2,500	100	100	300	200
San Fernando	10,200	2,700	12,900	2,500	3,800	9,400	200	400	500	400
Burbank Airport	10,100	2,500	12,600	1,700	2,100	6,100	600	600	1,300	1,500
Fullerton	3,500	6,700	10,200	1,500	1,800	3,200	600	600	1,300	1,300

Forecast base † Egress is mirror of access
* Full System for all stations
** increased by 15% to provide a more conservative reasonable maximum impact

6.2 Specific Station Access and Egress Volumes

This section summarizes the methodology and information used to estimate the access and egress modes of travelers for specific stations from the aggregated access and egress information generated by the high-speed rail ridership and revenue model. The process produces information for 2030 factored to produce 2035 estimates for use in the environmental process as described in Section 6.3.

The process assigns each station to one of several prototype categories based on its location in the region, the density and urban form around the station, and the likely parking cost. Initial estimates of access and egress mode shares are then assigned to each station based on the category assigned to the station. Forecasts of each station's access and egress mode shares are then adjusted until the results sum to regional control totals derived from the HSR ridership and revenue model. The following sections describe each step of this process and its development in more detail.

Station Access/Egress Prototypes

To estimate access/egress mode choice at HST stations, each station was assigned to a proto-typical category. The central assumption is that stations sharing certain key characteristics will display similar access/egress patterns. Key characteristics that are associated with access/egress mode patterns are:

- Station area urban form/density;
- Parking costs surrounding the station area;
- Station region density; and
- Quality of available transit connections.

Six station prototypes were defined to represent different combinations of these characteristics. The categories and station assignments are listed in Table 6- 9.

Table 6- 9: Station Categories and Assignments

Station Category	Stations Assigned to Category
"City Center" Highest density; highest parking cost; highest transit access, including rapid transit.	Transbay; LA/Union Station
"Urban Activity Center" High-density; high parking cost; rail (LRT or rapid transit) and extensive bus service.	San Jose; San Diego; Sacramento; Anaheim; Burbank; 4th and King, SF; Millbrae/SFO
"Developed Urban Area" Middle density; moderate parking cost; local and regional transit available.	Palo Alto; Redwood City; Ontario; Norwalk; Escondido, Burbank Airport, Fullerton
"Outlying Downtown or Activity Center" Traditional grid-based downtown in low-density suburban area; moderate to low parking cost; local bus transit.	Stockton; Bakersfield; Fresno; Riverside; Kings-Tulare; Merced
"Exurban or Outlying Area – Rail Transit" Exurban or outlying; low-density station area; low parking cost/free parking; local transit and regional rail transit.	Gilroy; Sylmar; City of Industry; Palmdale, San Fernando
"Exurban or Outlying Area – No Rail Transit" Exurban or outlying; low-density station area; low parking cost/free parking; low or no transit service.	Modesto Briggsmore; Temecula; University City

Representative Access/Egress Patterns for Airport and Rail Stations

Information on current access/egress patterns around existing airport and rail station areas served as the basis for development of representative access/egress patterns associated with the station categories described above. The main sources and key findings from each are listed below:

The 2001 and 2002 MTC surveys of airport access/egress travel patterns. Key findings from these surveys include[12]:

- Business travelers were about 1.5 times more likely to access the airport by drive and park than non-business travelers;
- Non-business travelers were about 1.5 times more likely to access the airport by drive and drop-off than business travelers;
- Business travelers were about twice as likely to access the airport by taxi or rental car than non-business travelers;
- Non-business travelers were about twice as likely to access the airport by transit than business travelers;
- Non-business travelers were more than two times as likely as business travelers to be picked

[12] Note that these relationships varied somewhat by airport.

up in a personal vehicle; and

- Whether the individual was a Bay Area resident had a stronger impact overall on mode choice than did their trip purpose. Visitors were more likely to be dropped off and picked up, while residents were more likely to drive and park.
- In addition, the average access/egress mode shares for the three Bay Area airports were considered (see Table 6- 10).

Table 6- 10: Approximate Average Access/Egress Mode-splits for Bay Area Airports

	Metropolitan Transportation Commission Airports					
	Drive and Park	Drive and Drop /Pickup	Rental	Taxi	Transit	Other/ unknown
Access (Average)	~25%	~25%	20%	20%	10%	0
Egress (Average)	15%	40%	15%	15%	5%	15% (unknown)

Note: Values rounded to the nearest five percent, therefore, they do not sum to 100 percent. Values represent averages among the three San Francisco Bay area airports for 2002 (in San Francisco, San Jose, and Oakland). For access trips, drive and drop, and drive and park mode shares were not differentiated in the survey (all were considered "personal vehicle" trips). The mode share was estimated using the average response to questions regarding the disposition of personal vehicles.

