CAMBRIDGE SYSTEMATICS

California High-Speed Rail 2012 Business Plan

Ridership and Revenue Forecasting

draft technical

memorandum

prepared for

Parsons Brinckerhoff for the California High-Speed Rail Authority

prepared by

Cambridge Systematics, Inc.

October 19, 2011

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1.0 Overview

1.1 BACKGROUND

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 multimodal 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, including constants and coefficients, used to forecast interregional or intra-SCAG trips. Additional work was done to estimate the modes of access and volumes of parking demand at specific stations and to extrapolate to years other than the 2030 model forecast year. The Program Manager used the CS forecasts developed for the environmental studies as the starting point for ridership and revenue forecasts in the Authority's 2009 *Report to the Legislature.*

In 2010, the ridership and revenue model development documentation and use was summarized for the Authority's 2011 project-level environmental documents.[1]

1.2 MODEL UPDATES AND ENHANCEMENTS

At the beginning of the Authority's FY 2010/2011, CS began the first steps of a multiyear update of the existing Ridership and Revenue (R&R) model to provide enhanced capabilities for analysis of refined operating plan and pricing options, and develop independent, risk-based forecasts for use by both public and private investors. The work plan involved these items:

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[1] *California High-Speed Rail Ridership and Revenue Model Development, Application, and Project-Level EIR/EIS Forecasts*, prepared by Parsons Brinckerhoff, with Cambridge Systematics Inc., for the California High-Speed Rail Authority November 2010. http://www.cahighspeedrail.ca.gov/Ridership_and_Revenue_Forecasting_Study.aspx.

- Develop improvements to the model's input and output procedures to create a more efficient work flow;
- Engage with an Authority-selected Peer Review Panel (PRP) to review prior work and develop an approach to improving the model for future applications, including the 2012 Business Plan;
- Carry out a new trip frequency survey, since both CS and the PRP were concerned that trip frequencies may have changed over time, especially considering changes to the California economy;
- Obtain new data to enable recalibration and validation to 2008 conditions; and
- Begin developing longer-term enhancements to improve forecasts and develop approaches for risk-based forecasting.

Peer Review Panel

The Authority engaged an independent Peer Review Panel (PRP) in December 2010. Reporting to the Authority's CEO, the Panel was charged with providing a comprehensive in-depth review of the models used to estimate ridership and revenue and the forecasts derived from them. The Panel consists of five members:

1. Frank Koppelman, Ph.D., Professor Emeritus of Civil Engineering, Northwestern University (chair);
2. Kay W. Axhausen, Dr. Ing., Professor, Institute for Transport Planning and Systems, ETH Zürich (Swiss Federal Institute of Technology Zurich);
3. Billy Charlton, San Francisco County Transportation Authority;
4. Eric Miller, Ph.D., Professor, Department of Civil Engineering and Director, Cities Centre, University of Toronto; and
5. Kenneth A. Small, Ph.D., Professor Emeritus, Department of Economics, University of California-Irvine.

The panel was provided with a complete set of the report documentation, met in January 2010 to review the documentation, and prepared a report summarizing their questions. The panel divided their questions into several categories, in the indicated sections of the report:

- Section 3.0 – Incomplete documentation;
- Section 4.0 – Short-term issues;
- Section 5.0 – Long-term issues;
- Section 6.0 – Econometric issues; and
- Section 7.0 – Data requirements for model enhancement.

CS provided responses to all substantive questions and concerns raised by the PRP in a series of memoranda. CS also met with the PRP twice to discuss the issues and the implications for forecasting work for the Business Plan and beyond. CS also worked with the PRP and the Authority to arrive at a common understanding of how the R&R forecasting fit within the context of anticipated decisions – and the timing of those decisions – that need to be made by the HSTA and other public entities involved in funding and operations. The Panel's reports and CS responses are available separately on the Authority's web site.[2,3,4]

Approach to Developing the Business Plan Forecasts

CS worked with the Program Manager to develop an approach to preparing forecasts for use in the Authority's 2012 Business Plan predicated on the following concepts:

- The R&R model produces reasonable forecasts with reasonable sensitivities to changing conditions.
- Models are not perfect, and their imperfections need to be understood and reflected in the forecasts used for business planning purposes through prudent adjustments and interpretation.
- There are several areas where improvements to the R&R model are warranted. Some of these were identified by CS several years ago, and others were identified by the peer review panel. None of the improvements are sufficiently significant to terminate forecasting for current planning efforts, including the business plan.
- Since it could be done within the schedule constraints of the business planning effort, further investigation of the frequency of trips greater than 50 miles – those that are candidates for HST travel – was warranted.
- Similarly, changes in conditions since the model was first developed warrant updates for use in the Business Plan. In particular:

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[2] Independent Peer Review of the California High-Speed Rail Ridership and Revenue Forecasting Process Findings and Recommendations from the January-March 2011 Review Period, July 22, 2011.

[3] Independent Peer Review of the California High-Speed Rail Ridership and Revenue Forecasting Process Findings and Recommendations from April-July 2011 Review Period, August 1, 2011.

[4] Both peer review panel reports and CS' responses are available on the Authority's web site: http://www.cahighspeedrail.ca.gov/Ridership_and_Revenue_Forecasting_Study.aspx.

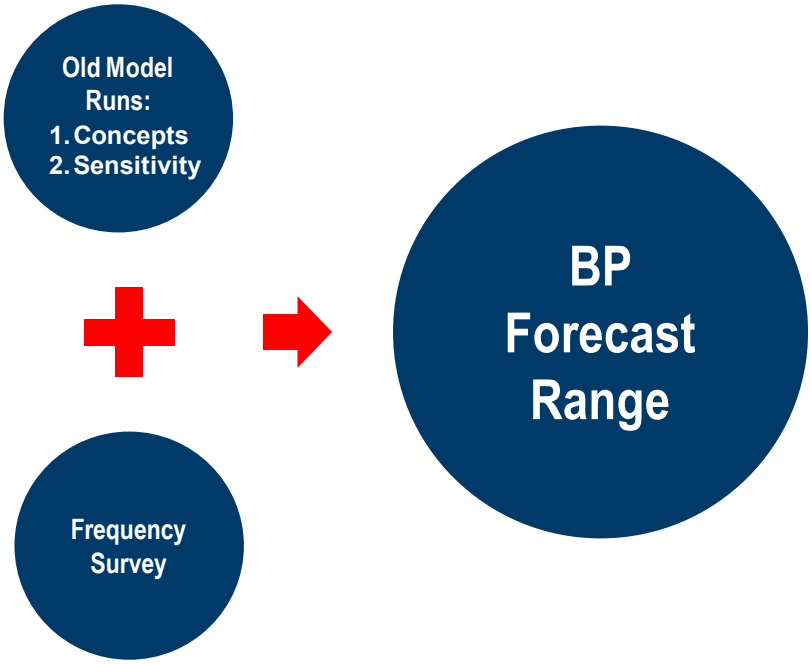
  - Airline fares and frequencies have changed, and the potential for further change, in particular in response to the introduction of HST service (see Section 2.1);
  - Conventional rail fares and frequencies have changed (see Section 2.2); and
  - Economic conditions have changed, and the outlook for future population and employment has changed (see Section 3.0).
- Future conditions cannot be known with certainty. The forecasts used for business planning purposes need to recognize those uncertainties and present a reasonable range. There is an ample body of literature supporting this approach.

CS worked with the Program Manager to develop a forecasting process that would provide a reasonable range of R&R forecasts for use in the business plan. Consistent with the findings and recommendations of the peer review panel that process involved these steps (Figure 1.1):

- Continue to use the existing model to test scenarios important for the business plan.
- Update the existing transportation system to reflect current conditions, planned changes, and forecast future conditions, specifically:
  - Fares, routes, and service frequencies for conventional rail and air service; and
  - Cost of auto travel.
- Incorporate revisions to socioeconomic growth assumptions, including:
  - Update population, housing, and employment forecasts for 2030 to reflect observed changes between 2000 and the present as well as the impacts of the recession of 2007-2009; and
  - Development of medium and low forecasts of socioeconomic growth to complement the existing "high" forecasts.

In parallel with the above efforts, CS developed and conducted, with input from the PRP, an on-line survey of long-distance travel made by California residents over the previous two-month time period. The survey was designed to provide current information regarding travel of 50 miles, including trip frequencies, trip purposes, origins, and destinations of trips, and mode used for travel. The primary use of the data will be for calibration and validation of a refined version of the R&R model to 2008 conditions. That refinement effort is being performed with input from the PRP and is scheduled for completion in early 2012. Nevertheless, the survey data provided information useful for initial tests of the impacts of changes in trip frequencies by trip purpose through the factoring of results of existing model runs performed for the business plan. The results of the investigations into alternative assumptions regarding trip frequencies are in Section 4.0.

Figure 1.1 Business Plan Forecast Concept



From this starting point, CS worked with the Program Manager to test a range of potential phasing scenarios as well as ranges of airline responses to HST competition and ranges of socioeconomic growth. The remainder of this technical memorandum documents the details of the work performed under this overall framework.

2.0 Revised Service Assumptions

CS updated the model to reflect changes in current and anticipated future airfares and airline service frequencies, current fares and service frequencies for conventional rail in California, and assumed costs of driving automobiles.

2.1 AIRLINE FARES, SERVICE FREQUENCIES, AND COMPETITIVE RESPONSES

The ridership and revenue forecasts made for all work prior to the 2012 Business Plan were based on assumed airfares and airline service frequencies that reflected the air service patterns in effect in the California Corridor markets between Northern and Southern California in 2005. Additionally, several reviewers of the prior forecasts had expressed concerns about the lack of analysis of possible airline competitive response to the introduction of high-speed train (HST) service and its effect on the forecast.

CS engaged Aviation System Consulting, LLC (ASC), a California-based expert firm to address these issues. ASC analyzed the past decade of U.S. Department of Transportation data on airline service and fare levels, explained the economic factors affecting airline responses to changes in competition and capacity, and helped determine scenarios of potential airline competitive response to the introduction of HST service. ASC's memorandum is in Appendix A, with a summary below.

Both the airline industry in general and the air service patterns in the California Corridor markets have changed significantly since 2005, due to increased competition from low-cost airlines, entry of new carriers and airline consolidation, rising fuel costs, and efforts by the legacy carriers to reduce costs. In particular, the entry of Virgin America in the San Francisco to Los Angeles market in August 2007 and the San Francisco to San Diego market in February 2008 and the competitive response from other airlines, particularly JetBlue Airways and Southwest Airlines, has significantly changed the patterns of air service between the Bay Area and Southern California.

Furthermore, in previous forecasts, CS made no adjustments for possible airline competitive response to the introduction of HST service. This response could take one of two forms. Airlines could reduce service frequency and/or increase fares to offset reduced load factors as air travel in these markets drops due to the diversion of trips to HST. Alternatively, they could attempt to retain market share by reducing fares. At the same time, the competitive response of the existing airlines to the entry of Virgin America offers some indication of the likely airline response to the introduction of HST service. From the perspective of an individual airline, it really does not matter whether a loss of market share

results from service entry by a new airline or a new intercity mode (such as HST). The airline has to decide whether to accept the resulting loss of market share and adjust the level of air service and fare structure accordingly, or attempt to retain as much of its market share as possible by reducing fare levels and/or changing aircraft size in order to maintain service frequencies.

The introduction of HST service is likely to lead to a reduction in traffic in each of the markets as some potential air passengers choose to use the HST service. Depending on the extent of the mode shift from air to HST and the growth in air travel demand between now and the start of HST service, the remaining air passenger traffic in the Corridor may still be comparable to current levels or even higher. However, there will most likely be a significant decline from the levels immediately prior to the start of HST service. Therefore, the airlines will need to reduce capacity in order to maintain load factors at an economically viable level. This could happen by either reducing frequency or using smaller aircraft.

ASC suggests that the baseline assumption for fares in 2030 be the same as they were in 2009, with a low fare scenario 9 percent lower (Table 2.1). The high fare scenario would be an increase in real fares by $12 to $18 dollars, depending on the market.

Table 2.1 Air Service Assumptions for Use in Future HST Ridership Forecasts

	Airfares	Average Load Factor	Average Aircraft Size	Flight Frequency
Baseline Scenario	2009 average fares by market in constant 2005 dollars	75%	Increase in average aircraft size in each market with a smaller average aircraft size to the median aircraft size in 2009 for markets from the Northern California airports to the relevant Southern California airport, plus a further increase of 2 percent in all markets	Determined from flight frequency equation for the assumed market diversion ratio
Low-Fare Scenario	9% reduction in real fares from 2009 levels	78%	A further increase of 6% above the Baseline Scenario	Same
High-Fare Scenario	Increase in real fares over 2009 levels by $12 to $18 in 2030 depending on market, averaging 16%	70% or 73% depending on market	Same as Baseline Scenario	Same

Source: Aviation System Consulting.

2.2 REVISED CONVENTIONAL RAIL SERVICE AND FARE ASSUMPTIONS

Conventional rail (CVR) service and fare assumptions for 2030 were updated to reflect 2011 current and forecasted conditions. The updated CVR lines include:

- Pacific Surfliner (Santa Barbara – Los Angeles – San Diego);
- San Joaquin (Oakland and Sacramento to Bakersfield);
- Capitol Corridor (San Jose – Oakland – Sacramento);
- Altamont Commuter Express (Stockton – East Bay Area);
- Multiple Los Angeles area Metrolink services; and
- Caltrain San Jose-San Francisco service.

CS updated the fare assumptions for all lines to on-line published fares in 2011. These 2011 fares were converted to 2005 dollars using California CPI values for April 2011 (234.113) and the 2005 average value (202.6).

The 2011 operating plans, including the stop pattern, peak and off-peak service frequency, and travel times were obtained from the on-line published weekday schedule. Consistent with previous assumptions, the peak period was assumed to include three hours during the a.m. peak, and three hours during the peak period. The off-peak period was 10 hours. CS then converted the published daily trips to headways.

Table 2.2 summarizes the differences in service between 2011 and 2030. Additional details are provided in the documentation of each scenario provided in Section 5.0.

Table 2.2 Source and Summary of 2030 CVR Operating Plan Forecasts

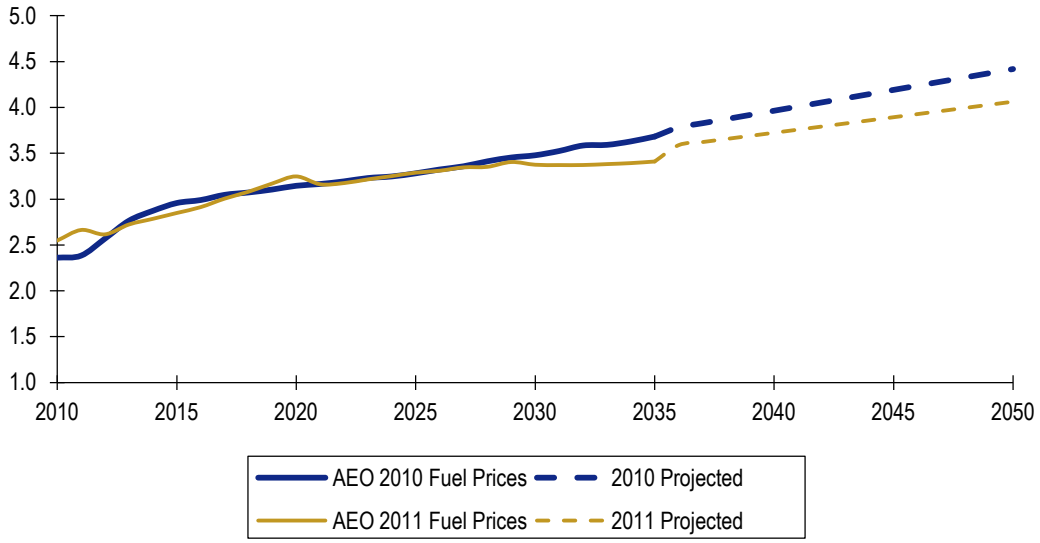
	Source of 2030 Forecasts	Summary of Service Changes from 2011
Pacific Surfliner	California State Rail Plan, 2008, assumed 2020 service frequencies	Increase by two daily round-trip services between San Diego and Los Angeles and by one daily round-trip service between Los Angeles and Santa Barbara
San Joaquin	California State Rail Plan, 2008, assumed 2020 service frequencies	Increase to six daily round trips between Stockton and Oakland and to three daily round trips between Stockton and Sacramento
Capitol Corridor	California State Rail Plan, 2008, assumed 2020 service frequencies	Increase by two daily round-trip services between Oakland – Sacramento and between San Jose-Oakland
Altamont Commuter Express	Current 2011 Service Plan	N/A
Metrolink	2010 LOSSAN Strategic Assessment, assumed 2030 service plan	Includes planned Metrolink service extensions
Caltrain	Caltrain, Short-Range Transit Plan, Fiscal Year 2009 through Fiscal Year 2018, December 2009, assumed 2030 service plan	Increase by four trains per hour between San Jose and San Francisco and by two trains per hour between San Jose and Gilroy in the peak period

2.3 REVISED AUTOMOBILE OPERATING-COST ASSUMPTIONS

Gasoline Price Forecasts

In January 2011, CS reviewed the fuel price projections developed by the U.S. Energy Information Administration's (EIA) 2010 and 2011 Annual Energy Outlook (AEO). EIA reports provided fuel-cost forecasts out to year 2035 (Figure 2.1). The forecasts used in the analysis were based on retail prices for the Pacific Region and represent assumed economic growth of 2.4 percent per year for AEO 2010 and 2.7 per year for AEO 2011. Based on the EIA 2011 forecast, retail gas price will be around $3.38 per gallon, in 2005 dollars.

Figure 2.1 U.S. Energy Information Administration Gasoline Price Forecasts and CS Projections: 2010-2050
In 2005 Dollars

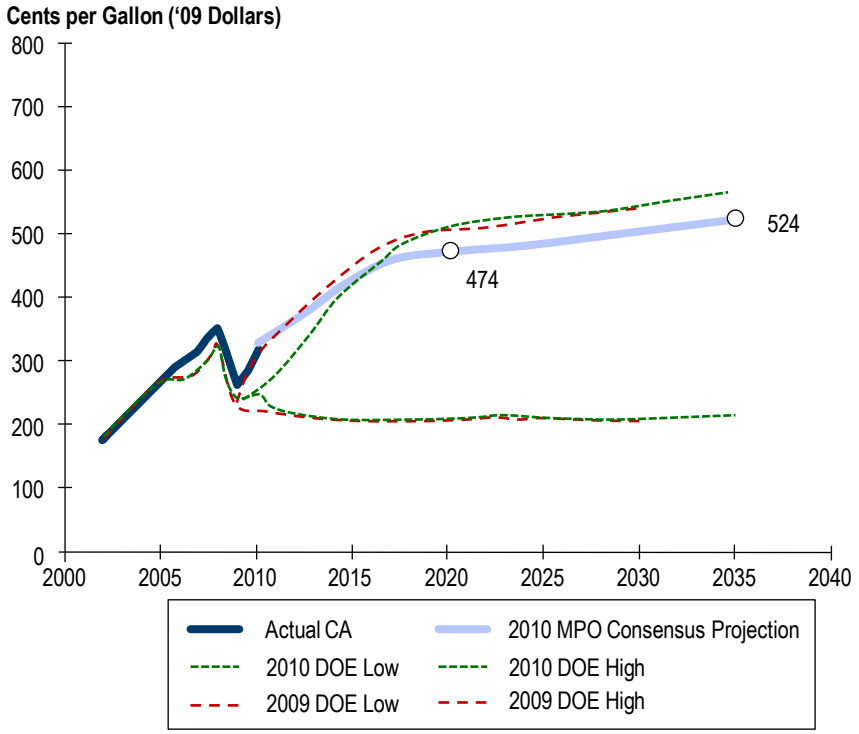


Source: CS projection of Energy Information Administration forecasts.

For the purposes of alternatives evaluations beyond 2035, CS projected AEO forecasts out to 2050 using a linear function. According to the AEO 2011 report, actual fuel costs for year 2010 have increased 19 cents over the cost forecast in the AEO 2010 report. AEO 2011 cost forecasts for year 2020 also have seen an increase (10 cents) over AEO 2010. The trend is reversed in 2030, as updated forecasts are projected 10 cents lower in the 2011 report. CS' trendlines carry these figures out to 2050 where the projected AEO 2011 estimate is 36 cents lower than forecasted in 2010.

Other forecasts put retail gas prices at a higher cost in 2030. The California Metropolitan Planning Organizations (CA MPO) have recently adopted consensus projections for fuel prices through 2035 (Figure 2.2). Based on the estimates, retail gas price in 2030 will be around $5.00 per gallon in 2009 dollars. Using the California CPI values for 2009 (224.11) and 2005 (202.6), gasoline price will be at $4.52 per gallon in 2005 dollars. This cost is around 34 percent higher ($1.14) than the estimated cost developed by EIA.

Figure 2.2 California MPO Consensus Projection
In 2009 Dollars



Source: California Metropolitan Planning Organizations.

Motor Vehicle Fuel Economy Forecast

CS reviewed the 2008 Caltrans Motor Vehicle, Stock, Travel, and Fuel Forecast (MVSTAFF). According to the report, the estimated fuel economy for automobiles using gasoline in 2030 is 22.84 mpg (Table 2.3). Given the recent proposal to increase the corporate average fuel economy (CAFE) standard to 54.5 miles per gallon by 2025, the project team decided to use a higher fuel efficiency figure of 23.8 mpg for the 2030 runs.

Table 2.3 California Vehicle Fuel Economy Forecast

	Statewide Vehicle Fuel Economy (Miles per Gallon)		
	Auto		
Year	Gas	Diesel	Total
2000	21.910	27.303	21.937
2005	21.562	28.205	21.588
2006	21.543	28.224	21.942
2007	22.042	27.828	22.061
2008	21.800	28.364	21.820
2009	21.924	28.598	21.942
2010	22.041	28.616	22.057
2015	22.502	28.482	22.513
2020	22.729	28.354	22.738
2025	22.830	28.320	22.839
2030	22.849	28.320	22.858

Source: California Motor Vehicle Stock, Travel, and Fuel Forecast, 2008.

2030 Auto Operating Cost

Because of the level of future gasoline prices is so uncertain, CS used a gas price of $3.80 per gallon in 2005 dollars (see Table 2.4), which is in between the CA MPO and EIA estimates. Combined with an assumed auto fuel efficiency of 23.8 mpg, the gasoline operating cost in 2030 is estimated at 16 cents per mile. Using 9 cents per mile for the non-gas operating costs, CS estimated the total auto operating cost for 2030 at 25 cents per mile in 2005 dollars. This cost reflects an increase of 4.2 percent over the operating cost used in the May 2009 runs. Although CA MPO and MVSTAFF currently would suggest higher gas prices and lower fuel economy for a central case, the project team has agreed to use a more conservative scenario for the HST model runs.

Table 2.4 Proposed Auto Operating Cost for 2030 Model Runs

	2030 Retail Gas Price (2005 Dollars)	2030 Fuel Economy (MPG)	Non-Gas Operating Cost (Cents)	2030 Auto Operating Cost (Cents per Mile)
CA MPO	$4.52 per gallon	22.8[a]	9.0	28.8
EIA	3.38 per gallon	22.8[a]	9.0	23.8
Proposed	**$3.80 per gallon**	**23.8**	**9.0**	**25.0**

Source: Cambridge Systematics, Inc.

[a] From Caltrans Motor Vehicle, Stock, Travel, and Fuel Forecast.

3.0 Socioeconomic Forecast Updates

3.1 BACKGROUND

The 2030 population, household and employment forecasts used for the original R&R model were developed in 2006-2007 from local agency socioeconomic projections, including those developed and updated by the Association of Bay Area Governments (ABAG), the Southern California Association of Governments (SCAG), the San Diego Association of Governments (SANDAG), and the Sacramento Council of Governments (SACOG), as well as from California State Department of Finance (DOF) and Caltrans projections. The forecasts developed by these agencies were based, in part, on observed data such as the 2000 Census. As such, the forecasts were influenced by the strong period of economic growth in California fueled, in part, by the "dot com" boom.

The recession of 2007-2009 has dampened expectations regarding future population, household, and employment growth. State and local agencies currently are in the process of developing 2035 forecasts that reflect the downturn in the economy, but those forecasts are not yet available.

To develop R&R forecasts for the 2012 Business Plan, CS updated the socioeconomic forecasts to reflect the best available information readily available from independent sources. Forecasts for future business plans or those that might be needed for "investment-grade" work will delve even deeper into potential socioeconomic outcomes with independently developed forecasts.

Given the circumstances, the original R&R socioeconomic forecasts were considered to be on the high side, and are referred to as the "2030 Pre-Recession" forecasts in this report.

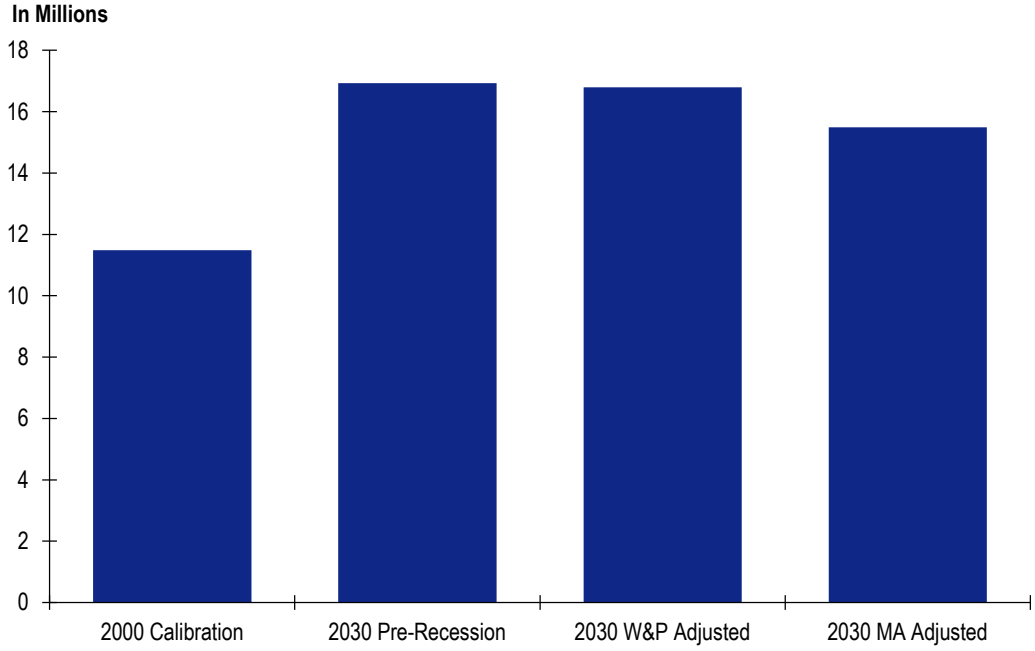
3.2 ALTERNATE 2030 FORECASTS

CS developed two alternate forecasts of population, households, and employment to account for decreased expectations regarding future socioeconomic growth. Whereas the forecasts used for environmental studies are required to use officially adopted government forecasts, those used for a financial business plan are usually developed using independent forecasts. Independent forecasts can be more responsive to changing economic conditions. CS developed the two alternative forecasts as follows:

- **2030 W&P Adjusted Forecast –** The initial alternate forecast was developed using forecasts purchased from Woods and Poole Economics, Inc. (W&P) at two points in time. The W&P forecasts were for county-level population, households, and total employment for the State. One of the forecasts was made in 2008 (prior to the recession) and one produced in 2011 (after the recession). The ratios of the two W&P forecasts for 2030 were used to factor the original 2030 Pre-Recession forecasts on a county-by-county basis. For example, the ratio of the 2011 W&P forecast of total employment for Alameda County for 2030 to the 2008 forecast of employment for 2030 was 0.95. Thus, the 2030 Pre-Recession forecast of employment for Alameda County was factored by 0.95. The resulting differences in population, households, and employment by county were allocated to traffic analysis zones (TAZ) comprising the counties in such a way to reflect the growth, or lack of growth, in individual TAZs. Therefore, TAZs that were originally forecast to remain stable between 2000 and 2030 Pre-Recession also were stable between 2000 and 2030 W&P Adjusted. TAZs that had high growth originally, also had high growth in the revised forecast.
- **2030 Moody's Analytics Adjusted Forecast –** A second 2030 alternate forecast was developed using 2011 forecasts for 2030 purchased from Moody's Analytics. Moody's Analytics data include county-level forecasts of population, households, and employment by economic sector for the State. In contrast to the 2030 W&P Adjusted forecasts, the 2030 Moody's Analytics Adjusted forecasts of population and households by county were used directly for the 2030 county control totals. An alternate procedure was required for the employment data. Since the employment data included forecasts by economic sector, it was possible to aggregate the employment to the retail, service, and other employment groups used by the R&R model. However, the Moody's Analytics data do not include estimates of agricultural employment and proprietors. Thus, adjustment factors for the county-level employment forecasts by employment group were developed by comparing the 2000 Moody's Analytics employment estimates to the 2000 employment data used in the original R&R model calibration and validation.

Figure 3.1 summarizes the statewide household estimates and forecasts for 2000, 2030 Pre-Recession, 2030 W&P Adjusted, and 2030 Moody's Analytics Adjusted. The 2000 estimate (2000 Calibration) has been summarized from the data used for the original R&R model calibration and validation. Only households have been summarized since they are used in the R&R model. Population is not directly used in the R&R forecasting process. The 2030 W&P Adjusted forecast of households is about 1 percent lower than the 2030 Pre-Recession forecast and the 2030 Moody's Analytics Adjusted forecasts is about 8 percent lower. Note that there is a bigger drop in population than in households because of changing household sizes over time.

Figure 3.1 Statewide Household Estimates and Forecasts

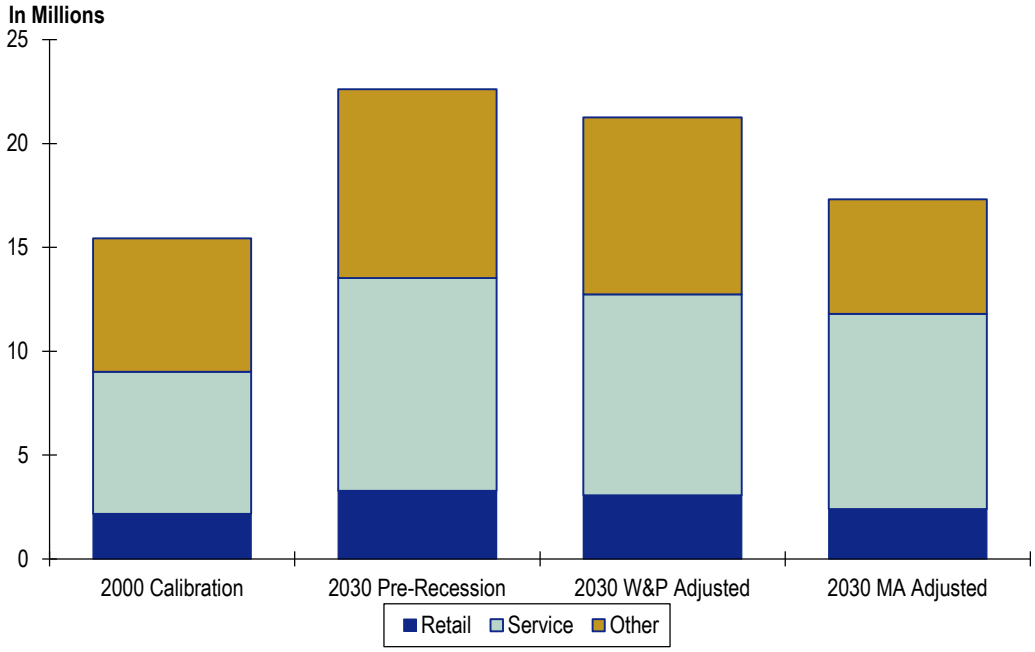


Source: Cambridge Systematics analysis of various data sources:

- 2000 Calibration from 2000 data used for HSR R&R model calibration and validation.
- 2030 Pre-Recession from data developed in 2006-2007 for HSR R&R travel forecasts.
- 2030 W&P Adjusted – adjusted 2030 data based on forecasts produced by Woods & Poole Economics, Inc.
- 2030 MA Adjusted – adjusted 2030 data based on forecasts produced by Moody's Analytics.

Figure 3.2 summarizes the statewide employment estimates and forecasts for 2000, 2030 Pre-Recession, 2030 W&P Adjusted, and 2030 Moody's Analytics Adjusted. Color coding in the figure represents retail, service and other employment. The 2030 W&P Adjusted forecast of total employment is about 6 percent lower than the 2030 Pre-Recession forecast and the 2030 Moody's Analytics Adjusted forecasts is about 23 percent lower.

Figure 3.2 Statewide Employment Estimates and Forecasts by Employment Group



Source: Cambridge Systematics analysis of various data sources:

- 2000 Calibration from 2000 data used for HSR R&R model calibration and validation.
- 2030 Pre-Recession from data developed in 2006-2007 for HSR R&R travel forecasts.
- 2030 W&P Adjusted – adjusted 2030 data based on forecasts produced by Woods & Poole Economy, Inc.
- 2030 MA Adjusted – adjusted 2030 data based on forecasts produced by Moody's Analytics.

3.3 Diverging Relationships between Jobs and Population

It is common for ridership forecast models to be predicated on the basic assumption that the future will be much like the present, only more or less so. Past relationships that tie the amount and type of travel with the amount and location of households and different kinds of employment are the basis for estimates of trip frequency and trip distribution. Over the course of many years, these historical relationships can change, and it is difficult to predict the implications that these changes will have on travel.

As we emerge from the recession of 2007-2009 and look into the future, CS noticed that future forecasts from a variety of sources of the relationship between population and jobs are considerably different from recent trends. This could have significant, yet unknowable implications for future ridership on the California HST system. A summary of this emerging issue is provided in Appendix B.

4.0 Alternative Trip Frequency Assumptions

One of the most important drivers of the demand for high-speed train service in California is the frequency with which Californians take trips of the distances best served by high-speed train (HST) service. Both CS and the Peer Review Panel (PRP) identified the estimates of trips in the greater-than-50-mile category as an important area of uncertainty in the forecasts.

To help address this issue, CS developed a Long-Distance Travel Survey to collect current long-distance travel data to help provide perspective for the 2012 Business Plan, as well as for the revalidation of the California High-Speed Rail Ridership and Revenue Model (CAHSR R&R Model). CS contracted with Harris Interactive for the data collection, and the survey was fielded in May 2011. The survey provided a comprehensive source of data for all trip purposes for home-based interregional travel in California. Survey responses from the 2011 survey were expanded to match the estimated 2008 population[5] for the State of California that will be used as a basis for a planned recalibration and revalidation.

The expanded results provide an updated picture of medium- and long-distance interregional travel in California from that used for the 2000 calibration and validation of the existing CAHSR R&R Model. Appendix C has complete documentation of the trip frequency survey. Key survey findings were:

- The overall number of medium-distance (50-99 miles) interregional trips (one-way linked trips) within California estimated for 2008, 478,400, was 36 percent lower than those used for the 2000 model calibration and validation (752,000).
- The overall number of long-distance (100+ miles) interregional trips within California estimated for 2008, 526,600, was 5 percent higher than those used for the 2000 model calibration and validation (499,000).
- The overall trips rates for medium- and long-distance interregional trips within California for 2008 were 0.037 and 0.041 person trips per household per day, respectively. In comparison, the overall 2000 trip rates were 0.065 and 0.044 for the same trip lengths.

[5] The estimate of 2008 population for California was developed from a population synthesis process by UC Davis.

- Overall, the combined trip rate for all interregional trips made by California residents to destinations within California over 50 miles from home was 28 percent less in 2008 than in 2000.
- The composition of medium- and long-distance trips by trip purpose estimated for 2008 are substantially different than the shares used for the 2000 model calibration and validation. The estimated 2008 long-distance trip shares for the combined business/commute trip purpose and the combined recreation/other trip purpose were 17 percent and 83 percent, respectively. In comparison, the shares for the combined business/commute and recreation/other trip purposes for the 2000 calibration and validation were 50 percent each.
- Main travel mode shares for medium distance trips (50-99 miles) for 2008 were similar to those used for the 2000 model calibration and validation for the business/commute and recreation/other trip purposes. For long-distance travel (100+ miles), the estimated 2008 data show substantially lower auto mode shares for business/commute travel than those used for the 2000 model calibration and validation (64 percent for 2008 and 88 percent for 2000); the decreased auto shares shown for 2008 were balanced by substantially higher air shares for the business/commute trips (33 percent for 2008 versus 11 percent for 2000). Main travel mode shares for recreation/other travel estimated for 2008 were similar to those used for the 2000 model calibration and validation.

Results from the survey were used to develop factors that could be applied to a forecast from the original CAHSR R&R model to provide a preliminary idea of impacts of the updated picture of long-distance travel in California. The factors were derived by comparing the medium- and long-distance trip rates from the 2011 survey to the original data used for the 2000 model calibration and validation by purpose for the MTC, SANDAG, SACOG, and SCAG regions as well as for the rest of California as a whole. The estimated impacts of the updated trip rates are presented in Section 5.0.

5.0 Ridership and Revenue Forecasts for HST Scenarios

CS developed ridership and revenue forecasts for 30 scenarios specified by the Program Manager using the High-Speed Rail Ridership and Revenue Model. In general, there were four types of scenarios:

- **Phase 1 –** Variations on HST service from San Francisco to Anaheim. These runs typically tested the impact of either service plans or underlying forecast assumptions in the complete Phase I system.
- **Bay to Basin –** Variations on HST service from the Bay Area to San Fernando.
- **Initial operating segments – North (IOS-N) –** Variations on a potential initial operating segment featuring a northern terminal in either the Bay Area or northern Central Valley, and a southern terminal at Bakersfield.
- **Initial operating segments – South (IOS-S) –** Variations on a potential initial operating segment featuring a north terminal in the Central Valley and a south terminal at either Palmdale or San Fernando.

Features that differentiate the scenarios include:

- Service frequencies during peak and off-peak periods;
- Availability and type of connection services at the terminals;
- Socioeconomic data;
- Auto operating costs; and
- HST, air, and conventional rail fare policies.

5.1 SUMMARY OF 30 SCENARIOS

Table 5.1 summarizes the assumptions used for all 30 scenarios and Table 5.2 summarizes the ridership and revenue forecasts. Appendix D provides detailed results about the scenarios in nine memoranda developed over the course of the business planning process.

The Program Manager used these estimates of ridership and along with estimates of cost and other factors to focus the Business Plan on the most promising scenarios. Ultimately, five scenarios formed the basis for the ridership and revenue forecast ranges used for the business plan. The R&R model results for these scenarios are described in the rest of this section. Section 6.0 explains how these model results were used to develop ranges for the 2012 Business Plan.

Table 5.1 HST Scenario Assumptions

Memo No.	Run No.	Run Type	North Terminus	South Terminus	HST Fare Policy[a]	Air Fare Policy[a]	CVR Fare Policy	Motor Fuel	Socioeconomic Data (SE)	Peak Trains per Hour (TPH)	Operating Plan Notes	Connection Service	Connection Notes
No. 1	10-001	Phase 1	SF Transbay	Anaheim	50% of base airfare, split 75% and 125% for peak and off-peak	Factored 2009 airfares	2005 Fares	24 cents per mile	2030 Pre-Recession Forecast	3 (120 min. freq); 2 (40 min. freq); 3 (60 min. freq); 1 (30 min. freq)	8 trains from SF; 1 from Merced	N/A	Split fares
	10-002	Phase 1	SF Transbay	Anaheim	50% of airfare	Factored 2009 airfares	2005 Fares	24 cents per mile	2030 Pre-Recession Forecast	15	10 trains from SF; 2 from LAUS; 3 from Sacramento	N/A	No Redwood/Palo Alto stop
	10-003	IOS North	SF Transbay	Bakersfield	50% of airfare	Factored 2009 airfares	2005 Fares	24 cents per mile	2030 Pre-Recession Forecast	5	All trains from SF	N/A	N/A
	10-004	IOS North	SF 4th/King	Bakersfield	50% of airfare	Factored 2009 airfares	2005 Fares	24 cents per mile	2030 Pre-Recession Forecast	5	2 trains from SF; 3 from San Jose	N/A	N/A
	10-005	IOS North	SF 4th/King	Bakersfield	83% of airfare	Factored 2009 airfares	2005 Fares	24 cents per mile	2030 Pre-Recession Forecast	3	2 trains from SF; 1 from San Jose	N/A	N/A
No. 2	10-006	IOS North	SF 4th/King	Bakersfield	83% of airfare	Factored 2009 airfares	2005 Fares	24 cents per mile	2030 Pre-Recession Forecast	3	2 trains from SF; 1 from San Jose	Coach (South)	Dedicated coach services from Bakersfield to Los Angeles Basin destinations
	10-007	IOS North	Merced	Bakersfield	83% of airfare	Factored 2009 airfares	2005 Fares	24 cents per mile	2030 Pre-Recession Forecast	1	All from Merced	Amtrak (North); Coach (Merced); Coach (South)	Amtrak from Merced to Oakland and Sacramento; dedicated coach services from Bakersfield to Los Angeles Basin destinations, from Merced to San Jose, and from Emeryville to San Francisco
	10-009	IOS North	San Jose	Bakersfield	83% of airfare	Factored 2009 airfares	2005 Fares	24 cents per mile	2030 Pre-Recession Forecast	3	All from San Jose	Caltrain (North); Coach (South)	Caltrain cross-platform transfer from San Jose to San Francisco; dedicated coach services from Bakersfield to Los Angeles Basin destinations
	10-022	IOS North	San Jose	Bakersfield	83% of airfare	Factored 2009 airfares	2005 Fares	24 cents per mile	2030 Pre-Recession Forecast	3	2 trains from San Jose; 1 from Merced	Caltrain (North); Amtrak (Merced); Coach (South)	Caltrain cross-platform transfer from San Jose to San Francisco; Amtrak from Merced to Sacramento; dedicated coach services from to Los Angeles Basin destinations
No. 3	10-011	IOS South	Fresno	Palmdale	83% of airfare	Factored 2009 airfares	2005 Fares	24 cents per mile	2030 Pre-Recession Forecast	1	All from Fresno	Amtrak (North); Coach (North and South)	Amtrak from Fresno to the Bay Area and Sacramento treated as extensions of HST; dedicated coach services from Palmdale to Los Angeles Basin destinations, from Fresno to San Jose, and from Emeryville to SF Transbay
	10-020	IOS South	Fresno	Palmdale	83% of airfare	Factored 2009 airfares	2005 Fares	24 cents per mile	2030 Pre-Recession Forecast	1	Fresno Amtrak and Fresno HST stations are treated as separate stations	Amtrak (North); Coach (North and South)	Same as 10-011, but shuttle connect between Fresno HST/Amtrak = 15 minutes added transfer time
	10-023	IOS South	Merced	Palmdale	83% of airfare	Factored 2009 airfares	2005 Fares	24 cents per mile	2030 Pre-Recession Forecast	2	All from Merced	Amtrak (North); Coach (North and South)	Amtrak from Merced to Oakland and Sacramento treated as extension to HST service; dedicated coach services from Palmdale to Los Angeles Basin destinations, from Merced to San Jose, and from Emeryville to San Francisco

a For analysis that began in May 2009, CS factored the 2005 airfares by 8 percent. This reflected typical fare increases on the Bay Area to Los Angeles Basin routes. For analysis that began in May 2011, CS used 2009 fares based on actual fares as reported in the work by Aviation System Consulting, LLC, described in Section 2.1.