Source: 2002 Metropolitan Transportation Commission Survey of airport access/egress travel patterns. http://www.mtc.ca.gov/maps_and_data/datamart/survey/airpass1.htm.

Access/egress results by station from the Amtrak Capitol Corridor Satisfaction Study conducted by Corey, Canapary & Galanis in 2007. Key findings from this survey include:

- Stations in dense urban areas (e.g., Oakland Jack London Square; Sacramento) had the lowest percentage of drive and park and drive and drop-off modes and the highest percentage of transit and other modes. Conversely, stations in low-density or outlying areas (e.g., Auburn, Rocklin, Roseville) had the highest share of drive modes.
- Taxi was used very infrequently for all stations.
- Rental car was not listed as an access or egress mode.
- Walk/bike were used for a very significant share of access and egress trips, especially in areas such as Berkeley, Davis, Oakland Jack London Square, and Sacramento. Walking was used twice as frequently for access trips compared to egress trips.
- Public transit and shuttles accounted for about 14 percent of access trips and 19 percent of egress trips.

In addition, the Capitol Corridor results (see Table 6- 11) were considered when estimating approximate maximum and minimum mode share values reflecting the range of station types.

Table 6- 11: Systemwide Access/Egress Share for Capitol Corridor Stations

	Drive and Park	Drive and Drop	Rental	Taxi	Transit	Walk/Bike Other
Access	20-65%	15-45%	0%	0-2%	2-40%	2-45%
Egress	10-70%	10-40%	0%	1-6%	5-45%	10-65%

Note: The Richmond Station was anomalous, with 64 % of access/egress trips by passenger rail, and was not included. Drive and park mode includes carpools. Transit mode includes rail transit, Amtrak thruway bus, bus transit, shuttles, and Amtrak long-distance train.

Source: Access/egress results by station from the Amtrak Capitol Corridor Satisfaction Study conducted by Corey, Canapary & Galanis in 2007.

TRB Transportation Research Circular E-C026, "Evaluating the accessibility of U.S. Air-ports – Results from the American Travel Survey. Personal Travel: the Long and Short of it," 1999. This source analyzed non-commute trips of 100 miles or more made at airports throughout the United States. Key findings from this survey include:

- Access to Airports – Drive and park is the dominant access mode overall, but its share varies considerably by airport. Airports around cities with very high parking costs (e.g., New York City airports) showed very high use of shuttles and taxis (as much as 60 per-cent of access trips) and less use of driving/parking at the airport.
- Access to Airports – Public transit access mode share varied little between cities, ranging from 0 to a little over 10 percent. Washington National airport had the highest use of rail transit as the access mode (10 percent).
- Access to Airports – Business travelers were more likely to drive and park or take a taxi when accessing the airport than non-business travelers.
- Access to Airports – Non-business travelers (leisure, etc.) were more likely to be dropped off or to take public transit than business travelers.
- Egress from Airports – Picked up by private vehicle was the dominant egress mode, fol-lowed closely by rental car. However, egress mode shares also varied significantly by airport. For example, taxi and shuttle were used for more than 50 percent of egress trips from New York City airports compared to 25 percent for all cities. Rental car was used for less than 10 percent of egress trips from New York City airports, as compared to more than 35 percent overall. Again, this probably reflects the high cost of parking in New York City.
- Egress from Airports – Public transit egress mode share varied little between cities, ranging from 0 to a little over 10 percent.

In addition, the range of access/egress results from the airports included in the analysis (Table 6- 12) were considered.

Table 6- 12: Range of Access/Egress Mode-splits for Selected U.S. Airports

	Drive and Park/Unpark	Drive and Pickup/Dropoff	Rental	Taxi	Transit	Other
Access (1995 ATS)	20-65%	15-40%	0	5-60%	0-10%	0/NA
Egress	0	20-45%	5-50%	10-55%	0-10%	0/NA

Note: Values over five rounded to the nearest fifth. Values represent a range of airports, including those in and around Philadelphia, Boston, New York, Chicago, Washington, San Francisco, Los Angeles, Atlanta, and others.

Source: TRB Transportation Research Circular E-C026, "Evaluating the accessibility of U.S. Airports – Results from the American Travel Survey. Personal Travel: the Long and Short of it." 1999.

The 1995 American Travel Survey[13] includes analysis of access/egress patterns for non-commute trips of 100 miles or more made throughout the United States. Some key findings from this effort include:

- About 40 percent of long-distance train travelers accessed the station by driving and parking. Another 32 percent were dropped off; 15 percent used public transit (bus or subway); 10 percent took taxi; and the remaining 3 percent walked or took another mode. None rented a vehicle.
- About 49 percent of long-distance train riders were picked up at the station; 16 percent used public transit; 23 percent took taxi from the station; 6 percent walked from the station; and only a small proportion rented a vehicle.

BART Station Profile Study, August 1999. Key findings from this study include:

- Walk and transit access and egress are very high around high-density downtown stations (San Francisco, Oakland).
- Similar to the Amtrak Capitol Corridor data, walk mode share is significantly higher for egress trips.

General Principles for HSR Station Access and Egress

Due to the varying nature of the sources listed above, no one source was sufficient to define the likely access/egress patterns at any given HSR station type, particularly because of the need to match the modal categories in the HSR model: drive and park; drive and drop-off; taxi; transit; and other. None of the sources listed above define access/egress mode shares in the same categories. For example, rental car was not included in the list of modes chosen to access Amtrak Capitol Corridor stations. Walk/bike was not listed as an option for accessing airports.

Given these discrepancies, it was necessary to apply judgment when using the research results to estimate HSR access/egress mode shares. Principally, the sources were used to establish upper and lower bounds for mode shares and to estimate relationships between mode shares for different trip purposes. Several general principles were derived from the research which guided the estimation of the shares:

Business Trips:

- Drive/park mode share is about 1.5 times drive/drop-off mode share;
- Taxi is used more than rental car in areas with high parking costs; otherwise rental car is

[13] http://www.bts.gov/publications/1995_american_travel_survey/us_profile/entire.pdf.

used more than taxi;
- Rental car and taxi are used infrequently overall, but more frequently for business versus non-business trips; and
- Automobile mode share rises as station area density decreases.

Commute Trips:
- Drive/park mode share is about 1.5 times drive/drop-off mode share. However, in areas with high parking costs, drive and park mode share will be approximately equal to drive and drop-off mode share;
- Transit/shuttles and walk/bike/other will be used more frequently than they are for business/other trip purposes;
- Transit/shuttles will be used more frequently than walking;
- Rental car and taxi will be used infrequently; and
- Automobile mode share rises as station area density decreases.

Other Trips:
- Drive/drop-off mode share is about 1.5 times drive/park mode share (the reverse of business and commute trip purposes);
- Transit/shuttle and walk/bike/other will be used less frequently than for commute trip types but more frequently than for business trips;
- Rental car and taxi will be used infrequently; and
- Automobile mode share rises as station area density decreases.

Differences Between Access and Egress Trips

The main differences between access and egress mode shares observed in the sources above is in the share of trips by the "drive and pickup/drop-off" mode versus the "drive and park/unpark" mode.

Drive and park have a greater share for access trips, and drive and pickup/drop-off and rental car had a greater share for egress trips. These apparent differences may be due in part to imbalanced sampling of trip ends. For example, in the analysis of American Travel Survey Data, "drive-parked vehicle" was not listed as a possible egress mode. This is because the survey focused on only one trip end; interviewees were asked to report their mode of egress only from the destination airport/train station. They were not asked to report the mode of egress for the return egress trip from the home airport/train station. If all trip ends were sampled, it would be expected that access and egress patterns would be approximately similar.

Table 6- 13 presents composite mode shares that represent the expected average mode shares for both access and egress trips. These values reflect the principles described previously, and are used as a starting point in defining individual station prototype shares.