Table 5.1 HST Scenario Assumptions (continued)

Memo No.	Run No.	Run Type	North Terminus	South Terminus	HST Fare Policy[a]	Air Fare Policy	CVR Fare Policy	Motor Fuel	Socioeconomic Data (SE)	Peak Trains per Hour (TPH)	Operating Plan Notes	Connection Service	Connection Notes
No. 4	10-012	IOS South	Fresno	San Fernando	83% of airfare	Factored 2009 airfares	2005 Fares	24 cents per mile	2030 Pre-Recession Forecast	1	All from Fresno	Amtrak (North); Coach (North and South)	Amtrak from Fresno to Oakland and Sacramento treated as extensions of HST service; dedicated coach services from San Fernando to Los Angeles Basin destinations, from Fresno to San Jose, and from Emeryville to San Francisco
	10-021	IOS South	Fresno	San Fernando	83% of airfare	Factored 2009 airfares	2005 Fares	24 cents per mile	2030 Pre-Recession Forecast	2	Fresno Amtrak and Fresno HST stations are treated as separate stations	Amtrak (North); Coach (North and South)	Same as 10-012; but double peak service and separate Fresno Stations; bus added to Santa Anita in off-peak
	10-024	IOS South	Merced	San Fernando	83% of airfare	Factored 2009 airfares	2005 Fares	24 cents per mile	2030 Pre-Recession Forecast	3	1 of 3 skip Visalia	Amtrak (North); Coach (North and South)	Amtrak connections from Merced to Oakland and Sacramento treated as extensions of HST service; feeder coach connections from San Fernando to Los Angeles Basin destinations, from Merced to San Jose, and from Emeryville to San Francisco
No. 5	10-010	Bay to Basin	San Jose	LAUS	83% of airfare	Factored 2009 airfares	Inflation adjusted fares based on Caltrain fare chart	24 cents per mile	2030 Pre-Recession Forecast	4	All from San Jose	Caltrain (North)	Caltrain cross-platform transfer at San Jose to San Francisco
No. 6	10-008	Phase 1	San Francisco	Anaheim	83% of airfare	Factored 2009 airfares	2005 Fares	24 cents per mile	2030 Pre-Recession Forecast	7	6 trains from SF; 1 from Merced	N/A	N/A
	10-013 (2030)	Phase 1	San Francisco	Anaheim	83% of airfare	Factored 2009 airfares	2005 Fares	24 cents per mile	2030 W&P Forecast	7	6 trains from SF; 1 from Merced	N/A	N/A
	10-013 (2020)	Phase 1	San Francisco	Anaheim	83% of airfare	Factored 2009 airfares	2005 Fares	24 cents per mile	2030 W&P Forecast	7	6 trains from SF; 1 from Merced	N/A	N/A
	10-013 (2050)	Phase 1	San Francisco	Anaheim	83% of airfare	Factored 2009 airfares	2005 Fares	24 cents per mile	2030 W&P Forecast	7	6 trains from SF; 1 from Merced	N/A	N/A
	10-014a	Phase 1	San Francisco	Anaheim	83% of airfare but capped at $72	Actual 2009 airfares	2005 Fares	24 cents per mile	2030 W&P Forecast	7	6 trains from SF; 1 from Merced	N/A	N/A
	10-014b	Phase 1	San Francisco	Anaheim	83% of airfare but capped at $72	Actual 2009 airfares	2011 Fares	25 cents per mile	2030 W&P Forecast	7	6 trains from SF; 1 from Merced	N/A	N/A
	10-015	Phase 1	San Francisco	Anaheim	83% of airfare but capped at $72	Reduced by 9% from 10-014b	2011 Fares	25 cents per mile	2030 W&P Forecast	7	6 trains from SF; 1 from Merced	N/A	N/A
	10-016	Phase 1	San Francisco	Anaheim	83% of airfare but capped at $69	Reduced by 9% from 10-014b	2011 Fares	25 cents per mile	2030 W&P Forecast	7	6 trains from SF; 1 from Merced	N/A	N/A

a For analysis that began in May 2009, CS factored the 2005 airfares by 8 percent. This reflected typical fare increases on the Bay Area to Los Angeles Basin routes. For analysis that began in May 2011, CS used 2009 fares based on actual fares as reported in the work by Aviation System Consulting, LLC, described in Section 2.1.

Table 5.1 HST Scenario Assumptions (continued)

Memo No.	Run No.	Run Type	North Terminus	South Terminus	HST Fare Policy[a]	Air Fare Policy	CVR Fare Policy	Motor Fuel	Socioeconomic Data (SE)	Peak Trains per Hour (TPH)	Operating Plan Notes	Connection Service	Connection Notes
No. 7	11-026c	Bay to Basin	San Jose	San Fernando	83% of airfare	Actual 2009 airfares	2011 fares except Caltrain between SF-SJ and Metrolink up to LAUS – $0 when riding HST	25 cents per mile	2030 W&P Forecast	5	4 trains from SJ; 1 from Merced	Caltrain (North); Coach (Merced); Coach(South)	Caltrain connection between San Jose and SF 4th and King; dedicated coach service from Merced to Sacramento and from San Fernando to Los Angeles Basin destinations
	11-030b	Bay to Basin	San Jose	San Fernando	83% of airfare	Actual 2009 airfares	2011 fares except Caltrain between SF and SJ – $0 when riding HST	25 cents per mile	2030 W&P Forecast	4	3 trains from SJ; 1 from Merced	Caltrain (North); Coach (Merced); Coach (South)	Caltrain connection between San Jose and SF 4th and King; dedicated coach connections from Merced to Sacramento and SF Transbay, and from San Fernando to Los Angeles Basin destinations
	11-031d	IOS North	San Jose	Bakersfield	83% of airfare	Actual 2009 airfares	2011 fares except Caltrain between SF and SJ – $0 when riding HST	25 cents per mile	2030 W&P Forecast	4	3 trains from SJ; 1 from Merced	Caltrain (North); Coach (Merced); Coach(South)	Caltrain connection between San Jose and SF 4th and King; dedicated coach connections from Merced to Sacramento and SF Transbay, and from Bakersfield to Los Angeles Basin destinations
No. 8	11-027d	IOS South	Merced	Palmdale	83% of airfare	Actual 2009 airfares	2011 fares except Metrolink transfers at Palmdale to Anaheim.	25 cents per mile	2030 W&P Forecast	3	All from Merced; 1 of 3 skip Visalia	Coach (North and South)	dedicated feeder coach connections from Merced to Sacramento, San Francisco, and San Jose; and from Palmdale to Los Angeles Basin destinations; 15 minutes coach service transfer time
	11-028d	IOS South	Merced	San Fernando	83% of airfare	Actual 2009 airfares	2011 Amtrak and Metrolink Fares	25 cents per mile	2030 W&P Forecast	3	All from Merced; 1 of 3 skip Visalia	Coach (North and South)	dedicated coach connections from Merced to Sacramento, San Francisco, and San Jose; and from San Fernando to Los Angeles Basin destinations; 15 minutes coach service transfer time
No. 9	11-017c	Phase 1	San Francisco	Anaheim	83% of airfare but capped at $72	Actual 2009 airfares	2011 Fares	25 cents per mile	2030 Moody's Analytics Forecast	7	6 trains from SF; 1 from Merced	N/A	N/A

a For analysis that began in May 2009, CS factored the 2005 airfares by 8 percent. This reflected typical fare increases on the Bay Area to Los Angeles Basin routes. For analysis that began in May 2011, CS used 2009 fares based on actual fares as reported in the work by Aviation System Consulting, LLC, described in Section 2.1.

Table 5.2 HST Ridership and Revenue Forecasts

						HST Systemwide		Interregional		Interregional Percent Change		
Memo No.	Run No.	Run Type	North Terminus	South Terminus	Compared to	Ridership (Millions)	Revenue (Millions)	Ridership (Millions)	Revenue (Millions)	Ridership	Revenue	Summary of Results
No. 1	10-001	Phase 1	SF Transbay	Anaheim	May 2009 Phase I	55.9	$2,308	42	$2,126	4.20%	-2.60%	Systemwide and interregional ridership increases due to higher capture of recreation/other trips. Recreation/other trips are highly sensitive to price, while business/commute trips are more likely to pay a higher price to travel at convenient times.
	10-002	Phase 1	SF Transbay	Anaheim	Full	92.4	$3,810	73.7	$3,596	0.10%	-2.60%	With the peninsula stop eliminated, travel times through the Redwood City area shorten by five minutes. This increases ridership in long-distance markets.
	10-003	IOS North	SF Transbay	Bakersfield	N/A	15.7	$524	11.2	$474	N/A	N/A	Limited IOS system results in considerably lower ridership and revenue compared to May 2009 Phase I system – loss of express service between SF Transbay and San Jose results in lower frequency of service and higher travel times for intraregional Bay Area trips.
	10-004	IOS North	SF 4th/King	Bakersfield	10-003	11.8	$432	10	$412	-11%	-13%	Limited service and longer run times to San Francisco drive lower ridership.
	10-005	IOS North	SF 4th/King	Bakersfield	10-003	7.6	$501	7.1	$490	-37%	3%	Higher fares, lower frequencies, longer Bay Area run times, and lower connectivity reduces interregional and intraregional ridership.
No. 2	10-006	IOS North	SF 4th/King	Bakersfield	10-005	11.4	$802	10.9	$790	54%	61%	Dedicated coach service to Los Angeles Basin boosts ridership.
	10-007	IOS North	Merced	Bakersfield	N/A	13.4	$683	13.4	$683	N/A	N/A	Amtrak feeder services to Oakland and Sacramento provide only minor offset to loss of San Francisco terminus. Elimination of Bay Area HST stations contributes to significant reduction in interregional travel to/from the Bay Area.
	10-009	IOS North	San Jose	Bakersfield	10-006	10.1	$705	10.0	$702	-8%	-11%	Elimination of HST service to San Francisco reduces interregional HST trips.
	10-022	IOS North	San Jose	Bakersfield	10-009	11.4	$746	10.2	$737	2%	5%	The addition of the Merced HST station and transfer options to Sacramento via the Amtrak San Joaquin Valley line increases interregional ridership.
No. 3	10-011	IOS South	Fresno	Palmdale	10-007	8.3	$779	8.3	$779	22%	41%	Service extension to Palmdale and Amtrak service frequency enhancement increases ridership.
	10-020	IOS South	Fresno	Palmdale	10-011	7.7	$717	7.7	$717	-7%	-8%	Split HST and Amtrak stations lower interregional ridership (there is 15-minute increase in transfer time for passengers transferring from HST to Amtrak in Fresno).
	10-023	IOS South	Merced	Palmdale	10-007	13.1	$1,209	13.1	$1,209	93%	120%	Service Extension to Palmdale and the doubling of peak-hour service frequency drive ridership gains.
No. 4	10-012	IOS South	Fresno	San Fernando	10-007	10.4	$817	9.4	$801	38%	46%	Service extensions south to San Fernando and improvements in Amtrak service boost ridership. Another contributing factor is the inclusion of Amtrak stations in the San Joaquin Valley, specifically at Merced and Madera.
	10-021	IOS South	Fresno	San Fernando	10-012	10.9	$930	9.9	$912	5%	14%	Improved frequency drives interregional ridership increase.
	10-024	IOS South	Merced	San Fernando	10-023	16.4	$1,439	15.4	$1,421	18%	18%	Service extension into San Fernando Valley and frequency increase drive gains.
No. 5	10-010	Bay to Basin	San Jose	LAUS	10-009	21.4	$1,686	18.9	$1,633	89%	133%	Service extensions south to Los Angeles Union Station and improvements in HST service boost ridership.

Table 5.2 HST Ridership and Revenue Forecasts (continued)

Memo No.	Run No.	Run Type	North Terminus	South Terminus	Compared to	HST Systemwide Ridership (Millions)	HST Systemwide Revenue (Millions)	Interregional Ridership (Millions)	Interregional Revenue (Millions)	Interregional Percent Change Ridership	Interregional Percent Change Revenue	Summary of Results
No. 6	10-008	Phase 1	San Francisco	Anaheim	Phase I	31.6	$2,234	24.3	$2,062	-40.0%	-8.0%	Decrease in service frequency and increase in HST fares reduce ridership.
	10-013 (2030)	Phase 1	San Francisco	Anaheim	10-008	31.9	$2,253	24.7	$2,085	1.0%	1.0%	New Geographic Distribution of Population and Employment Increases Ridership – the growth in interregional HST travel results from an increase in population within the Bay Area and coastal California, offsetting a decrease in population and employment in other parts of California.
	10-013 (2020)	Phase 1	San Francisco	Anaheim	10-013 (2030)	28.6	$1,970	21.3	$1,799	-14.0%	-14.0%	Lower population results in a decrease in total trips. Lower auto congestion results in a greater decrease in HST trips.
	10-013 (2050)	Phase 1	San Francisco	Anaheim	10-013 (2030)	35.6	$2,574	28.5	$2,409	15.0%	16.0%	Increase in population results in an increase in total trips; Higher auto congestion results in a greater increase in HST trips; Changes in geographic distribution of population decreases ridership.
	10-014a	Phase 1	San Francisco	Anaheim	10-013 (2030)	35.2	$2,198	27.8	$2,027	13.0%	-3.0%	The increase in interregional HST travel is due to the decrease in service frequency between major airports and lower HST fares for several HST station pairs.
	10-014b	Phase 1	San Francisco	Anaheim	10-014A	37.1	$2,307	28.6	$2,108	3.0%	4.0%	Lower conventional rail service between long-distance markets and increased auto costs drive higher HST ridership.
	10-015	Phase 1	San Francisco	Anaheim	10-014b	36.2	$2,239	27.8	$2,040	-3.0%	-3.0%	Reduction in airfare increases air ridership at the expense of HST ridership.
	10-016	Phase 1	San Francisco	Anaheim	10-015	36.9	$2,230	28.5	$2,030	3.0%	~0%	Decrease in HST fare cap increases interregional ridership.
No. 7	11-026c	Bay to Basin	San Jose	San Fernando	10-014b	20.5	$1,505	20	$1,492	-30.0%	-29.0%	Elimination of HST stations in Bay Area and Los Angeles Basin negatively affects interregional and intraregional travels (transfer times to Caltrain or to dedicated coach services makes HST less attractive).
	11-030b	Bay to Basin	San Jose	San Fernando	11-026c	20.6	$1,508	20.2	$1,496	1.0%	0.2%	Service changes result in slightly higher ridership (frequencies at Gilroy, Fresno, Visalia, Bakersfield, and Palmdale increase by one TPH during peak periods due to operating plan changes).
	11-031d	IOS North	San Jose	Bakersfield	11-030b	11.5	$768	11.4	$768	-44.0%	-49.0%	The elimination of HST stations at Palmdale and San Fernando decreases interregional trips by 44 percent. This service reduction causes average travel times to Los Angeles Basin destinations to increase by more than 250 percent, making HST a significantly less attractive option to affected passengers.
No. 8	11-027d	IOS South	Merced	Palmdale	11-026c	10.8	$783	10.8	$783	-46.0%	-48.0%	The elimination of HST access points at San Jose, Gilroy and San Fernando, and increases in average headways, reduce interregional ridership by 46 percent.
	11-028d	IOS South	Merced	San Fernando	11-027d	13.1	$929	12.7	$917	18.0%	17.0%	HST service extension to San Fernando boosts ridership.
No. 9	11-017c	Phase 1	San Francisco	Anaheim	10-014b	27.7	$1,689	21.3	$1,532	-26.0%	-27.0%	Changes in socioeconomic data and trip rates reduce interregional ridership. The revised SE data resulted in slightly lower households and significantly lower employment.

5.2 HST FARE AND SERVICE ASSUMPTIONS

HST fares for the scenarios used to develop the 2012 Business Plan were all based on the following formula:

- For station pairs between the San Francisco Bay Area and the Los Angeles Basin: 83 percent of the passenger-weighted average of airfares between the San Francisco Bay Area and the Los Angeles Basin. This was $72 in 2005 dollars.
- For other station pairs:
  - $26.89 + $0.1614 per mile (in 2005 dollars) for interregional fares;
  - $19.72 + $0.1345 per mile (in 2005 dollars) for intraregional fares for SCAG region; and
  - $12.55 + $0.1076 per mile (in 2005 dollars) for intraregional fares for MTC and SANDAG regions.

  Fares for three movements were capped at $72 so that they would not be higher than the Bay Area to Los Angeles Basin movements.

The resultant fares in 2005 dollars are shown in Table 5.3. Stopping patterns for each of the scenarios used in the 2012 Business Plan are provided in the memos included in Appendix D.

Table 5.3 Assumed HST Fares
2005 Dollars

HST Stations	San Francisco (Transbay)	Millbrae	Redwood City	San Jose	Gilroy	Merced	Fresno	Visalia	Bakersfield	Palmdale	San Fernando	Los Angeles Union Station	Norwalk	Anaheim
San Francisco (Transbay)		14	15	18	20	48	57	63	72	72	72	72	72	72
Millbrae			14	16	19	48	57	62	72	72	72	72	72	72
Redwood City				15	18	47	55	60	71	72	72	72	72	72
San Jose					15	45	51	56	67	72	72	72	72	72
Gilroy						42	48	53	63	72	72	72	72	72
Merced							36	42	55	69	70	72	72	72
Fresno								33	45	59	60	63	65	68
Visalia									41	55	56	59	61	63
Bakersfield										41	42	45	47	49
Palmdale											26	27	28	30
San Fernando												22	24	26
Los Angeles Union Station													22	24
Norwalk														22
Anaheim														

Source: Parsons Brinckerhoff.

Notes: $72 Fare constrained to $72.
$72 Fare for San Francisco Bay Area to Los Angeles Basin.

5.3 FINDINGS FROM SCENARIOS USED IN BUSINESS PLAN

A summary table of key estimates from the scenarios used in the business plan is provided in Table 5.4.

Phase 1

Two of the CS model runs were used in the business plan. The first, labeled 10-014b, updated the conventional rail operating plans and auto operating costs to current conditions while keeping other elements of the analysis from the past constant. The second, labeled 10-017c, was identical except that it:

- Introduced revised assumptions related to socioeconomic growth to 2030 from forecasts purchased from Moody's Analytics; and
- Reflected revised trip frequency assumptions based on the survey conducted in 2011.

In addition to providing information on expected ridership and revenue for Phase 1, the Program Manager used the ratio between runs 10-014b and 10-017c to apply to the other phasing scenarios to reflect the socioeconomic and trip frequency changes in those scenarios.

10-014b – Phase 1 with Updated Conventional Rail Operation Plans and Auto Costs

Run Details

- **Limits:** San Francisco and Merced to Anaheim.
- **HST stations:** SF Transbay, SF 4th and King, Millbrae, Redwood City, San Jose, Gilroy, Merced, Fresno, Visalia, Bakersfield, Palmdale, San Fernando Valley, Los Angeles Union Station, Norwalk, Anaheim.
- **Hourly peak trains:** five between San Francisco and Los Angeles; three between San Francisco and Anaheim; one between San Francisco and Merced; and one from Merced to Los Angeles.
- **Fares:**
  - **Air:** Updated to reflect 2009 conditions; and
  - **HST:** 83 percent of average airfare, capped at $72.
- Auto operating costs: 25 cents per mile.
- Socioeconomic data: 2030 W&P forecast,
- Trip Frequency Assumptions: Original.

Ridership and Revenue Estimates

Systemwide annual ridership in 2030 for this phase/scenario is estimated to be 37.1 million passengers generating $2.3 billion in revenue (2010 dollars) (Table 5.4). Estimated average weekday boardings at each station and their estimated access modes are shown in Table 5.5. The busiest stations are expected to be the two end-of-line stations (San Francisco Transbay and Anaheim), with significant boardings also expected at Los Angeles Union Station, Palmdale, and San Jose.

11-017c – Phase 1 with Updated Socioeconomic Forecasts and Trip Frequency Estimates

Run 11-017c is identical to run 10-014b but underlying trip rate data is updated using a new socioeconomic data based on 2011 Moody's Analytics forecasts and trip rates based on the trip frequency survey conducted in 2011.