Table 6- 13: Estimated Access/Egress Mode Share by Station Type and Trip Purpose

Station Category	Drive Parked Vehicle	Pickup / Dropoff	Rental Car	Taxi	Transit/ Shuttle	Walk/ Bike/Other	Sum
Business Trips							
1	25%	15%	10%	25%	15%	10%	100%
2	35%	20%	15%	15%	10%	5%	100%
3	40%	25%	15%	10%	5%	5%	100%
4	50%	35%	5%	5%	4%	1%	100%
5	55%	35%	3%	3%	3%	1%	100%
6	60%	35%	1%	2%	1%	1%	100%
Commute Trips							
1	25%	18%	1%	1%	30%	25%	100%
2	34%	24%	1%	1%	25%	15%	100%
3	45%	30%	1%	1%	15%	8%	100%
4	50%	35%	1%	1%	9%	4%	100%
5	55%	40%	1%	1%	2%	1%	100%
6	60%	36%	1%	1%	1%	1%	100%
Other Trips							
1	20%	30%	10%	5%	20%	15%	100%
2	25%	35%	10%	5%	15%	10%	100%
3	30%	45%	10%	5%	5%	5%	100%
4	35%	50%	10%	1%	3%	1%	100%
5	40%	55%	1%	1%	2%	1%	100%
6	41%	55%	1%	1%	1%	1%	100%

Forecasting Access/Egress Patterns for Individual Stations

The mode shares displayed in Table 6- 13 are applied to station boarding totals by trip purpose from the HSR model to provide an initial forecast of the number of access and egress trips by mode.

These initial forecasts then undergo an iterative growth-factor adjustment process until they sum to statewide control totals. The iterative adjustment is necessary to assure consistency between individual station area estimates and the output of the HSR model. Reasonable matching of station-level estimates and statewide totals is achieved using an iterative growth factoring procedure.

The iterative adjustment process produces final values for the number of daily average access and egress trips by mode for each station. The following adjustments are then performed to convert person-trips to vehicle-trips and to reflect the impact of trip duration on vehicle accumulation for parked vehicles.

- **Drive and Park Trips** – This value is adjusted to provide a better estimate of multi-day parking demand associated with drive and park trips. The initial value is divided by average party size, and then adjusted to account for varying trip duration.

- **Drive and Drop-Off/Pick-up Trips** – These trips are divided by average party size to determine the number of average daily auto drop-off trips.
- **Rental Car Trips** – These trips are divided by average party size to determine the number of average daily rental car transactions.
- **Taxi Trips** – These trips are divided by average party size to determine the number of aver-age daily taxi transactions.
- **Transit/Shuttle Bus, and Walk/Bike/Other Trips** – No adjustment are made.

Table 6-14 shows the average party size and trip duration (number of nights) by trip purpose de-rived from the stated-preference surveys.

The process is intended to produce a planning-level estimate of parking needs. The estimate should be considered an upper bound on actual needs, which may vary significantly from the estimate. In addition, it should be noted that station-area development decisions and broader policy decisions will have a significant impact on demand for parking, transit, non-motorized modes, and rental car (e.g., car-sharing). For example, the Amtrak Capitol Corridor policy of al-lowing bicycles on-board has contributed to significant use of bicycles for station access/egress.

Table 6- 14: Average Party Size and Number of Nights Duration by Trip Purpose

Type	Average Party Size
Business	1.5
Commute	1.2
Other	2.5
Trip Duration (Number of Nights Away)	
0	27%
1	16%
2-3	33%
4-6	16%
7+	8%

Note: Intraregional trips will be assumed to have a duration of 0 nights.

6.3 Estimating 2035 Access / Egress Volumes for the Environmental Analysis

To estimate 2035 access/egress activity for a station, forecasts of passenger arrivals/departures by mode were factored based on 2030 forecasts.

For most stations, Full System forecasts provided the highest volumes of activity and the reasonable maximum impact scenario for environmental analysis. For those stations in the Authority's November 2008 Report to the Legislature (Report), the May 2009 operations scenario with higher parking costs was the base.

For Burbank downtown, Bakersfield, and Escondido, where higher boardings had been forecast in a Full System run with an operating pattern with more stops at these stations, the 2030 Full System forecast for those stations from the August 2008 runs was used. However, these boardings, having been created by a run with lower parking costs than those in the base case, were reduced by the observed percentage difference in each station between otherwise identical runs, resulting in reductions of 2% for boardings in Bakersfield, 3% in Escondido, and 10% at Burbank. (Only volumes of boardings were changed; the distribution of access modes was kept the same.)

For alternative stations not in the Report, the base Full System 2030 forecast was taken from:

- Fullerton – August 2008 alternative Phase 1 run, adjusted for the revised operating plan of May 2009 with higher frequency of service, for Full System operations with more SCAG area connections (based on increase in Norwalk boardings between Phase 1 to Full System), and increased parking costs.
- Kings-Tulare – March 2010 Full System run with 4 trains per hour stopping.
- 4th & King – March 2010 Full System run with higher parking cost.
- San Fernando and Burbank Airport – April 2010 Full System run with higher parking cost.

For Anaheim, Merced, and San Francisco, where boardings are forecast to be higher than after the Full System is open to operations, the Phase 1 forecast for 2030 was the starting point.

Once the 2030 forecasts for each station for which only 2030 forecasts were available (Kings-Tulare, San Fernando, Burbank Airport, and Fullerton), the 2035 activity forecasts were calculated by increasing the the 2030 mode activity figures by 7.7% based on the higher end of the range of growth 2030-2035 in station boardings shown in model runs.

7.0 References

California High-Speed Rail Authority. No date. *California High-Speed Train Project Ridership and Revenue Forecasts.* Prepared by Parsons Brinckerhoff, Cambridge Systematics, Inc. and SYSTRA Consulting, Inc. Available at http://www.cahighspeedrail.ca.gov/assets/0/152/198/30e065f8-419e-4d79-bd99-4eee8aafc106.pdf

California High-Speed Rail Authority. 2010. California High-Speed Rail Ridership and Revenue Model. Final Technical Memorandum. Prepared by Cambridge Systematics, Inc. March 2010. Available at http://www.cahighspeedrail.ca.gov/assets/0/79/205/434dcac9-8565-4052-a7bf-66827ecaa8de.pdf

Cambridge Systematics, Inc. 2009. *2030 and 2035 Ridership and Revenue Forecasts, May 2009 Scenario*. Memorandum to Nick Brand. June 10, 2009 (revised August 14, 2009). Available at http://www.cahighspeedrail.ca.gov/assets/0/79/205/01e9677f-29a3-44ab-a3a3-5b863d4df9b3.pdf

Cambridge Systematics, Inc. 2010. *Increased Parking Cost Scenario*. Memorandum to Nick Brand. March 9, 2010. Available at http://www.cahighspeedrail.ca.gov/assets/0/79/205/22082cf8-3735-458b-a8f2-227b830c0f29.pdf

Cambridge Systematics, Inc. 2010. *01Y HigherParkingCostAfterMTCModelRef FullSystem 2030 20100211.xls.* 2030 Full System Model Run Results, February 11, 2010.

Cambridge Systematics, Inc. 2010. *01Y HigherParkingCostAfterMTCModelRef FullSystem 2035 20100212.xls*. 2035 Full System Model Run Results, February 12, 2010.

Cambridge Systematics, Inc. 2010. *Final Coefficients and Constants in HSR Ridership & Revenue Model*. Memorandum to Nick Brand. January 29, 2010.

Metropolitan Transportation Commission. 2005. *Bay Area/California High-Speed Rail Ridership and Revenue Forecasting Study; Socioeconomic Data, Transportation Supply, and Base Year Travel Patterns Data, Draft Report*. Prepared by Cambridge Systematics, Inc., Sub Corey, Canapary & Galanis, Mark Bradley Research & Consulting, HLB Decision Economics, Inc, SYSTRA Consulting, Inc. and Citilabs. December 2005. Available at http://www.cahighspeedrail.ca.gov/assets/0/152/198/98024f29-d7c3-47b0-b545-d509e3a15f5d.pdf

Metropolitan Transportation Commission. 2005. *Bay Area/California High-Speed Rail Ridership and Revenue Forecasting Study; Findings from First Peer Review Panel Meeting, Final Report*. Prepared by Cambridge Systematics, Inc., Sub Corey, Canapary & Galanis, Mark Bradley Research & Consulting, HLB Decision Economics, Inc, SYSTRA Consulting, Inc. and Citilabs. July 2005. Available at http://www.cahighspeedrail.ca.gov/assets/0/152/198/cd999988-e929-497b-bd73-9b22714c8cb1.pdf

Metropolitan Transportation Commission. 2005. *Bay Area/California High-Speed Rail Ridership and Revenue Forecasting Study; Model Design, Data Collection and Performance Measures, Technical Memorandum*. Prepared by Cambridge Systematics, Inc., Sub Corey, Canapary & Galanis, Mark Bradley Research & Consulting, HLB Decision Economics, Inc, SYSTRA Consulting, Inc. and Citilabs. May 2005. Available at http://www.cahighspeedrail.ca.gov/assets/0/152/198/0f929577-fd96-4c0e-baf9-3b94c7e0c905.pdf