11-017c Run Details

- **Limits:** San Francisco and Merced to Anaheim.
- **HST stations**: SF Transbay, SF 4th and King, Millbrae, Redwood City, San Jose, Gilroy, Merced, Fresno, Visalia, Bakersfield, Palmdale, San Fernando Valley, Los Angeles Union Station, Norwalk, Anaheim.
- **Hourly peak trains:** five between San Francisco and Los Angeles; three between San Francisco and Anaheim; one between San Francisco and Merced; and one from Merced to Los Angeles.
- **Fares:**
  - **Air**: Updated to reflect 2009 conditions, and
  - **HST:** 83 percent of average airfare, capped at $72.
- **Auto operating costs:** 25 cents per mile.
- **Socioeconomic data**: Updated to reflect 2011 Moody's Analytics forecast.
- **Trip Frequency Assumptions:** Updated to reflect 2011 survey.

Ridership and Revenue Estimates

Systemwide annual ridership in 2030 for this scenario is estimated to be 27.7 million passengers – about 75 percent of the amount in Scenario 10-014b (Table 5.7). Annual revenue in 2030 is estimated at $1.7 billion, about 74 percent of the Scenario 10-014b amount. Estimated average weekday boardings at each station and their estimated access modes are shown in Table 5.8, with similar patterns to those from Scenario 10-014b.

Table 5.4 Forecast 2030 Annual Region-to-Region Ridership and Revenue
(Millions; Revenue in 2010 Dollars)

	10-014b – San Francisco to Anaheim (Updated Conventional Rail Operation Plans and Auto Costs) Scenario		11-017c – Moody's Analytics SE Data Scenario		11-026c – San Jose to San Fernando (Five TPH) Scenario		11-028d Merced to San Fernando Scenario		11-031d – San Jose to Bakersfield Scenario	
Market	**HST Ridership**	**HST Revenue**	**HST Ridership**	**HST Revenue**	**HST Ridership**	**HST Revenue**	**HST Ridership**	**HST Revenue**	**HST Ridership**	**HST Revenue**
Los Angeles Basin – Sacramento	1.8	$143	1.1	$89	0.5	$40	0.9	$69	0.4	$25
Los Angeles Basin – San Diego	0.1	$4	1.2	$39	0.0	$1	0.0	$1	0.0	$0
Los Angeles Basin – Bay Area	8.5	$685	6.7	$540	6.8	$553	2.4	$188	3.2	$240
Sacramento – Bay Area	0.0	$0	0.0	$0	0.0	$0	0.0	$0	0.0	$0
San Diego – Sacramento	0.0	$2	0.0	$2	0.0	$0	0.0	$0	0.0	$0
San Diego – Bay Area	1.9	$153	1.7	$139	0.3	$26	0.1	$9	0.1	$5
Bay Area – San Joaquin Valley	5.5	$396	2.8	$197	4.1	$292	0.8	$51	4.1	$286
San Joaquin Valley – Los Angeles Basin	5.2	$362	4.7	$319	4.0	$281	5.6	$405	1.6	$99
Sacramento – San Joaquin Valley	0.4	$32	0.0	$4	0.2	$11	0.4	$24	0.2	$10
San Diego – San Joaquin Valley	0.1	$4	0.0	$1	0.0	$2	0.0	$2	0.0	$1
Within Bay Area Peninsula	3.3	$59	1.5	$27	0.0	$0	0.0	$0	0.0	$1
Within North Los Angeles Basin	1.5	$44	1.5	$42	0.4	$12	0.4	$12	0.0	$0
Within South Los Angeles Basin	1.2	$28	1.0	$25	0.0	$0	0.0	$0	0.0	$0
North Los Angeles – South Los Angeles	2.5	$67	2.4	$63	0.0	$0	0.0	$0	0.0	$0
Within San Diego region	0.0	$0	0.0	$0	0.0	$0	0.0	$0	0.0	$0
Within San Joaquin Valley	0.5	$32	0.1	$5	0.7	$40	1.1	$59	0.6	$33
Other	4.6	$295	2.9	$198	3.3	$247	1.4	$107	1.2	$68
Total	**37.1**	**$2,307**	**27.7**	**$1,689**	**20.5**	**$1,505**	**13.1**	**$929**	**11.5**	**$768**
Within entire Los Angeles Basin	5.2	$140	4.9	$130	0.4	$12	0.4	$12	0.0	$0
Within entire MTC	3.3	$59	1.5	$27	0.0	$0	0.0	$0	0.03	$0.5
Total between Regions	**28.6**	**$2,108**	**21.3**	**$1,532**	**20.0**	**$1,492**	**12.7**	**$917**	**11.4**	**$768**

Source: Cambridge Systematics, Inc.

Table 5.5 2030 Annual HST Ridership and Revenue Estimates
Phase 1 with Updated CVR Operating Plans and Auto Costs: Scenario 10-014b (Millions)

	Ridership	Revenue (2010 Dollars)
Systemwide	37.1	$2,307
Interregional	28.6	$2,108
Intraregional	8.5	$199

Source: Cambridge Systematics, Inc.

Table 5.6 2030 Average Weekday HST Boardings by Access Mode
Phase 1 with Updated CVR Operating Plans and Auto Costs: Scenario 10-014b

Station Name	Pick Up/ Drop Off	Drive Parked Vehicle	Rental Car	Taxi	Transit/ Shuttle	Bike/ Walk/ Other	Station Boardings
San Francisco (Transbay)	3,860	3,530	1,930	2,340	7,020	7,320	26,000
San Francisco (4th and King)	90	40	90	100	210	170	700
Millbrae	490	670	250	250	610	520	2,800
Redwood City	840	890	260	220	270	310	2,800
San Jose	1,370	1,750	630	600	1,640	1,410	7,400
Gilroy	1,470	2,230	170	280	150	100	4,400
Merced	1,280	2,000	350	320	410	230	4,600
Fresno	1,020	1,350	270	170	250	130	3,200
Visalia	460	590	120	70	110	60	1,400
Bakersfield	1,710	2,290	450	300	420	220	5,400
Palmdale	2,820	4,000	280	450	270	180	8,000
San Fernando Valley	1,460	1,850	110	170	130	90	3,800
Los Angeles Union Station	1,610	1,830	800	960	2,840	2,950	11,000
Norwalk	1,590	2,010	590	530	680	700	6,100
Anaheim	5,130	6,910	1,970	1,830	2,460	2,410	20,700
Total	**25,200**	**31,940**	**8,270**	**8,590**	**17,470**	**16,800**	**108,300**

Source: Cambridge Systematics, Inc.

Table 5.7 2030 Annual Ridership and Revenue Estimates
Phase 1 with Updated Socioeconomic Forecasts and Trip Frequency Estimates: Scenario 10-017c (Millions)

	HST Ridership	HST Revenue
Systemwide	27.7	$1,689
Interregional	21.3	$1,532
Intraregional	6.4	$156

Source: Cambridge Systematics, Inc.

Table 5.8 2030 Average Weekday Trips by Access Mode
Phase 1 with Updated Socioeconomic Forecasts and Trip Frequency Estimates: Scenario 10-017c

Station Name	Pick Up/ Drop Off	Drive Parked Vehicle	Rental Car	Taxi	Transit/ Shuttle	Bike/ Walk/ Other	Station Boardings
San Francisco (Transbay)	2,520	2,250	1,380	1,660	4,230	4,260	16,300
San Francisco (4th and King)	60	10	80	60	50	40	300
Millbrae	310	380	180	150	310	270	1,600
Redwood City	530	500	170	130	160	210	1,700
San Jose	850	960	430	350	910	800	4,300
Gilroy	1,140	1,260	50	70	110	70	2,700
Merced	1,210	1,300	310	100	200	90	3,200
Fresno	1,050	1,070	270	70	170	70	2,700
Visalia	510	510	130	30	80	40	1,300
Bakersfield	1,070	1,130	270	80	170	80	2,800
Palmdale	2,960	3,120	110	150	280	180	6,800
San Fernando Valley	1,410	1,530	60	80	130	90	3,300
Los Angeles Union Station	1,610	1,620	810	890	2,720	2,740	10,400
Norwalk	1,620	1,690	630	460	480	630	5,500
Anaheim	5,410	5,640	2,100	1,520	1,620	2,100	18,400
Total	**22,260**	**22,970**	**6,980**	**5,800**	**11,620**	**11,670**	**81,300**

Source: Cambridge Systematics, Inc.

Initial Operating Segment (IOS) – North

Scenario 11-031d – San Jose to Bakersfield

Scenario featuring three peak TPH between San Jose and Bakersfield; one peak TPH between Merced and Bakersfield; Caltrain connection between San Jose and SF 4th and King; dedicated coach connections from Merced to Sacramento and SF Transbay, and from Bakersfield to Los Angeles Basin destinations.

Run Details

- **Limits:** San Jose and Merced to Bakersfield.
- **HST stations**: San Jose, Gilroy, Merced, Fresno, Visalia, Bakersfield.
- **Hourly peak HST trains:** three between San Jose and Bakersfield; one between Merced and Bakersfield.
- **Connections:**
  - Caltrain connection between San Jose and SF 4th and King, and
  - Dedicated coach connections from Merced to Sacramento and SF Transbay, and from Bakersfield to Los Angeles Basin destinations.
- **Fares:**
  - **Air:** Updated to reflect 2009 conditions, and
  - **HST:** 83 percent of average airfare, capped at $72.
- **Auto operating costs:** 25 cents per mile.
- **Socioeconomic data:** 2030 W&P forecast.
- **Trip Frequency Assumptions:** Original.

11-031d Ridership and Revenue Estimates

Systemwide annual ridership in 2030 for this scenario is estimated to be 11.5 million passengers (Table 5.9) – about 31 percent of that estimated for Phase 1 in Scenario 10-014b. Annual revenue in 2030 is estimated at $768 million, about 33 percent of Scenario 10-014b. Estimated average weekday boardings at each station and their estimated access modes are shown in Table 5.10, with the biggest expected boardings at the termini, and the largest interim station at Merced.

Table 5.9 2030 Annual HST Ridership and Revenue Estimates
IOS North: San Jose to Bakersfield: Scenario 11-031d (Millions)

	Ridership	Revenue
Systemwide	11.5	$768
Interregional	11.4	$768
Intraregional	0.03	$0.5

Source: Cambridge Systematics, Inc.

Table 5.10 2030 Average Weekday HST Boardings by Access Mode
IOS North: San Jose to Bakersfield: Scenario 11-031d

Station Name	Pick Up/ Drop Off	Drive Parked Vehicle	Rental Car	Taxi	Transit/ Shuttle	Bike/Walk/ Other	Station Boardings
San Jose	1,500	1,930	830	1,070	2,680	2,990	11,000
Gilroy	350	700	80	140	70	60	1,400
Merced	770	1,580	280	400	550	420	4,000
Fresno	580	760	160	130	220	150	2,000
Visalia	30	40	10	10	10	10	100
Bakersfield	3,400	5,110	1,040	1,030	1,530	1,100	13,200
Total	**6,630**	**10,120**	**2,400**	**2,780**	**5,060**	**4,730**	**31,700**

Source: Cambridge Systematics, Inc.

Initial Operating Segment (IOS) – South

Scenario 11-028d – Merced to San Fernando

Scenario featuring three peak TPH between Merced and San Fernando;

Run Details

- **Limits:** Merced to San Fernando
- **HST stations:** Merced, Fresno, Visalia, Bakersfield, Palmdale, San Fernando
- **Hourly peak**: Three, with one that skips Visalia
- **Fares:**
  - **Air:** Updated to reflect 2009 conditions
  - **HST:** 83 percent of average airfare, capped at $72
- **Connections:**
  - Dedicated coach connections from Merced to Sacramento, San Francisco, and San Jose; and from San Fernando to Los Angeles Basin destinations.
- **Auto operating costs:** 25 cents per mile
- **Socioeconomic data:** 2030 W&P forecast
- **Trip Frequency Assumptions:** Original

Ridership and Revenue Estimates

Systemwide annual ridership in 2030 for this scenario is estimated to be 13.1 million passengers (Table 5.11) – about 14 percent greater than that estimated for the IOS North scenario (11-031d). Annual revenue in 2030 is estimated at $929 million, about 21 percent higher than IOS North. Estimated average weekday boardings at each station and their estimated access modes are shown in Table 5.12, with the biggest expected boardings at the termini, and similar numbers of boardings at Bakersfield, Fresno, and Palmdale, and considerably less at Visalia.

Table 5.11 2030 Annual HST Ridership and Revenue Estimates
IOS South: Merced to San Fernando: Scenario 11-028d (Millions)

	Ridership	Revenue
Systemwide	13.1	$929
Interregional	12.7	$917
Intraregional	0.4	$12

Source: Cambridge Systematics, Inc.

Table 5.12 2030 Average Weekday Boardings Access Mode
IOS South: Merced to San Fernando: Scenario 11-028d

Station Name	Pick Up/ Drop Off	Drive Parked Vehicle	Rental Car	Taxi	Transit/ Shuttle	Bike/Walk/ Other	Station Boardings
Merced	2,000	3,970	1,190	1,410	3,150	2,690	14,400
Fresno	330	570	190	190	440	380	2,100
Visalia	20	30	10	10	20	10	100
Bakersfield	360	660	210	220	510	430	2,400
Palmdale	600	1,150	180	300	270	290	2,800
San Fernando	2,810	5,690	910	1,510	1,290	1,380	13,600
Total	**6,120**	**12,070**	**2,690**	**3,640**	**5,680**	**5,180**	**35,400**

Source Cambridge Systematics, Inc.

Bay to Basin

Scenario 11-026c – San Jose to San Fernando

Run Details

- **Limits:** San Jose and Merced to San Fernando.
- **HST stations:** San Jose, Gilroy, Merced, Fresno, Visalia, Bakersfield, Palmdale, San Fernando.
- **Hourly peak trains:** four between San Jose and San Fernando; one between Merced and San Fernando.
- **Fares:**
  - **Air**: Updated to reflect 2009 conditions; and
  - **HST**: 83 percent of average airfare, capped at $72.

- **Connections:**
  - Caltrain connection between San Jose and San Francisco 4th and King; and
  - Dedicated coach connections from Merced to Sacramento and from San Fernando to Los Angeles Basin destinations.
- **Auto operating costs:** 25 cents per mile.
- **Socioeconomic data:** 2030 W&P forecast.
- **Trip Frequency Assumptions:** Original.

Ridership and Revenue Estimates

Systemwide annual ridership in 2030 for this scenario is estimated to be 20.5 million passengers (Table 5.13) – about 55 percent of that estimated for the Phase 1 scenario (10-014b).Annual revenue in 2030 is estimated at $1.5 billion, about 65 percent of the revenue expected from Scenario 10-014b. Estimated average weekday boardings at each station and their estimated access modes are shown in Table 5.14, with the biggest expected boardings at the termini, with the next highest amount at Merced.

Table 5.13 2030 Annual HST Ridership and Revenue Estimates
Bay to Basin – San Jose to San Fernando: Scenario 11-026c (Millions)

	Ridership	Revenue
Systemwide	20.5	$1,505
Interregional	20.0	$1,492
Intraregional	0.4	$12

Source Cambridge Systematics, Inc.

Table 5.14 2030 Average Weekday HST Boardings by Access Mode
Bay to Basin – San Jose to San Fernando: Scenario 11-026c

Station Name	Pick Up/ Drop Off	Drive Parked Vehicle	Rental Car	Taxi	Transit/ Shuttle	Bike/Walk/ Other	Station Boardings
San Jose	1,900	2,240	1,610	1,600	4,770	5,190	17,300
Gilroy	610	1,040	130	220	160	140	2,300
Merced	1,200	2,070	580	550	1,160	830	6,400
Fresno	700	900	320	180	410	280	2,800
Visalia	30	30	10	10	10	10	100
Bakersfield	1,160	1,450	530	290	640	430	4,500
Palmdale	1,400	1,860	180	300	300	250	4,300
San Fernando	5,710	8,270	890	1,480	1,320	1,120	18,800
Total	**12,710**	**17,860**	**4,250**	**4,630**	**8,770**	**8,250**	**56,500**

Source: Cambridge Systematics, Inc.

6.0 Forecasts for Business Plan

The Program Manager used the forecasts from the ridership and revenue (R&R) model runs prepared by CS as the starting point for developing forecasts for use in the Business Plan, consulting with CS on the appropriate use of the model output. This section describes the process used to estimate ridership and revenue for business plan scenarios from the model runs prepared by CS, covering these elements:

- Final adjustments to the operating plan;
- Addition of airport access travel not forecast by R&R model;
- Creating scenario ranges; and
- Adjusting to the assumed start up dates of each phase.

6.1 FINAL ADJUSTMENTS TO THE OPERATING PLANS

Each scenario's ridership was used to develop a detailed version of the operating plan to verify that sufficient high-speed train and feeder coach capacity was provided to handle the forecast loads during the two daily peak periods as well as the 10 off-peak hours. In the course of this work, PB identified opportunities to improve load factors by turning back or reducing service where loads were light, as well as situations where additional train sets were needed to provide sufficient capacity primarily in peak hours, but also in some off-peak hours. The effect from frequency changes was estimated using the sensitivities demonstrated in the report to the Peer Review Panel of June 8, 2011. The following specific adjustments were made to the operating plans, with a summary in Table 6.1:

- IOS South – Between Merced and the San Fernando Valley station, two additional trains were added for the total of both peak periods in each direction, up from eight trains in the forecast.
- IOS North – No changes were added to the IOS North pattern.
- Bay to Basin – Two additional trains were added for each peak period in each direction, up from five trains, and five additional trains in each peak period were added to San Jose, up from eight trains in the forecast. In the off-peak, one additional train per hour was added to San Jose bringing the total to three trains per hour from the two previously.
- Phase 1 – Two additional trains were added in each peak hour between Los Angeles and San Jose, bringing the total to seven per hour. However, these two trains were not added for capacity north of San Jose, so they were assumed to turn around at San Jose, leaving service to San Francisco at five

trains per hour. In the off-peak, one additional train per hour was needed to Merced, bringing the total to two. With very low load factors because of the transfers required and strong Capitol Corridor and San Joaquin conventional rail service, direct HST service between San Francisco and Merced was assumed to be deferred until service could run through to the North San Joaquin Valley and Sacramento.

In addition, the Program Manager estimated the effect of providing dedicated feeder coach service for each HST in Phase 1 between Sacramento and Merced and points in between by applying the observed percentage changes in IOS scenarios with and without feeder services to the affected markets in Phase 1.

Table 6.1 Adjustments Made for Operating Plan Improvements
2030

Implementation Phase	Annual Riders (in Millions)			Annual Revenue (2010 Dollars in Millions)		
	Model	Change	Revised	Model	Change	Revised
IOS South	12.8	+0.5	13.3	$904	+$46	$950
IOS North	10.7	–	10.7	$710	–	$710
Bay to Basin	20.7	+2.0	22.7	$1,512	+148	$1,660
Phase 1	37.1	+3.7	41.8	$2,307	+$135	$2,572

Source: Parsons Brinckerhoff.

6.2 ADDITION OF AIRPORT ACCESS TRAVEL NOT FORECAST BY R&R MODEL

The R&R model does not forecast HST traffic to and from airports. The team analyzing alternatives in the San Jose to San Francisco corridor identified access to SFO at the Millbrae stop as a potentially significant market, and it was examined in consultation with the team and regional planners.

The SFO airport in 2009 handled 14 million airline passengers originating in the Bay Area, or about 56,800 on an average weekday. Roughly 10 percent of the passengers used BART, Caltrain at Millbrae, or public buses to access the airport, with vans and shuttles bringing another 18 percent. By 2035, Bay Area originating passengers are forecast to increase to 25 million. The regional distribution of passenger origins for 2009 was modified for 2035 to reflect differences in expected growth in the Bay Area. Diversion of access trips to HST was then estimated, ranging from less than 2 percent for the North Bay to 11 percent for the South Bay.

The total passengers using HST to reach Millbrae to access SFO was two million short-distance riders annually in 2030 and $36 million in revenue (2010 dollars).

6.3 CREATING SCENARIO RANGES

The range of ridership and revenue forecasts developed for the business plan were built by testing reasonable variations in assumptions related to four key variables:

- Population growth to 2040 and beyond;
- Changes in, or variations over time in the types of trips that are being made in the corridor, such as long versus short and business/commuter or recreation/other;
- Motor fuel prices and auto fleet efficiency; and
- Airfares.

The Program Manager developed three ridership and revenue scenarios representing relatively wide range of inputs and assumptions. The three scenarios are defined by combinations of assumptions that range from favorable (for "high") and less favorable (for "low"). The high to low scenarios represent a range of likely outcomes, but they are not the highest and lowest outcomes possible.

The range of values for the key variable inputs and assumptions discussed above are shown in Table 6.2 along with the data sources for the high and low end of the range for each. Details of how these ranges were developed are provided in the subsections that follow.

Table 6.2 Variable Input Range

Variable	High	Low	Sources
2040 California Population	49.5 million	44.6 million	High – Woods and Poole, 2011 Low – Woods and Poole, 2011, less 10 percent
Airfares (in relation to 2009 fares)	+16%	-9%	Aviation System Consulting, LLC, 2011
Driving Costs	+10%	-20%	Program Manager assumptions
Trip-Making Patterns	Favorable	Unfavorable	High – Surveys made 2000-2005 Low – Survey made in May 2011

Source: Parsons Brinckerhoff.