Metropolitan Transportation Commission. 2006. *Bay Area/California High-Speed Rail Ridership and Revenue Forecasting Study; Findings from Second Peer Review Panel Meeting, Final Report*. Prepared by Cambridge Systematics, Inc., Mark Bradley Research & Consulting, and SYSTRA Consulting, Inc. July

2006. Available at http://www.cahighspeedrail.ca.gov/assets/0/152/198/0f929577-fd96-4c0e-baf9-3b94c7e0c905.pdf

Metropolitan Transportation Commission. 2007. *Bay Area/California High-Speed Rail Ridership and Revenue Forecasting Study; Findings from First Peer Review Panel Meeting, Final Report*. Prepared by Cambridge Systematics, Inc. September 2007. Available at http://www.cahighspeedrail.ca.gov/assets/0/152/198/8fbb7c99-2364-44c6-8b1d-f6a22ef17c68.pdf (NOTE: The report title on the website is "Findings from Third Peer Review Panel Meeting: September 2007")

Metropolitan Transportation Commission and California High-Speed Rail Authority. 2006. *Bay Area/California High-Speed Rail Ridership and Revenue Forecasting Study; Levels-of-Service Assumptions and Forecast Alternatives, Final Report*. Prepared by Cambridge Systematics, Inc., SYSTRA Consulting, Inc. and Citilabs. August 2006. Available at http://www.cahighspeedrail.ca.gov/assets/0/152/198/ac4ecb11-2c15-47cc-bee9-5e45c4f6abc5.pdf

Metropolitan Transportation Commission and California High-Speed Rail Authority. 2006. *Bay Area/California High-Speed Rail Ridership and Revenue Forecasting Study; Interregional Model System Development, Final Report*. Prepared by Cambridge Systematics, Inc. and Mark Bradley Research & Consulting. August 2006. Available at http://www.cahighspeedrail.ca.gov/assets/0/152/198/fccdc294-2c59-4767-99db-386f9be1fcf6.pdf

Metropolitan Transportation Commission and California High-Speed Rail Authority. 2007. *Bay Area/California High-Speed Rail Ridership and Revenue Forecasting Study; Ridership and Revenue Forecasts, Final Report*. Prepared by Cambridge Systematics, Inc. August 2007. Available at http://www.cahighspeedrail.ca.gov/assets/0/152/198/cba2bcf7-f9a2-4c34-a746-d920d58bd068.pdf

Metropolitan Transportation Commission and California High-Speed Rail Authority. 2007. *Bay Area/California High-Speed Rail Ridership and Revenue Forecasting Study; Statewide Model Networks, Final Report*. Prepared by Cambridge Systematics, Inc. and Citilabs. August 2007. Available at http://www.cahighspeedrail.ca.gov/assets/0/152/198/5f1e9149-f082-4a14-a01b-7252d04e917b.pdf

Metropolitan Transportation Commission and California High-Speed Rail Authority. 2007. *Bay Area/California High-Speed Rail Ridership and Revenue Forecasting Study; Statewide Model Validatio, Final Report*. Prepared by Cambridge Systematics, Inc. and Mark Bradley Research & Consulting. July 2007. Available at http://www.cahighspeedrail.ca.gov/assets/0/152/198/08d53ddb-8e9a-4873-8352-62459875f3f8.pdf

Metropolitan Transportation Commission and California High-Speed Rail Authority. 2007. *Bay Area/California High-Speed Rail Ridership and Revenue Forecasting Study; Final Report*. Prepared by Cambridge Systematics, Inc., Sub Corey, Canapary & Galanis, Mark Bradley Research & Consulting, HLB Decision Economics, Inc, SYSTRA Consulting, Inc. and Citilabs. July 2007. Available at http://www.cahighspeedrail.ca.gov/assets/0/152/198/2344ccef-6b81-4597-b76e-818a7795586b.pdf

Metropolitan Transportation Commission and Cambridge Systematics, Inc. 2005. *High Speed Rail Study, Survey Documentation*. Prepared by Corey, Canapary & Galanis Research. December 2005. Available at http://www.cahighspeedrail.ca.gov/assets/0/152/198/55941a0b-3c42-4616-8046-9c6e5c5a2930.pdf