Because the four variables are not entirely dependent on each other, i.e. lower population growth will not necessarily drive airline fares lower, and higher driving costs will not necessarily be accompanied by changes in underlying travel patterns favorable to HST, the Program Manager and the Financial Advisor judged that a reasonable range of scenarios to test for the business plan would not extend to the most optimistic or pessimistic end.

The Business Plan scenario range was produced by taking the upper and lower ends of the population growth and the trip-making patterns, while holding air fares and the cost of driving constant. The high end of the range thus created is 48 percent above the low, with the medium scenario the average of the two. A similar range would be produced by other combinations of varied inputs, such as changing the travel factors while holding the other inputs steady, or varying all the variable inputs to less than their full extent.

As part of the 2012/13 work for the ridership upgrade, a probability-based analysis is planned as part of a risk analysis that will produce a more nuanced range of forecasts with associated numerical levels of confidence.

A variety of events could occur which could push the outcomes higher or lower than the range of forecasts used in the business plan. Examples of events that might cause higher ridership include higher fuel prices for automobiles, tolling and/or time of day pricing for highways, more severe highway congestion than assumed, higher air fares, more onerous airport security screening than in place today, more favorable urban development patterns with greater infill around high-speed train stations and transit-oriented development, more extensions of public rapid transit as the result of the passage of Measure R in Los Angeles and similar efforts in other California cities, and greater population and economic growth than assumed.

Examples of events that could cause lower ridership include security screening at HST stations, slower than expected or less frequent HST service, new modal competition such as luxury buses or cars that drive themselves, changes in trip making patterns due to changes in the relationship between jobs and population (the latter described in Appendix B), and lower population and economic growth than assumed.

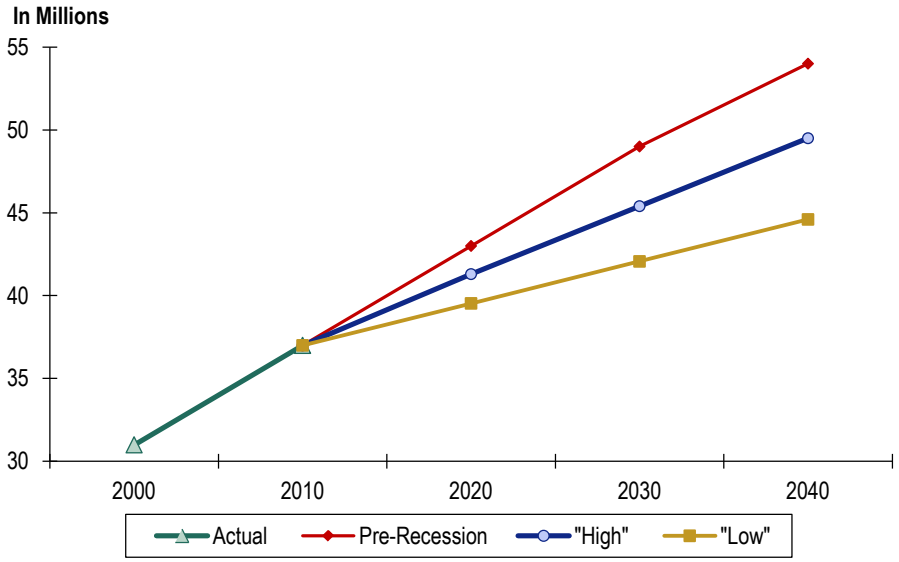
Population Growth to 2040 and Beyond

California has grown from 30 to 37 million residents between 1990 and 2010, and its economy has grown as well.[6] California is forecast to continue its growth but at a slower rate than before the recession of 2007-2009. Figure 6.1 shows how population grew from 2000 to 2010 as well as three potential scenarios for growth through 2040. One of the scenarios is that used in the prior business plan

[6] U.S. Census Bureau.

(labeled "prerecession." The "high" and "low" scenarios account for changes brought about by the recession. The prerecession estimate assumed about 54 million people in California by 2040. The updated high scenario used for this Business Plan assumed about 49.5 million, and the low scenario assumes about 44.6 million. The Business Plan's Medium scenario assumes population growth midway between the two.

Figure 6.1 California Population
Actual and Forecast through 2040



Source: Parsons Brinckerhoff.

Trip-Making Patterns in California

An important element in future potential ridership and revenue on the HST system is the frequency and type of the trips that have a potential to use the service. Both CS and the peer review panel identified this as an important risk factor to be recognized in the forecasts. CS conducted a new survey of medium- and long-distance trip making at the same time scenario forecasts were being developed (see Section 2.0.)

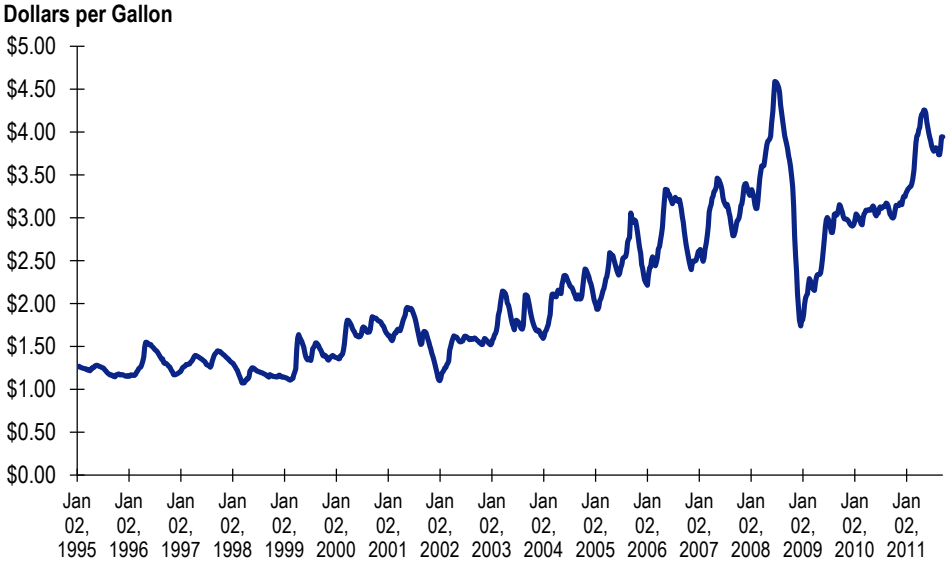
This change in trip pattern resulted in a lower HST forecast since personal and other trips tend to be made by groups who prefer to drive. It is unclear whether this trend represents a long-term change, is a product of the current economic climate, or is simply a result of different surveying techniques.

For use in the Business Plan, the high scenario uses the previous mix of trips, which is characterized in the exhibits that follow as "favorable." The low scenario uses the 2011 survey results and is characterized as "unfavorable." The Medium lies midway between.

Motor Fuel Prices and Auto Fleet Efficiency

The cost of driving is significantly influenced by the price of gasoline, which has been extremely volatile in the last several decades. Figure 6.2 shows how gasoline prices have varied since 1995 in California. During a single six-month period, the price of gasoline ranged from over $4.50 per gallon to under $2.00 per gallon, then increasing again.[7] However, the overall trend has been upward, resulting in an increase in gasoline prices even after accounting for general price inflation. It seems unlikely that this trend will reverse, although the costs of driving may decrease if significant improvements in fuel efficiency are made or drivers increasingly adopt hybrid, electric, or other technologies in their vehicles.

Figure 6.2 Retail Price of Regular Gasoline: California
1995-2011



Source: U.S. Energy Information Agency.

For purposes of these forecasts, a range of gasoline costs were created around the August 2011 California average of $3.80 per gallon of regular gasoline. The high end of driving cost is assumed to be 10% higher, from a combination of $5.50 per gallon gasoline, a 25% improvement in fleet gas mileage, and no change in costs of tires, oil, and other routine maintenance. The low end is 20% lower, from a combination of $2.85 per gallon gasoline, a 9% improvement in fleet miles per gallon, and no change in the other variable costs.

[7] U.S. Energy Information Agency, http://205.254.135.24/oil_gas/petroleum/data_publications/wrgp/mogas_history.html.

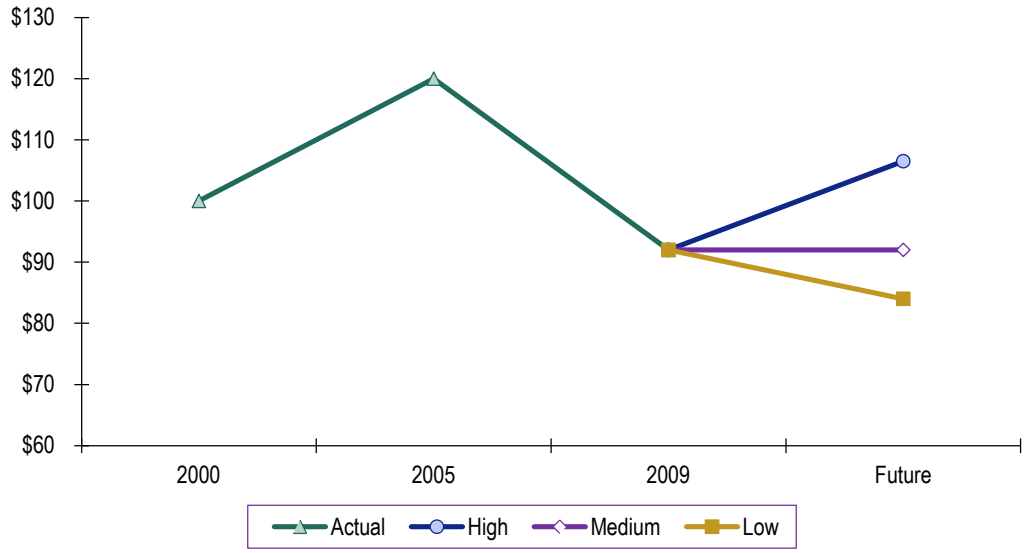
Airfares

The potential range of airfares used to develop the ridership forecasts were based on a review of recent and long-term trends in airfares in the California markets, expected fuel costs, and historical changes as airports face capacity constraints. Key observations include the following (see also Section 3.1):

- With low-cost air carriers (Southwest, Virgin America, and JetBlue) heavily present in all airport pairs, airfares are unlikely to decrease much further.
- Capacity constraints on the region's airports and continued growth in long-distance demand will shift many airlines' priority to transcontinental and international flights, adding premiums to the remaining shorter distance intrastate flights.
- Air travel will become less predictable as weather and other delays are exacerbated by airport capacity constraints, despite additional planned investment in modern air traffic control systems.
- Jet fuel accounts for more than 30 percent of the operating costs for domestic U.S. airlines but increases in fuel efficiency will offset price increases.

Figure 6.3 shows past trends in the average airfare between the San Francisco Bay area and the Los Angeles Basin and the range of future prices used in the scenarios. Similar to the cost of driving, all three Business Plan scenarios assume that airfares stay constant at 2009 levels, although fares appear to have risen in 2010 and 2011.

Figure 6.3 Average Airfare Los Angeles Basin to San Francisco Bay Area
2010 Dollars



Source: Aviation Systems Consulting, LLC, 2011.

Summary of Scenarios

The resulting riders and revenue ranges are shown for the business plan scenarios in Table 6.3. Ridership and revenue forecasts for 2030 were grown to 2040 levels at the rate of 0.5 percent per year.

Table 6.3 Business Plan Scenarios
Annual Riders and Revenues – Year 2040, Phase 1

Implementation Step	Riders (Millions)	Revenue (Millions of 2010 Dollars)
IOS-N – Valley to Bay	7.6 to 11.2	$490 to $750
IOS-S – Valley to Basin	9.5 to 14.0	$660 to $990
B2B – Bay to Basin	16.1 to 23.7	$1,180 to $1,740
Phase 1 – San Francisco to Los Angeles/Anaheim	29.6 to 43.9	$1,830 to $2,710

Source: Parsons Brinckerhoff.

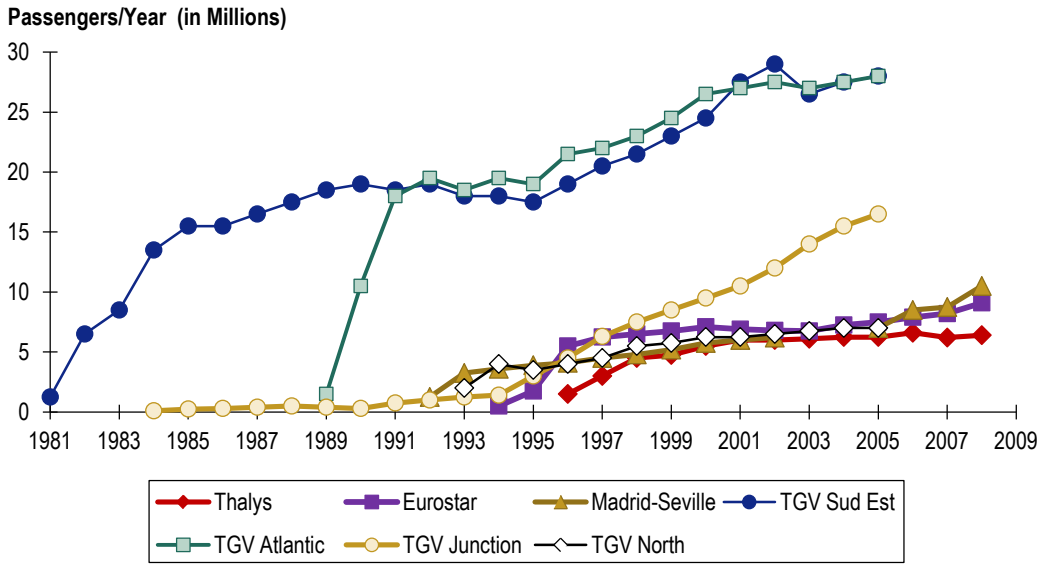
Adjustments for Starting Date Ramp-Up and Growth

When new transportation or other services are introduced, it generally takes time to reach their full long-term market potential. For HST this implies that ridership will ramp up over time, and experience from other HST introductions conforms to the general expectation. Figure 6.4 shows the growth in ridership for six European services from France (TGV), Britain (Eurostar), Spain (Madrid-Seville), and Belgium (Thalys).

- The fastest ramp-up was in the Madrid-Seville line with an increase over two years to a steady growth in ridership.
- The next fastest was the TGV between Paris and the Atlantic Coast regions, reaching "steady state" ridership in the third to fourth year, followed by a steady period, and then more growth reflecting further line improvements.
- At the slower end, the Thalys system – among Belgium, Holland, western Germany, and France – took six years to reach a steady point.

In developing its ramp-up assumption for the ridership forecast, the Authority drew upon this international experience (see additional discussion below). For the California forecast, a five-year ramp-up of ridership and revenue was assumed after each of the implementation steps is opened for revenue service according to the following schedule:

Figure 6.4 Ridership Ramp Up and Growth
Representative European HST Systems



Source: Parsons Brinckerhoff analysis of published sources.

- Forty percent of the expected ridership potential is achieved in year 1;
- Fifty-five percent in year 2;
- Seventy percent in year 3;
- Eighty-five percent in year 4; and
- One hundred percent in year 5.

In addition to ramping up at the start of service, ridership and revenue will grow as population, employment, and trip-making increases. To support financial planning efforts associated with this Business Plan, the 2030 forecasts were decreased by 1.0 percent per year to produce estimates for the years 2022 to 2029. To produce forecasts for the years 2031 to 2060, the 2030 forecasts were increased by 0.5 percent per year. These rates are based on the changes in results among three test forecasts using post-recession population and demographic information from Woods & Poole for the years 2020, 2030, and 2050.

6.4 DISCLAIMER

The information and results presented in this memorandum are estimates and projections that involve subjective judgments, and may differ materially from the actual future ridership and revenue. This memorandum is not intended nor shall it be construed to constitute a guarantee, promise, or representation of any particular outcome(s) or result(s). Further, the material presented in this memorandum is provided for solely purposes of the Authority's business planning and should not be used for any other purpose.

Appendix A

Potential Airline Response to High-Speed Rail Service in California

Potential Airline Response to High-Speed Rail Service in California

August 2011

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Introduction

The current ridership and revenue forecasts prepared for the California High-Speed Rail Authority are based on assumed airfares and airline service frequencies that reflect the air service patterns in effect in the California Corridor markets between Northern and Southern California in 2005. No adjustments are made in the ridership forecast analysis for possible airline competitive response to the introduction of high-speed rail (HSR) service. This response could take one of two forms. Airlines could reduce service frequency and/or increase fares to offset reduced load factors as air travel in these markets is reduced by the diversion of trips to HSR. Alternatively, they could attempt to retain market share by reducing fares. Furthermore, both the airline industry in general and the air service patterns in the California Corridor markets have changed significantly since 2005, due to increased competition from low-cost airlines, entry of new carriers and airline consolidation, rising fuel costs, and efforts by the legacy carriers to reduce costs. In particular, the entry of Virgin America in the San Francisco to Los Angeles market in August 2007 and the San Francisco to San Diego market in February 2008 and the competitive response from other airlines, particularly JetBlue Airways and Southwest Airlines, has significantly changed the patterns of air service between the Bay Area and Southern California.

At the same time, the competitive response of the existing airlines to the entry of Virgin America offers some indication of the likely airline response to the introduction of HSR service. From the perspective of an individual airline, it really does not matter whether a loss of market share results from service entry by a new airline or a new intercity mode (such as HSR). The airline has to decide whether to accept the resulting loss of market share and adjust the level of air service and fare structure accordingly, or attempt to retain as much of its market share as possible by reducing fare levels and/or changing aircraft size in order to maintain service frequencies.

This technical memorandum discusses the underlying economic factors that influence airline service decisions and presents the results of an analysis using U.S. Department of Transportation data on airline service and fare levels to document the trends in air service in the California Corridor markets since 2005 and in particular the airline response to the introduction of service by Virgin America. Based on the findings of this analysis, alternative air service scenarios are proposed for use in future HSR ridership forecasting that take into account potential airline competitive response to the introduction of HSR service.

The memorandum concludes by discussing the potential opportunity for a more detailed case study of the experience with airline response to the introduction of the Acela service in the Northeast Corridor.

Economic Factors Influencing Airline Service Decisions

The decision by an airline whether to enter a given market, or continue to offer service in that market if it is already serving the market, and the details of the service offered in terms of flight frequencies, fare levels, and the type of aircraft equipment used are influenced by a number of considerations, the most important of which is whether it can make a profit doing so. However, determining whether a particular service is profitable involves a number of considerations and is not always a straightforward matter. While the fare revenue derived from the passengers flying in the market has to at least cover the direct operating cost of the aircraft used to serve the market, unless the airline is willing to cross-subsidize the service from other markets for some reason, there are other costs involved in operating an airline that also have to be covered from the overall revenue of the airline, but do not necessarily have to be covered proportionately by the revenue from each market.

These costs include the overall corporate management and administration, including marketing costs, the capital costs of the aircraft, which of course will be used to serve many different markets during a given period of time, and the costs of operating the airline's facilities at each airport, usually referred to as station costs. Since a given station may serve flights in a wide range of markets with different fare levels, the way in which the airline allocates those costs to each flight is somewhat arbitrary. In general, adding flights at a station will incur some additional costs, due to the additional personnel required to handle the passengers and baggage and service the aircraft and possibly additional facilities, such as gate positions, check-in counters, and so forth. However, the number of additional personnel required will depend on the overall staff utilization at the time the flights are scheduled. Similarly, whether the airline would need additional facilities to handle the flights will depend on whether they are scheduled at times when the existing facilities are heavily utilized or not.

It is common in airline economics to divide airline costs into direct operating costs (DOC), which comprise those costs involved in operating the aircraft, and indirect operating costs (IOC), which comprise everything else. However, even this distinction involves some arbitrary assignment of costs to one category or the other, since obviously the aircraft cannot be

operated without ground support infrastructure. The three largest components of DOC are the costs of flight crew, fuel, and aircraft maintenance. Historically cabin crew have been considered part of IOC, because they are not directly involved in operating the aircraft, but for passenger service it makes more sense to include the cabin crew costs as part of DOC, together with flight crew. In the past, flight and cabin crew costs have been the largest component of DOC, but with the recent rise the price of oil, fuel has become the largest single component. If oil prices continue to rise, fuel will form an increasingly large component of DOC.

Over the past two decades the airlines have succeeded in increasing average load factors, *i.e.* the percentage of seats on each flight that are occupied by passengers. This helps spread the DOC of each flight over more passengers, and has been one strategy by which airlines have managed to continue to reduce fares at a time when fuel costs have been rising. However, this process has pretty much run its course by now and there is limited opportunity to achieve further increases in average load factor. At the same time, the legacy network carriers have managed to bring their DOCs (and indeed other costs) closer to those of the low-cost carriers by achieving wage and benefit concessions from their employees, particularly flight crew.

Another cost-reducing strategy that the legacy network carriers have pursued is to make greater use of their regional airline partners to serve shorter-haul or less dense markets. This has two advantages. Regional airlines generally pay lower wages than mainline airlines for similar positions, particularly flight crew. Traditionally airline flight crew wages vary with the size of the aircraft, with flight crew operating larger aircraft having higher pay, so flight crew operating regional airline aircraft would tend to be paid less anyway, but the regional airlines often pay even less than the mainline airlines do for similar aircraft types. The other advantage is that the smaller aircraft operated by regional airlines allow more frequent service in less dense markets, and this higher frequency tends to offset any competitive advantage that low-cost carriers might have by offering lower fares. Business travelers tend to care more about having a wider choice of flights, so that they can plan their travel at a convenient time relative to the purpose of their trip, and are often willing to incur a fare difference in order to fly on an airline with a higher frequency in the market.

Role of Fare Competition

A major factor in determining what fare revenue an airline can expect to obtain in a given market is the extent of competition from other airlines in the market and the fare levels that they

are charging in the market. Air travelers have ready access to fare information from airline websites and online booking portals such as Travelocity and Orbitz, so an airline need to offer similar fares to its competitors in a market or it will not attract many passengers. Of course, there is not a single fare for a given market, but a range of fares that depend on how long before the travel date the reservation is made and how full the flights are. Airline yield management systems restrict the availability of more deeply discounted fares at more popular times and as the flights fill up, so the fare actually available in a given market for a given traveler will depend on the choice of flight departure time and how close to the travel date the booking is made.

As airlines add flights in a market, or new carriers enter the market, more capacity becomes available and flights take longer to fill up. As a result, more passengers are able to get more deeply discounted fares and the average fare in the market goes down. The airlines may also reduce fares (or increase the availability of cheaper fares) in order to stimulate demand and attempt to fill the additional capacity. In the past this has led to fare wars, in which none of the airlines competing in a market end up making much or any money, but in recent years the airlines have been more disciplined in not adding too much capacity to markets and driving average fares down. With the reduction in air travel demand in the recent recession, the airlines were able to reduce capacity in order to maintain average fares and avoid fare wars.

However, a related consideration is the need to maintain market share. An airline can reduce capacity by eliminating flights, but if as a result the other airlines in the market offer more frequent service, the airline may see its market share drop and offset the advantage of reducing capacity, leaving it with reduced load factors and fewer flights. Replacing service with mainline aircraft with service by a regional airline partner is a way to reduce capacity without reducing frequency. However, passengers generally prefer traveling on larger aircraft if the choice is available, so reducing capacity in this way may result in loss of market share if the competition continues to operate mainline aircraft.

Implications for Competition between Air and High-Speed Rail

The introduction of HSR service in the California Corridor will present airlines with two competitive issues. If HSR fares are significantly below the comparable air fare for travel at a given time and the same extent of advance purchase, then some travelers who would otherwise choose air travel will take the HSR service instead. This will reduce demand and result in lower load factors if capacity is not reduced proportionately. The lower load factors will reduce

passenger revenue for each flight and could result in many of these flights becoming unprofitable. Reducing capacity in the market by reducing flight frequency could cause a greater shift in demand to HSR, particularly if, as a result, the HSR service offers more frequent service.

An alternative competitive approach would be to reduce fares closer to those offered by the HSR service, in order to retain as much market share as possible. However, depending on the fares offered by the HSR service, it may not be economically viable to continue offering service at these lower fares.

Defining the California Corridor Air Markets

The California Corridor is one of the busiest air markets in the U.S. and is generally understood to consist of air services between airports in the San Francisco Bay Area and Sacramento area in Northern California and airports in Southern California, including San Diego. It also includes airports in the San Joaquin Valley and Central Coast region between Monterey in the north and Santa Barbara in the south. However, because most passengers flying between the San Joaquin Valley airports and airports in the Bay Area (primarily San Francisco International Airport (SFO)) and Southern California (primarily Los Angeles International Airport (LAX)) are connecting to other flights at those airports, while the planned California high-speed rail system will not directly serve the Central Coast region communities, these markets have been excluded from the analysis of recent trends in the Corridor markets.

Both the Bay Area and the Los Angeles Basin are served by multiple airports with airline passenger service. Although not every airport in Northern California has air service to every airport in Southern California, every airport in Northern California has air service to at least one airport in Southern California and most airports have air service to the majority of airports at the other end of the Corridor. Thus there are a large number of airport-pair markets in the Corridor and air travelers in the Corridor have a substantial choice of alternative airports that they could use.

For the purpose of this analysis, Northern California comprises the Bay Area and the Sacramento area. The Bay Area is served by four airports: SFO, Oakland International Airport (OAK), Mineta San José International Airport (SJC) and Charles M. Schulz Sonoma County Airport (STS). The Sacramento area is served by one airport with passenger airline service, Sacramento International Airport (SMF). At the other end of the Corridor, Southern California comprises the 6-county Los Angeles basin (including Imperial County to the east) and San Diego

County. This region is served by seven airports that currently have passenger airline service to Northern California: LAX, Ontario International Airport (ONT), Bob Hope Burbank Airport (BUR), Long Beach Airport (LGB), John Wayne Orange County Airport (SNA), Palm Springs International Airport (PSP), and San Diego International Airport (SAN). There are also a number of smaller airports that have commuter airline service, but these do not currently have service to Northern California and have not been included in the analysis.

Data Sources for Analysis of California Corridor Air Markets

The principal source of data on air travel in the California Corridor used in the analysis presented in this memorandum is the passenger traffic data reported by the airlines to the U.S. Department of Transportation and available from the Bureau of Transportation Statistics (BTS) website. These data comprise two separate datasets:

1. Monthly traffic data reported by large certificated air carriers on Schedule T-100 of Form 41 (referred to as T-100 data). These data include passengers, freight and mail transported by flight segment and on-flight market, together with data on the number of aircraft operations scheduled and performed, available capacity (seats), and aircraft hours operated by aircraft equipment type.

2. Quarterly data on passenger itineraries and fares reported by large certificated air carriers as part of the Airline Origin and Destination Survey (referred to as database DB1B or the 10 percent O&D Survey). This is not strictly a survey, but a sample of 10 percent of all passenger itineraries obtained from the airline tickets or equivalent records. The data consists of the quarterly count of the number of sampled passengers traveling on a given itinerary (where an itinerary is defined as a specific sequence of flight segments at a given fare).

There are a number of important considerations that need to be borne in mind when interpreting these data. These are briefly discussed in the following paragraphs, but it should be appreciated that a full discussion of all the issues that can arise in interpreting the data is beyond the scope of this memorandum.

The BTS divides the monthly T-100 data into two datasets: T-100 market and T-100 segment data, where the T-100 market data provides a count of the number of passengers (or

amount of freight or mail) transported on the same flight by a given airline between a given origin and destination airport. The T-100 segment data provides a count of the number of passengers (or amount of freight or mail) transported on each non-stop flight between a given origin and destination airport, by airline and aircraft equipment type. The difference between market traffic and segment traffic can be understood by considering a passenger who takes a flight from (say) Oakland International Airport (OAK) to Phoenix Sky Harbor Airport (PHX) that makes an intermediate stop at Ontario International Airport (ONT). This flight has two segments: OAK to ONT and ONT to PHX. This passenger will be counted in the T-100 market dataset as having an origin of OAK and a destination of PHX. The same passenger will be counted twice in the T-100 segment dataset, once for the non-stop segment OAK to ONT and again for the non-stop segment ONT to PHX.

In the case of passengers taking a non-stop flight from their origin to their destination, they will be counted once in both the T-100 market and T-100 segment data for that airport pair. Expressed in another way, the segment data is the number of passengers on board the flight for a given flight segment, while the market data is the number of passengers flying *on the same flight* between a given origin airport (where they board the flight) and a given destination airport (where they leave the flight). The market origin and destination airport may not be the airports where the passengers began their air trip or their final destination. Passengers boarding a flight at a given airport include both those who are beginning their (directional) air trip and those connecting from other flights at that airport. Similarly, passengers leaving a flight at a given airport include those for whom this is their final destination and those connecting to other flights to continue their trip.

The O&D Survey database is divided into three components: a coupon database, a market database, and a ticket database. A given passenger's ticket is divided into a number of coupons, where each coupon corresponds to a different flight on the itinerary. The market database provides information on the directional origin and destination. Thus the passenger count in the market from SFO to LAX will include both passengers from the Bay Area on the outbound leg of a round trip as well as passengers from Southern California on the return leg of a round trip. The ticket database indicates the first airport on the itinerary, and thus by combining the market database with the ticket database, it is possible to separate the passenger count in a directional market into passengers on the outbound and return legs of their trips.

However, the market database does not distinguish the route taken between the origin and destination, and whether this was on a direct or connecting flight. Thus the passenger count from the market database for travel between SFO and San Diego (say) will include both passengers on direct flights between the two airports as well as those making connections at an intermediate airport, such as LAX. While this is generally more of a concern in longer-distance markets, where there may be a significant amount of traffic connecting at intermediate hubs (or indeed there may be no direct flights and it may be necessary to take connecting flights), there is some connecting traffic between the Bay Area airports and San Diego that typically changes flights at LAX.

In order to analyze connecting traffic, it is necessary to use the coupon database, where there is a separate record for each coupon in an itinerary. Since each segment of an itinerary involving a connection will have a separate coupon in the ticket, it is possible to construct the complete itinerary and identify any intermediate stops to change flights. However, because a passenger traveling on the same flight that makes an intermediate stop will only have one coupon for that flight, it is not possible to distinguish between passengers on non-stop flights between a given origin and destination and those on one-stop or multi-stop flights.

Although the O&D Survey data reported by the U.S. airlines include passengers on international itineraries, including the domestic portion of itineraries involving both domestic and international legs, these data are restricted and not included in O&D Survey data available on the BTS website.

O&D Survey Expansion

Because the O&D Survey is only a sample (approximately 10 percent) of all passenger itineraries, the passenger counts need to be expanded to give the total number of passengers in a given market. If it were an accurate 10 percent sample, it would simply be a matter of multiplying the O&D Survey passenger counts by 10 to give the number of passengers with a given itinerary. However, for a variety of reasons, the O&D Survey passenger counts for a given market often differ from the T-100 market counts by a factor of more or less than 10.

In order to determine the appropriate expansion factors to use for the California Corridor analysis, a comparison was made between the T-100 market data and the O&D Survey coupon data for each of the airport-pair markets in the Corridor for 2009, as described in more detail in Appendix A. This showed that the survey expansion factors for Southwest Airlines and Virgin

America are significantly lower than those for the other airlines in the Corridor markets and well below 10, averaging 9.4 in the case of Southwest and 9.7 in the case of Virgin America. The survey expansion factors for JetBlue were very close to 10, and averaged 10.0 for the full year for the two markets between OAK and LGB and between SJC and LGB. For the other airlines, after allowing for the proportion of passengers in each market who had an itinerary that involved both domestic and international segments (and as a result were excluded from the O&D Survey passenger counts), it appears reasonable to use survey expansion factors of 10 for true domestic itineraries.

These survey expansion factors were then used to estimate the number of passengers with a trip origin at one of the California Corridor airports and a final destination at one of the airports at the other end of the Corridor.

Recent Trends in Air Service in the California Corridor

Table 1 shows the recent trend in the local passenger traffic for the California Corridor markets between the Bay Area and Southern California (including San Diego), based on the O&D Survey. It can be seen that the annual local passenger traffic in the Corridor markets at the four Bay Area airports combined declined significantly from 2000 to 2005 to about 82% of the 2000 traffic level, then grew to 2007, although to a level of only about 90% of the 2000 traffic level, before declining again in 2008 and 2009.

However, the market shares of each airport changed dramatically over this period, particularly in recent years, with SFO steadily increasing both its traffic and market share over the period 2005 to 2009, ending up with passenger traffic in the Corridor markets about 23% above the 2000 traffic level, for the reasons explained in the following discussion.

Table 2 shows the corresponding trend in local passenger traffic between Sacramento and Southern California. Unlike the Bay Area, the annual local passenger traffic in the Corridor markets increased slightly from 2000 to 2005, and continued to grow until 2007 to a level 15% above that in 2000. With the onset of the recession in late 2007, the traffic declined in 2008 and 2009 to a level of about 92% of the 2000 traffic level.

Table 1. Recent Trends in Local Passengers – Bay Area to Southern California

		Estimated O&D Passengers (both ways)					
		2000	2005	2006	2007	2008	2009
OAK	BUR	839,381	883,892	908,204	949,173	841,825	766,718
	LAX	1,530,030	1,146,316	1,102,921	1,051,679	786,624	644,502
	LGB	0	464,270	421,730	399,030	357,050	231,190
	ONT	597,163	635,396	607,986	628,693	557,329	465,069
	SNA	762,539	796,070	834,669	878,171	680,503	508,620
	SAN	708,623	1,009,027	1,069,535	1,019,128	780,109	647,300
		4,437,737	4,934,971	4,945,046	4,925,874	4,003,439	3,263,399
Pct 2000			111.2%	111.4%	111.0%	90.2%	73.5%
SFO	BUR	450,020	99,310	156,150	145,300	97,240	71,420
	LAX	1,419,830	721,490	950,160	1,246,503	1,738,201	1,877,739
	LGB	0	70	0	0	32,980	168,780
	ONT	200,800	38,330	89,360	46,740	38,990	38,800
	PSP	95,310	137,210	158,850	158,880	149,380	143,810
	SNA	589,490	242,500	246,380	220,600	201,473	650,727
	SAN	1,008,678	347,100	319,910	626,552	1,012,399	1,119,464
		3,314,108	1,486,700	1,764,660	2,185,867	3,173,422	3,999,321
Pct 2000			44.9%	53.2%	66.0%	95.8%	120.7%
SJC	BUR	460,199	437,295	439,554	480,809	450,996	410,556
	LAX	1,147,415	682,634	750,511	748,327	615,371	529,173
	LGB	0	0	0	0	108,450	147,740
	ONT	354,157	344,121	352,678	377,853	328,405	273,450
	PSP	26,370	3,210	5,130	9,590	10,450	10,800
	SNA	871,380	639,536	635,255	672,910	622,661	524,100
	SAN	844,152	753,072	791,918	773,408	674,107	603,983
		3,703,674	2,859,868	2,975,044	3,062,897	2,810,439	2,499,802
Pct 2000			77.2%	80.3%	82.7%	75.9%	67.5%
STS	LAX	2,880	0	0	54,360	69,770	61,280
Bay Area		11,908,419	9,380,849	9,840,900	10,487,704	10,154,310	9,895,222
Pct 2000			78.8%	82.6%	88.1%	85.3%	83.1%

Source: Analysis of U.S. DOT 10% O&D Survey airline data from Bureau of Transportation Statistics

However, the changes in the individual markets from 2000 to 2007 were not the same, with traffic in some markets declining while that in other markets grew. In particular, the traffic in the market between SMF and LAX declined significantly, while that in the markets between SMF and BUR and between SMF and ONT declined slightly from 2000 to 2005, before

recovering to a level in 2007 slightly above the 2000 traffic level. In contrast, traffic in the markets between SMF and SNA and between SMF and SAN grew strongly from 2000 to 2007, while service commenced between SMF and LGB in 2006, increased in 2007, then declined to 2009 like all the other markets.

Table 2. Recent Trends in Local Passengers – Sacramento to Southern California

		Estimated O&D Passengers (both ways)					
		2000	2005	2006	2007	2008	2009
SMF	BUR	567,214	540,621	539,260	575,691	522,194	467,032
	LAX	810,428	612,360	627,871	598,030	526,060	459,380
	LGB		0	116,140	153,240	134,770	124,530
	ONT	657,539	633,628	647,810	674,237	602,531	514,927
	PSP	8,730	27,390	29,030	31,310	30,030	27,020
	SNA	215,250	492,551	508,460	551,398	486,521	448,992
	SAN	697,861	778,632	777,320	828,208	738,532	678,050
		2,957,023	3,085,182	3,245,893	3,412,114	3,040,638	2,719,931
Pct 2000			104.3%	109.8%	115.4%	102.8%	92.0%

Source: Analysis of U.S. DOT 10% O&D Survey airline data from Bureau of Transportation Statistics

Air Fares

The corresponding data on average fares for markets between the Bay Area and Southern California are shown in Table 3. These data show that a major factor in the shift of traffic from OAK and SJC to SFO has been the drop in average fares in Corridor markets to and from SFO compared to those to and from OAK and SJC, particularly since Southwest and Virgin America started service at SFO in 2007 and JetBlue began serving Southern California from SFO in October 2008. In 2005, average fares at SFO were significantly higher than those at OAK and SJC in all markets. By 2009, SFO had the lowest average fare in all markets except BUR, which was not served from SFO by any of the low-cost airlines, and between SJC and LGB, where the average fares were essentially the same.

Average fares increased in all markets to and from OAK and SJC between 2000 and 2009, with the exception of LGB (which was not served in 2000). However, the change in average fares in markets to and from SFO between 2000 and 2009 showed opposite effects, with average fares in some markets decreasing while those in other markets increased. In general, the

average fares in those markets that experienced an introduction of service by the low-cost carriers declined, while the average fares in markets that were only served by the legacy carriers or their regional airline partners increased.

Table 3. Recent Trends in Average Air Fares – Bay Area to Southern California

		Average Fares (current $) (each way)					
		2000	2005	2006	2007	2008	2009
OAK	BUR	80.38	95.18	100.46	94.10	105.28	104.22
	LAX	77.74	91.32	97.19	91.60	101.04	99.92
	LGB		82.58	88.03	83.26	84.30	76.47
	ONT	77.39	89.03	93.77	89.56	99.30	99.41
	SNA	83.82	96.21	100.37	96.33	112.05	108.21
	SAN	83.20	96.75	102.97	93.46	98.97	99.62
SFO	BUR	103.23	164.80	157.71	165.72	182.84	167.98
	LAX	102.66	144.28	122.84	109.19	103.25	89.94
	LGB		152.34			82.37	72.74
	ONT	95.17	104.97	106.15	162.82	167.93	95.38
	PSP	118.78	125.66	123.46	120.76	126.97	248.44
	SNA	112.01	154.60	163.52	178.32	183.84	85.70
	SAN	81.98	144.29	156.25	104.44	97.48	85.99
SJC	BUR	80.60	93.56	99.39	97.35	103.70	102.00
	LAX	78.54	92.61	100.11	97.40	104.15	102.41
	LGB					74.60	71.95
	ONT	78.30	87.93	93.10	87.46	96.13	96.69
	PSP	117.81	140.03	161.02	129.51	131.39	115.07
	SNA	86.34	97.78	104.84	102.65	108.92	102.99
	SAN	85.16	99.39	108.05	102.14	107.31	102.69
STS	LAX	126.12			107.45	117.52	109.16

Source: Analysis of U.S. DOT 10% O&D Survey airline data from Bureau of Transportation Statistics

Table 4 shows the average fares in the markets between SMF and Southern California. These show two opposite effects, with the average fares in some markets increasing between 2000 and 2009, while those in other markets declined. The average fares in the markets between SMF and BUR, LAX, ONT and SAN increased significantly between 2000 and 2009, while those in the markets between SMF and PSP and between SMF and SNA declined. JetBlue commenced service in the market between SMF and LGB in 2006, and although the average fare

increased slightly over the period from 2006 to 2009, by 2009 this market had the lowest average fare of any market between SMF and Southern California.

Table 4. Recent Trends in Average Air Fares – Sacramento to Southern California

		Average Fares (current $) (each way)					
		2000	2005	2006	2007	2008	2009
SMF	BUR	78.18	91.22	95.70	92.04	100.75	105.49
	LAX	77.05	89.16	94.66	94.34	105.05	107.80
	LGB			79.72	81.91	89.27	88.41
	ONT	78.47	88.70	93.65	91.71	101.03	104.91
	PSP	153.70	123.86	132.60	126.00	133.25	121.31
	SNA	123.81	95.53	100.66	98.14	111.31	107.89
	SAN	78.74	92.02	99.03	95.50	106.45	105.20

Source: Analysis of U.S. DOT 10% O&D Survey airline data from Bureau of Transportation Statistics

Tables 5 and 6 shown the foregoing average fares expressed in constant 2005 dollars, using the Consumer Price Index for all urban consumers (CPI-U) for the three largest metropolitan regions in the California Corridor. Fares between Northern California and the Los Angeles basin were adjusted to constant dollars using the average of the CPI-U for the Bay Area and Los Angeles-Riverside-Orange County Consolidated Metropolitan Statistical Area (CMSA), while fares between Northern California and San Diego were adjusted using the average of the CPI-U for the Bay Area and San Diego CMSA.

Airline Market Share

Southwest Airlines has remained the dominant carrier in all the Southern California markets from OAK and SJC with the exception of LGB, which was served by JetBlue from OAK from September 2002 and from SJC starting in May 2008. The recent trend in the Southwest Airlines market share in the other California Corridor markets from OAK and SJC is shown in Table 7, together with the markets from SFO which it served.

Table 5. Recent Trends in Average Air Fares – Bay Area to Southern California (Constant Dollars)

		Average Fares (2005 $) (each way)					
		2000	2005	2006	2007	2008	2009
OAK	BUR	92.39	95.18	96.87	87.86	95.11	94.14
	LAX	89.36	91.32	93.72	85.53	91.27	90.26
	LGB		82.58	84.89	77.74	76.15	69.08
	ONT	88.95	89.03	90.43	83.62	89.70	89.80
	SNA	96.34	96.21	96.79	89.94	101.22	97.75
	SAN	96.85	96.75	99.68	88.00	90.05	90.32
SFO	BUR	118.65	164.80	152.08	154.74	165.17	151.75
	LAX	118.00	144.28	118.46	101.95	93.27	81.25
	LGB		152.34			74.41	65.71
	ONT	109.39	104.97	102.36	152.02	151.70	86.16
	PSP	136.53	125.66	119.05	112.76	114.69	224.43
	SNA	128.75	154.60	157.69	166.50	166.07	77.42
	SAN	95.44	96.75	151.26	98.34	88.69	77.96
SJC	BUR	92.64	93.56	95.85	90.90	93.67	92.14
	LAX	90.28	92.61	96.54	90.95	94.08	92.51
	LGB					67.39	64.99
	ONT	90.00	87.93	89.78	81.66	86.84	87.34
	PSP	135.42	140.03	155.28	120.92	118.69	103.94
	SNA	99.25	97.78	101.10	95.85	98.40	93.04
	SAN	99.14	96.75	104.60	96.18	97.64	93.10
STS	LAX	144.96			100.32	106.16	98.61

Source: Analysis of U.S. DOT 10% O&D Survey airline data from Bureau of Transportation Statistics

Table 6. Recent Trends in Average Air Fares – Sacramento to Southern California (Constant Dollars)

		Average Fares (2005 $) (each way)					
		2000	2005	2006	2007	2008	2009
SMF	BUR	89.86	91.22	92.29	85.94	91.01	95.29
	LAX	88.57	89.16	91.28	88.08	94.90	97.38
	LGB			76.88	76.48	80.64	79.86
	ONT	90.20	88.70	90.31	85.63	91.26	94.77
	PSP	176.67	123.86	127.87	117.65	120.37	109.58
	SNA	142.32	95.53	97.07	91.63	100.55	97.46
	SAN	91.66	92.02	95.87	89.93	96.86	95.37

Source: Analysis of U.S. DOT 10% O&D Survey airline data from Bureau of Transportation Statistics

Table 7. Recent Trends in Southwest Airlines Market Share – Bay Area to Southern California

		Southwest Airlines Market Share					
		2000	2005	2006	2007	2008	2009
OAK	BUR	99.4%	99.6%	99.7%	99.7%	99.8%	99.9%
	LAX	74.1%	92.6%	90.0%	92.3%	94.2%	99.4%
	ONT	97.6%	99.0%	99.1%	99.2%	99.5%	99.6%
	SNA	62.4%	65.9%	67.7%	69.2%	87.3%	99.2%
	SAN	94.7%	98.4%	98.5%	98.8%	99.0%	99.4%
SFO	LAX				6.4%	27.5%	32.8%
	SNA					0.1%	34.1%
	SAN	44.5%			26.0%	43.1%	47.3%
SJC	BUR	99.9%	99.9%	100.0%	100.0%	100.0%	100.0%
	LAX	50.3%	80.6%	74.9%	76.8%	82.1%	82.2%
	ONT	97.8%	99.3%	99.3%	99.4%	99.6%	99.7%
	SNA	44.4%	57.1%	58.3%	64.5%	70.1%	79.7%
	SAN	65.1%	75.5%	76.1%	77.1%	84.4%	88.9%

Source: Analysis of U.S. DOT 10% O&D Survey airline data from Bureau of Transportation Statistics

It can be seen that Southwest has steadily increased its market share in all the markets that it serves. After entering the SFO to LAX and SFO to SAN markets in 2007, by 2009 it had achieved a market share of over 30% in the former and almost 50% in the latter, and had achieved the largest market share of any carrier in both markets, exceeding United Airlines, previously the dominant carrier in both markets, and Virgin America, which also entered both markets in 2007. After entering the SNA market in 2009, it achieved a market share of 34% for the year as a whole (reaching 42% in the fourth quarter), the largest market share of any carrier.

The corresponding market shares for Southwest Airlines in the Southern California markets that it serves from SMF are shown in Table 8.

In 2000, Southwest Airlines was the dominant carrier in all Southern California markets from SMF with the exception of LGB, PSP and SNA, none of which it served in 2000 (no carrier served the SMF to LGB market in 2000). By 2005 Southwest had become the dominant carrier in the SMF to SNA market, and from 2005 to 2009 steadily increased its market share of the SMF to LAX market.

Table 8. Recent Trends in Southwest Airlines Market Share – Sacramento to Southern California

		Southwest Airlines Market Share					
		2000	2005	2006	2007	2008	2009
SMF	BUR	98.2%	99.0%	99.1%	99.2%	99.3%	99.4%
	LAX	57.0%	81.3%	80.2%	82.7%	88.7%	89.1%
	ONT	96.4%	98.6%	98.5%	98.9%	99.1%	99.1%
	SNA		95.9%	90.8%	89.0%	96.4%	98.5%
	SAN	94.6%	96.9%	96.8%	97.8%	97.7%	98.0%

Source: Analysis of U.S. DOT 10% O&D Survey airline data from Bureau of Transportation Statistics

Flight Frequencies

The recent changes in average flight frequency in each of the California Corridor markets are shown in Tables 9 and 10. In general, the changes in flight frequency correspond to the changes in estimated O&D passenger traffic shown in Tables 1 and 2, although flight frequency is influenced by the total segment passenger traffic, which includes through and connecting passengers as well as O&D passengers.

Direct service from SJC to PSP in 2005 and 2006 was very intermittent and most passengers in this market used one-stop or connecting flights through LAX. Similarly, there was no direct service between STS and LAX in 2000, but passengers in this market used one-stop or connecting flights through SFO.

Airline Response to the Introduction of Service by Virgin America

In 2004 the Virgin Group announced that it planned to start a new low-cost U.S. airline, initially called Virgin USA and later changed to Virgin America, and selected SFO as its hub airport. After some delays in obtaining operating authority the airline began service on August 8, 2007 with flights to LAX and John F. Kennedy International Airport (JFK) in New York. In May 2007 JetBlue began service from SFO, initially serving JFK and Boston, and in August 2007, soon after Virgin America began operating, Southwest Airlines also began service from SFO, initially serving San Diego International Airport, Las Vegas and Chicago Midway. Over the next three years, all three airlines steadily expanded their service from SFO, in spite of the economic recession that began in late 2007.

Table 9. Recent Trends in Flight Frequency – Bay Area to Southern California

		Average Daily Departures (both ways)					
		2000	2005	2006	2007	2008	2009
OAK	BUR	27.8	26.6	29.5	30.2	29.0	26.6
	LAX	64.1	52.2	50.8	56.0	44.6	28.9
	LGB		11.0	10.8	10.3	8.9	6.0
	ONT	23.5	24.2	22.8	22.5	20.0	18.1
	SNA	22.6	24.7	26.6	26.7	19.8	16.1
	SAN	20.9	33.6	37.5	37.1	31.0	24.7
SFO	BUR	21.1	13.9	7.5	13.1	11.0	10.6
	LAX	76.2	45.7	53.2	68.5	84.1	76.5
	LGB					1.1	5.9
	ONT	11.0	1.2	6.3	7.6	8.6	7.5
	PSP	5.0	5.2	8.3	9.1	8.8	9.1
	SNA	19.6	20.2	20.0	20.0	20.9	31.6
	SAN	37.7	17.4	19.2	29.4	42.6	42.0
SJC	BUR	15.0	16.7	16.7	17.9	18.1	16.7
	LAX	57.8	55.0	54.9	59.0	48.0	16.7
	LGB					3.6	5.3
	ONT	13.4	16.7	16.6	16.5	14.8	12.1
	PSP	0.9			0.3	0.6	0.7
	SNA	29.3	29.1	30.3	27.9	29.1	25.4
	SAN	28.4	35.6	36.0	36.0	28.4	24.8
STS	LAX				3.3	4.3	3.7

Source: Analysis of U.S. DOT Form 41 airline traffic data from Bureau of Transportation Statistics

Table 10. Recent Trends in Flight Frequency – Sacramento to Southern California

		Average Daily Departures (both ways)					
		2000	2005	2006	2007	2008	2009
SMF	BUR	18.5	18.5	18.5	20.0	18.6	17.5
	LAX	28.4	30.7	30.2	36.6	31.2	24.4
	LGB			4.0	4.6	4.0	3.9
	ONT	20.2	22.2	22.3	22.2	20.7	18.7
	PSP		2.0	2.0	2.0	2.0	2.0
	SNA	8.3	13.5	15.8	17.1	13.8	13.0
	SAN	21.0	26.3	26.5	26.5	24.9	22.6

Source: Analysis of U.S. DOT Form 41 airline traffic data from Bureau of Transportation Statistics

As air travel to and from the Bay Area declined overall, air service was reduced significantly by all carriers at both OAK and SJC, with some carriers ceasing all service at those airports. The increased competition at SFO caused fares to drop in the markets served by the low-cost airlines and the combined effect of lower fares at SFO and reduced service at OAK and SJC caused a significant shift of regional passenger traffic from OAK and SJC to SFO.

In the California Corridor markets, Virgin America introduced service to San Diego International Airport on February 12, 2008 and Orange County John Wayne Airport (SNA) on April 29, 2009. However the service to John Wayne Airport was terminated in late May 2010. Southwest began service to LAX from SFO on November 4, 2007 and added service to SNA on May 9, 2009. JetBlue began service to Long Beach Airport from SFO on October 18, 2008. Thus by mid-2009 low-cost carrier competition from SFO to Southern California destinations had increased significantly, with Southwest and Virgin America providing competing service to LAX, John Wayne, and San Diego, while JetBlue provided service to Long Beach.

Although average fares declined in the three California Corridor markets served by Virgin America following the entry of Virgin America and Southwest in those markets, as shown in Table 3, Southwest did not significantly reduce the average fares in those markets from OAK and SJC in order to reduce the shift in market share from those airports to SFO. Of course, Southwest was also gaining some of the traffic that shifted to SFO. As average fares from SFO to LAX and SNA declined, JetBlue reduced the average fare in the SFO to LGB market and also reduced the average fare in the OAK and SJC to LGB markets, although not by as much. Thus there does appear to have been an attempt by JetBlue to retain some its market share at OAK and SJC. Although it was the only carrier serving LGB from any of the airports, LGB is located between LAX and SNA, and all three airports are serving essentially the same market in the southern part of the Los Angeles basin. In particular, prior to the entry of Virgin America and Southwest in the SFO to SNA market, the JetBlue service to LGB provided the lowest fare service between the Bay Area and Orange County. Although Southwest had provided service to SNA from OAK and SJC for many years, as shown in Table 7, the average fares in these two markets were significantly higher than the average fares in the markets from OAK and SJC to LGB, or from SFO to LGB when that service began in October 2008.

The other interesting aspect of the airline response to the introduction of service by Virgin America is the response of United Airlines in the markets from SFO to LAX, SNA and

SAN. Prior to the entry of Virgin America and Southwest in these markets, United (together with its regional partner United Express) had been not only the dominant carrier in these markets, but had been able to achieve much higher average fares in these markets than the competing service by Southwest from OAK and SJC, as can be seen from Table 3. In 2006, United had a 62% market share in the SFO to LAX market, a 66% market share in the SFO to SNA market, and an 89% market share in the SFO to SAN market. This market share eroded dramatically with the new competition in these markets from Virgin America and Southwest. United was forced to reduce its average fares in these markets to remain competitive with the new entrants. United's average fare in these markets in 2009 was typically somewhat higher than that of either Virgin America or Southwest, but significantly below the level that it had previously achieved.

However, the overall increase in traffic in these markets due to the shifts between the different airports stimulated by the lower fares resulted in United and its regional partner handling slightly more O&D traffic in the markets between SFO and LAX and SFO and SAN in 2009 than it handled in 2006 and significantly more in the market between SFO and SNA, as shown in Table 11 below. Of course, it was serving this traffic at a much lower average fare, so the overall revenue had declined significantly and these services had become much less profitable. Whether they were actually unprofitable is not clear.

In the market between SFO and LAX, United reduced its average fare from about $131 in 2006 to about $124 in 2007, and its O&D passengers increased by about 4%. United increased the average fare to about $127 in 2008 as Southwest and Virgin America greatly increased their market share at significantly lower average fares, and as a result United's O&D passengers declined by about 16%. United then reduced its average fare to about $98 in 2009 and its O&D passenger traffic recovered to slightly below the 2007 level but just above the 2006 level.

In the market between SFO and SAN, United reduced the average fare sharply from about $160 in 2006 to about $118 in 2007, and its O&D passengers increased by 19%. However, more modest reductions in average fare to about $111 in 2008 and about $96 in 2009 were not enough to offset the increasing market share of Southwest and Virgin America at average fares well below those of United, and its O&D passengers declined by 11% in 2008 and a further 5% in 2009, ending up about 1% above the 2006 level.

Table 11. Response of United Airlines to Market Entry by Southwest Airlines and Virgin America

			2006	2007	2008	2009
Average Fares *(current $) (one way)*						
SFO	LAX	United	131.08	123.92	127.05	97.77
		Southwest		75.67	98.09	82.87
		Virgin America		*Note 2*	84.77	81.02
	SAN	United	159.92	118.46	110.51	96.19
		Southwest		82.25	96.56	83.00
		Virgin America			82.11	80.67
	SNA	United	167.14	178.79	188.91	135.53
		Southwest				77.47
		Virgin America				77.25
Estimated O&D Pax *(both ways)*						
SFO	LAX	United	587,760	608,540	512,310	591,140
		Southwest		79,345	477,605	616,358
		Virgin America		113,407	413,986	391,851
	SAN	United	285,800	339,860	303,560	288,920
		Southwest		162,752	436,827	529,380
		Virgin America			257,011	285,355
	SNA	United	162,090	143,990	137,180	181,780
		Southwest				221,699
		Virgin America				173,038
Average Daily Departures *(both ways)*						
SFO	LAX	United	32.6	32.6	29.8	29.6
		Southwest		15.0	20.6	21.4
		Virgin America		10.2	12.0	11.4
	SAN	United	18.0	19.0	17.6	16.1
		Southwest		15.4	17.2	17.2
		Virgin America			8.8	8.7
	SNA	United	11.1	10.7	11.9	12.4
		Southwest				10.4
		Virgin America				8.3

Source: Analysis of U.S. DOT 10% O&D Survey and Form 41 airline traffic data from Bureau of Transportation Statistics

Notes: 1. For air service that commenced during the year, the average daily departures were calculated by averaging the total departures over the days of operation.

2. Virgin America did not file 10% O&D Survey reports for 2007. O&D passengers have been estimated from segment traffic reported on Form 41.

Southwest and Virgin America did not enter the market between SFO and SNA until 2009. From 2006 to 2008 United steadily increased its average fare in the market from about $167 in 2007 to about $189 in 2008. As a result, its O&D passenger traffic declined by 11% in 2007 and a further 5% in 2008. With the entry of Southwest and Virgin America, United reduced its average fare to about $136 in 2009, still well above those of Southwest and Virgin America, and its O&D passengers increased by 33% to a level some 12% above that in 2006.

Thus it appears that the changes in United's O&D passenger traffic in each of the markets between 2006 and 2009 were due partly to changes in market share as a result of the difference in average fare between United and Southwest and Virgin America and partly due to changes in the total level of O&D traffic in the market resulting from changes in the average fare. The two markets between SFO and LAX and SFO and SNA are not independent, but form part of the larger market between the Bay Area and the Los Angeles basin. In particular, the market between SFO and SNA draws passengers who might otherwise use LGB or ONT as well as LAX, so the changes in average fare in the market between SFO and SNA relative to the average fares in competing markets at the other airports affects the share of the total regional O&D traffic between the Bay Area and Los Angeles basin attracted to use SNA.

In spite of the small increase in O&D passengers on United and United Express from 2006 to 2009 in the markets between SFO and LAX and SFO and SAN, United reduced the flight frequency in both markets between 2006 and 2009, particularly after 2007. The overall reduction from 2006 to 2009 was about 9% in the market between SFO and LAX and about 11% in the market between SFO and SAN. This was achieved by a significant increase in load factor over the period of about 7 percentage points in the market between SFO and LAX (reaching about 77% load factor in 2009) and about 6 percentage points in the market between SFO and SAN (reaching about 75% load factor in 2009). In addition, United increased the average size of the aircraft serving both markets slightly between 2006 and 2009, by about 2% in the market between SFO and LAX (to an average of 147 seats per aircraft) and about 6% in the market between SFO and SAN (to an average of 142 seats per aircraft).

In contrast, United increased the flight frequency in the market between SFO and SNA from 2006 to 2009 by about 11%, or slightly less than the increase in O&D passengers over the same period. However, this was accomplished by reducing the number of mainline flights by about 26% and expanding the number of United Express flights by about 80%, giving a

reduction in seat capacity of about 11% over the period, resulting in an increase in load factor of about 10 percentage points, reaching a 69% load factor in 2009. Of course, as a result the average aircraft size in the market declined (from an average of 120 seats per aircraft in 2006 to an average of 96 seats per aircraft in 2009).

Thus United appears to have attempted to address the reduction in average fares in the markets between SFO and LAX and between SFO and SAN by increasing average load factors through reduced flight frequency, while in the market between SFO and SNA it both increased load factors and substituted regional airline flights for mainline flights. However, in neither case does it appear that the resulting reduction in cost would have been enough to offset the loss of fare revenue due to the lower fares, which varied from about a 9% reduction in the market between SFO and SNA to a massive 39% reduction in the market between SFO and SAN.

It is of course quite likely that the average fare levels in 2006 in all of these markets, particularly the markets between SFO and SAN and between SFO and SNA, made these markets highly profitable for United, and thus while the reduction in average fares significantly reduced the profitability of the markets, they may still have been economically viable for United at the 2009 fare levels.

In summary, the entry of Virgin America into the California Corridor markets prompted two rather different competitive responses from the existing airlines with a major presence in these markets. In the case of the low-cost carriers, Southwest and JetBlue, which had previously not served these markets out of SFO, they initiated service from SFO in direct competition to Virgin America, generally matching Virgin America's fares in the case of Southwest and undercutting Virgin America's fares in the case of JetBlue. In comparing fare levels between Virgin America and Southwest or JetBlue, it should be noted that Virgin America charges $25 to check the first bag, while Southwest and JetBlue do not. These baggage fees are not included in the fares reported in the 10% O&D Survey data. However, even in the case of Virgin America, the majority of the travelers in the California Corridor markets are making fairly short duration trips (in many cases same-day or overnight trips) and therefore are likely to be able to avoid checking baggage.

In the case of United Airlines, it reduced the average fare levels to respond to the entry of the low-cost carriers, but not as low as the average fares offered by the low-cost carriers. In addition it increased load factors by reducing flight frequency, and in the case of the market

between SFO and SNA substituted regional airline aircraft for mainline aircraft, thereby reducing seat capacity while increasing flight frequency. In the case of the markets between SFO and LAX and between SFO and SAN, it also slightly increased the average size of the aircraft serving the markets.

Alternative Air Service Scenarios for Use in Future HSR Ridership Forecasts

Forecasts of HSR ridership need to consider two issues: the likely future pattern of air service and air fares in the absence of HSR service and the potential airline response to the introduction of competition from HSR. The evolution of air service in the California Corridor markets in recent years has been characterized by two phenomena:

1. The increasing market share of Southwest Airlines in almost all the markets in the corridor with the exception of the smaller markets between Northern California and LGB or PSP, the very small market between STS and LAX, and the markets between SFO and BUR or ONT.
2. Introduction of service by Virgin America from SFO to three of the larger markets in Southern California (LAX, SAN and SNA) and by JetBlue between the four largest Northern California airports and LGB.

In many of the markets, Southwest is effectively the only carrier serving the market, and even in those markets where the legacy network airlines (America Airlines and United Airlines, or their regional airline partners) still maintain a presence, the market share of the network carriers has steadily eroded and in several of the markets may be becoming too small to remain viable.

SFO is the hub airport for Virgin America. Introducing service to airports in Southern California allows it to feed connecting or through passengers to and from its transcontinental services, so it is unlikely to introduce service to Southern California from other Northern California airports. However, it may introduce service from SFO to other Southern California airports that it does not currently serve. The most likely candidate is ONT, which currently has very limited service from SFO by United Express (four round trips per day) and higher average fares than service to ONT by Southwest from OAK and SJC.

JetBlue Airways currently serves the four primary Northern California airports from LGB, its focus airport in Southern California. However, LGB has a limit on the number of

flights that can be scheduled due to community noise concerns, and this limit is likely to be reached fairly soon. Therefore the opportunities to expand service between Northern California and LGB are limited. The California Corridor flights are generally operated as a continuation or feeder segment of transcontinental flights to or from the Northern California airports. It seems likely that as its transcontinental service to and from the Northern California airports expands, JetBlue will introduce service between those airports and other airports in Southern California. The most likely candidate markets are between SFO and BUR or ONT. However, this is likely to depend on whether Virgin America or Southwest decides to begin service in those markets first.

However this plays out, it seems highly probable that by the time the HSR service begins, there will be expanded low-cost carrier service in the markets between SFO and both BUR and ONT, as well as potentially some competition from JetBlue in markets from OAK, SJC or SMF to Southern California airports that are currently dominated by Southwest. This expanded competition will constrain the future growth of fares in constant dollars, although increases in fuel prices will affect all airlines more or less equally and will need to be covered by higher fares.

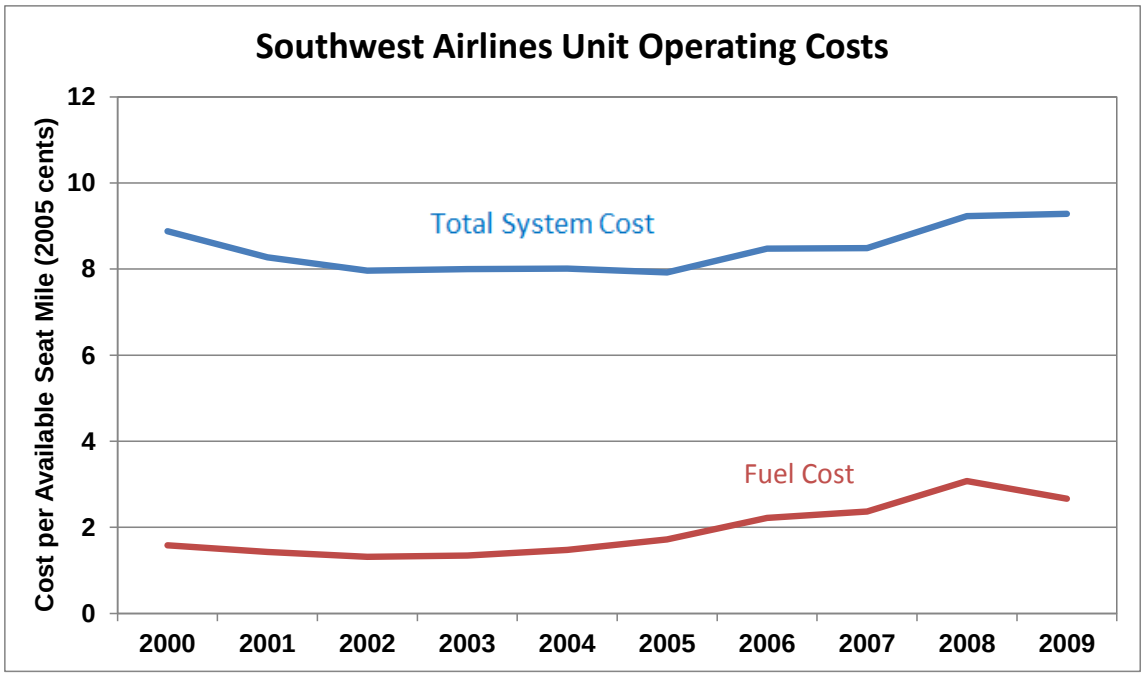
This suggests that further HSR ridership forecasts should consider at least two air fare scenarios: a baseline scenario in which average fares remain at 2009 levels in real terms and a higher fare scenario in which average fares increase in real terms to reflect a potential increase in the real price of fuel, assuming other cost components remain constant in real terms. In addition, the possibility that airfares continue to decline in real terms cannot be ruled out, whether due to increased competition in some markets or improved airline productivity and cost control measures, giving a third scenario.

Since Southwest Airlines is the dominant carrier in most of the California Corridor markets, its cost structure is likely to determine the influence of future fuel costs on fares. The recent trends in Southwest's unit costs are shown in Figure 1.

Although fuel costs have risen significantly from 2003 to 2009, other costs have remained relatively constant in real terms, although an increase in other costs (particularly labor) in 2009 offset the reduction in fuel costs. According to the most recent forecast of future prices of jet fuel by the U.S. Energy Information Administration (US EIA, *Annual Energy Outlook*, April 2011), the price of jet fuel is projected to rise by about 196% between 2009 and 2030.

This would give an annual average increase in the unit fuel cost for Southwest Airlines of about 0.12 cents per available seat mile. Assuming an average load factor of 75%, this would increase airfares between the Bay Area and Los Angeles basin airports by about $12 from 2009 and 2030 in constant 2005 dollars, and by about $15 between the Bay Area airports and San Diego and between Sacramento and the Los Angeles basin airports, and by about $18 between Sacramento and San Diego.

Figure 1. Recent Trend in Southwest Airlines Unit Costs



Source: Analysis of US DOT Form 41 airline cost data from MIT Airline Data Project

The most recent national aviation forecasts by the Federal Aviation Administration (FAA) (*FAA Aerospace Forecast Fiscal Years 2011-2031*, February 2011) is based upon a much more optimistic view of future jet fuel prices that assumes that these prices will rise by only 9.6% in constant dollars from 2009 to 2030. Under this assumption the FAA projects that real passenger yields (fare revenue per passenger-mile) will decline by about 9% from 2009 to 2030. While passenger yields are strictly not the same thing as airfares (which for the purpose of this analysis include taxes and fees, which may not change in the same way as the underlying fares set by the carriers), this provides a reasonable basis for a scenario in which future airfares decline in real terms.

Potential Effect on Airfares of Capacity Constraints

The foregoing airfare scenarios do not consider the potential impact of capacity constraints at California Corridor airports that could lead to higher airfares in the future. SFO, BUR, LAX, LGB, SNA, and SAN all face limits of one sort or another on the total number of air passengers they will be able to handle in the future. As each of these airports approaches its capacity limit, which is likely to occur well before 2030, it can be expected that airfares will rise above levels that would occur in the absence of these capacity constraints, shifting some of the unserved demand to other unconstrained airports. However, the extent to which this will occur will depend on the growth in other markets from those airports, as well as the strategies that the airports decide to implement to limit their traffic growth.

Some indication of the fare premium that might occur at a capacity-constrained airport can be inferred from past experience where airlines have been unable to add flights to meet demand due to slot controls at a congested airport or where lack of competition in a market has led to higher fares than have been experienced in related markets where alternative service has been provided by a low-cost carrier.

Slot Controlled Airports

Before Congress changed the high-density rule as part of the Air 21 legislation in 2000, the ability of airlines to add flights at the four slot-controlled airports (New York Kennedy, New York LaGuardia, Washington National, and Chicago O'Hare) was restricted by the slot limits imposed by the U.S. Department of Transportation. While the mechanism of slot controls is different from the likely situation at capacity-constrained California airports, the resulting effect is similar -- airlines are unable (or unwilling if they are limiting flights to avoid making delays worse) to add flights and average fares rise to balance supply and demand. An analysis of fare premiums at the four slot-controlled airports by Prof. Steven Morrison in 1997[1] showed that fares at LaGuardia and O'Hare were about 11% higher than for comparable routes from non-controlled airports on average, while those at Washington National were about 15% higher. However, fares at Kennedy showed no fare premium (actually they were about 2% below

[1] *Airline Deregulation and Fares at Dominated Hubs and Slot-Controlled Airports*, Statement of Steven A. Morrison, Professor of Economics, Northeastern University, at a Hearing before the Committee on the Judiciary, United States House of Representatives, November 5, 1997.

comparable routes on average). These fare differences were reported as being equivalent to $33 to $44 per round trip.

The differences in fare premiums between the slot-controlled airports seem reasonable. The capacity constraints at Kennedy primarily relate to peaking of international flights and airlines generally did not have difficulty adding flights at other times of day (as evidenced by JetBlue Airways obtaining the necessary slots to start service at Kennedy in early 2000). On the other hand, Washington National is much more convenient to downtown Washington than either Dulles International or Baltimore-Washington International and in addition to its slot limitations also has a perimeter rule and runway length constraints that limit the use of larger aircraft, all factors that would tend to allow airlines to obtain a higher fare premium.

However, to the extent that fare premiums are determined by the willingness of air travelers to use less convenient airports that are not capacity constrained, it would seem more appropriate to express them in dollars, rather than a percentage of airfare, since the inconvenience of using a more distant airport is largely independent of the airfare. Thus a one-way fare premium of $16.50 in 1996 would be equivalent to about $21 in 2005 dollars, although it could be expected that the fare premium might increase over time in constant dollars, as travelers' real value of time increases with increased real incomes. Of course, as indicated by the fare premium difference between La Guardia and Washington National, the fare premium is likely to vary with the relative convenience of the capacity-constrained and alternative unconstrained airports. In the Bay Area there is not much difference in the accessibility of OAK and SFO from downtown San Francisco, and OAK and SJC are more convenient than SFO from large parts of the Bay Area. However, in Southern California the situation is likely to be very different if LAX, BUR, SNA and LGB all start to experience capacity constraints, since ONT (the only airport with current commercial air service that is not expected to experience capacity constraints by 2030) is much less accessible from large parts of the Los Angeles basin.

Therefore it seems plausible that the airfare premium in California Corridor markets due to airport capacity constraints could be substantially higher than $21 in 2005 dollars.

The San Francisco to Orange County Market

The second case that provides some evidence for likely fare premiums at capacity constrained airports is the history of fares in the SFO to SNA market prior to the entry of Virgin America and Southwest Airlines. During the period from 2000 to 2007, United was the

dominant carrier in this market and fares were significantly higher than the markets between OAK or SJC and SNA, in both of which Southwest was the dominant carrier. In 2000, when American also had a significant presence in the SFO to SNA market, the average fare premium compared to OAK to SNA was $32 one-way (in 2005 dollars). By 2005 American had replaced its mainline service in the SFO to SNA market with service by American Eagle, its regional airline subsidiary, while United had started to serve the market with a combination of mainline service and United Express flights using regional jets operated by Sky West. its regional partner, and the average fare premium has increased to $58 one-way. By 2007 the average fare premium had reached $77 one-way, although this dropped to $65 the following year.

During this period the SFO to SNA market was a situation where travelers (at least some) were willing to pay a higher average fare to use their preferred airports (SFO and SNA) rather than incur the inconvenience of using a more distant airport where fares were less. This is exactly the situation that would be faced if some of the airports start to experience capacity constraints but others that are less convenient still have enough capacity to allow airlines to add flights (e.g. if LAX is capacity constrained but ONT still has plenty of capacity). In fact there was a capacity constraint of a sort at SNA before Virgin America and Southwest entered the SFO to SNA market, because American and United reduced capacity by shifting some or all of their flights to their regional airline partners with smaller equipment, so the number of available seats was reduced.

The reason that airlines are able to increase the average fare in a capacity-constrained market is precisely because some travelers are willing to pay a higher fare to avoid the inconvenience (and greater access cost) of using a different airport where fares are lower. If this was not the case, as the airlines tried to raise the fares, passengers would simply switch to the alternative markets where fares are lower and there would be insufficient demand to sustain the higher fares. Airlines would not necessarily have to make an explicit decision to raise the base fare in a capacity-constrained market since the yield management systems will automatically raise the average fares if demand exceeds supply by restricting the number of seats available for the more deeply discounted fares.

Obviously, the relative inconvenience of alternative airports depends on both the local geographic situation as well as the characteristics of the traffic (business travelers and those on one-day trips presumably valuing airport access convenience more than those making personal or

multi-day trips). Thus the premium that could be sustained at LaGuardia (where Kennedy and Newark are not that much further from Manhattan) is likely to be different from the premium that could be sustained in California Corridor markets where the alternative airport (which is likely to be ONT) is much further than the closest airport for the majority of air travelers with a ground trip end in the Los Angeles basin.

Thus the experience in the SFO to SNA market is probably a much better indicator of the likely fare premiums in the California Corridor markets as SFO and the Southern California airports start to experience capacity constraints than the experience at LaGuardia. It also has the merit of being based on much more recent data and the presence of low-cost airlines in competing markets (which was not true at the New York airports in 1996).

During the period under consideration air travelers between SFO and SNA had the option of using OAK or SJC, or flying between SFO and LAX or ONT. The average fare premium in 2007 in the SFO to SNA market compared to SFO to LAX was $65 one-way (again in 2005 dollars), while that compared to SFO to ONT was only $14 one-way. However, by 2007 United had replaced mainline service in the SFO to ONT market with service by United Express operated by its regional partner Sky West and fares had risen significantly. In 2005, when United still provided mainline service between SFO and ONT, the average fare premium in the SFO to SNA market compared to the SFO to ONT market was $50 one-way.

Thus it appears that some air travelers in the SFO to SNA market were willing to pay average fare premiums of as much as $75 one-way to avoid having to use OAK, SJC, LAX or ONT instead.

There is one important caveat to this finding. In 2007 there were approximately 878,000 local passengers in the OAK to SNA market, about 673,000 in the SJC to SNA market, but only about 220,000 in the SFO to SNA market. So clearly a large proportion of the travelers between the Bay Area and SNA did in fact chose to use the less expensive Southwest service from OAK and SJC. It is of course not known whether those who chose to fly between SFO and SNA did so because they felt that avoiding the inconvenience of using OAK or SJC was worth the fare difference or because they were simply unaware of the huge difference in fares. It is also possible that business travelers whose fares were being paid by their firm or someone else chose to fly on American or United to earn the frequent flier miles, even though the fares were much higher than on Southwest.

Implications for Potential Future Airfares in the California Corridors

Given that the average fares in the Bay Area to Southern California markets in 2009 were under $100 each way (in 2005 dollars), these fare premiums have significant implications for future fare levels in the California Corridor markets, if the airports begin to experience their anticipated capacity constraints

Flight Frequencies

Developing assumptions for future flight frequencies in each market is a little more complex than for airfares, because flight frequencies are a function of passenger traffic, average load factors, and average aircraft size, all of which are likely to change in the future. In particular, if air travel demand continues to grow, airlines will need to add capacity to handle the additional traffic and cannot simply continue to offer the same flight frequencies as today.

While some increases in average load factor and average aircraft size are likely, the potential for significant future increase in either in the California Corridor markets is limited. The factors that constrain the ability of airlines to increase average load factors and average aircraft size include:

1. Load factors are already at fairly high levels in many of the markets. The inherent variability of travel demand will make further increases progressively more difficult to achieve. Airlines can always fill empty seats by lowering fares, but if this reduces the total revenue from a flight that is not worth doing.

2. The options for using larger aircraft are limited in the California Corridor markets, given Southwest's dominant market share and its current fleet and fleet replacement plans. The introduction of B737-800 by Southwest may lead to a modest increase in average aircraft size, but it is not clear how much this aircraft would be used in the short-haul California Corridor markets, since it is more suited to the longer-distance transcontinental markets. Neither of the other two low-cost carriers (JetBlue and Virgin America) has announced any plans to acquire larger aircraft than their current Airbus A320 equipment. In fact, JetBlue is in the process of acquiring more of the smaller Embraer 190 aircraft and increasing the use of these aircraft in the California Corridor markets.

3. While the busier California Corridor markets may have enough traffic to be able to support the use of larger aircraft, typically aircraft do not fly back and forth in a single market, but are routed over the airline's network in the course of a day. Thus a given flight between OAK and BUR, say, may begin in Seattle, fly to Portland, then to OAK, then to BUR, and on to Las Vegas or Phoenix. The choice of aircraft equipment has to consider the expected passenger loads in all the markets served by that flight.

4. The more airlines that there are competing in a given market, the less traffic there will be for each airline. Since flight frequency is an important determinant of market share, there is a strong incentive to keep aircraft size as small as economically feasible in order to offer more flights. This is one reason why the legacy airlines have increased the use of their regional airline partners in many markets, since this allows them to use smaller aircraft, such a regional jets, and increase flight frequency.

An analysis of recent trends in average load factors in the California Corridor markets shows that for the total market between the Bay Area and the Los Angeles basin airports, the average load factor declined by about 2 percentage points from 2005 to 2009, giving an average load factor of 67% in 2009, about I percentage point below the level in 2000, while the average load factor for the market between the Bay Area airports and San Diego declined by about 3 percentage points from 2005 to 2009, giving an average load factor of 71% in 2009, about 5 percentage points below the level in 2000. For the total market between Sacramento and the Los Angeles basin airports, the average load factor declined by about 4 percentage points from 2005 to 2009, giving an average load factor of 67% in 2009, about 6 percentage points below the level in 2000. However, in the market between Sacramento and San Diego the average load factor increased by almost 5 percentage points to reach an average load factor of 76% in 2009, less than half a percentage point above the level in 2000.

Undoubtedly, some of the reduction in load factor between 2005 and 2009 in many of the markets has been due to a combination of the recent recession and the additional capacity resulting from market entry by Virgin America and the other low-cost carriers. As demand for air travel rises in the future, it should be possible for the airlines to take advantage of their yield management systems to increase load factors to levels similar to those experienced in 2000 or

even somewhat higher. Therefore for the baseline (constant real airfares) scenario, it seems reasonable to assume an average load factor of 75% across all markets. In the case of the lower fare scenario, which would tend to stimulate more traffic, it seems reasonable to increase this to 78%, while for the high fare scenario, it seems reasonable to assume average load factors of 73% in the markets between SFO and Southern California, between STS and LAX and between Sacramento and San Diego, and 70% is other markets.

A similar analysis of recent trends in average aircraft size in the California Corridor markets shows that for the total market between the Bay Area and the Los Angeles basin airports, the average aircraft size increased by about 3% from 2005 to 2009, while for the market between the Bay Area and San Diego for the same period the average aircraft size increased by about 8%. However, these increases were largely due to replacement of service by the regional airline partners of the legacy carriers in key markets by low-cost carrier entrants using larger aircraft. There are only two markets (between SFO and BUR and between SFO and ONT), both fairly small, where this process has yet to occur.

To the extent that lower average airfares would tend to encourage the airlines to attempt to achieve higher load factors or use larger aircraft (or increases in load factor or average aircraft size could allow lower average airfares), it seems reasonable to assume a somewhat higher average aircraft size in the case of the low airfare scenario than the other two scenarios. It also seems reasonable that markets that had a lower average aircraft size in 2009 would experience a larger increase in average aircraft size than those that already had a higher average aircraft size, due to the replacement of smaller aircraft by a fleet mix more typical of the markets with higher average aircraft size. Therefore for the baseline and high airfare scenario, it is assumed that the average aircraft size in those markets for which the average aircraft size is below the median average aircraft size across all markets from Northern California airports to the Southern California airport in question (with the exception of the market between STS and LAX) will increase to the median level, and then the average aircraft size in all markets will increase by a further 2% (corresponding to the increase in average aircraft size by United Airlines in the market between SFO and LAX following entry by Virgin America and Southwest). For the low airfare scenario, it is assumed that the average aircraft size will increase above that for the baseline scenario by a further 6% (corresponding to the increase in average aircraft size by

United Airlines in the market between SFO and SAN following entry by Virgin America and Southwest).

In the case of the SJC and SMF to PSP markets, the average aircraft size under the Baseline scenario was not increased by 2 percent above the median value across the major markets under current conditions, but rather the average aircraft size was increased by 2 percent above the current average aircraft size in each of the two markets. Due to the assumed diversion to HSR in these markets in 2030, replacing regional airline aircraft with larger equipment in these markets would not give a reasonable daily frequency, so it was assumed that they would continue to be served with regional airline aircraft.

The flight frequency in a given market needed to accommodate the traffic in the market can be determined from following equation:

$$F = P * (1+ R) / (L * S) \qquad (1)$$

where F = Average daily flights in the market
P = Average daily O&D air passengers in the market
R = Ratio of connecting and through passengers to O&D passengers in the market
L = Average load factor
S = Average aircraft size (seats)

For each market, the ratio of connecting and through passengers to O&D passengers can be obtained from recent trends. While this ignores the effects of any future changes in airline network structure and market share in the connecting and through markets, and different rates of growth in those markets from the California Corridor markets, this is consistent with the simplifications typically assumed (often implicitly) in most aviation demand forecasting.

The future growth in each of the markets from the Bay Area to Southern California has been estimated as part of the aviation demand forecasts prepared for the current update of the Bay Area Regional Airport System Plan Analysis, as shown in Table 12. Although these forecasts did not address demand between Sacramento and Southern California, it seems reasonable to assume that the growth rate in each market would be similar to that from the Bay Area.

Based on an analysis of the recent trends in the composition of traffic in each market, together with expected future changes in air service, the assumed ratio of connecting and through passengers to O&D passengers in each of the markets is given by Table 13.

Table 12. Forecast Growth in O&D Passengers – 2009 to 2030

	OAK	SFO	SJC	STS	SMF
BUR	106%	373%	143%		136%
LAX	194%	91%	173%	129%	129%
LGB	86%	111%	109%		100%
ONT	104%	400%	130%		131%
PSP		136%	272%		146%
SNA	150%	117%	146%		136%
SAN	150%	121%	158%		139%

Source: Bay Area Regional Airport System Plan Analysis

Table 13. Assumed Ratio of Connecting and Through Passengers to O&D Passengers

	OAK	SFO	SJC	STS	SMF
BUR	0.11	0.12	0.13		0.12
LAX	0.37	0.59	0.60	0.21	0.53
LGB	0.08	0.06	0.08		0.10
ONT	0.20	0.21	0.21		0.14
PSP		0.52			0.45
SNA	0.11	0.22	0.11		0.05
SAN	0.23	0.38	0.20		0.21

Source: Analysis of US DOT 10% O&D Survey and Form 41 airline data from Bureau of Transportation Statistics

One important caveat to the foregoing approach is that it calculates flight frequency on an industry basis (i.e. for all airlines serving a market in combination). However, in markets served by more than one airline, the flight frequency of each airline will vary depending on its average aircraft size and load factor, not that of the market as a whole, and of course will be less that the flight frequency for all airlines combined. Since an air passenger has to buy a ticket on a given airline, the flight frequency faced by that traveler once they have chosen an airline is that of the airline, not the market. Even allowing for the fact that travelers may select an airline based on the most convenient flight time for their travel plans, since competing airlines often offer flights at similar times, the average headway between departures will be longer than it would be if the total number of daily flights were spread uniformly throughout the day.

Competitive Response to HSR Service

The introduction of HSR service is likely to lead to a reduction in traffic in each of the markets as some potential air passengers choose to use the HSR service. Depending on the extent of the mode shift from air to HSR and the growth in air travel demand between now and the start of HSR service, the remaining air passenger traffic in the Corridor may still be comparable to current levels or even higher. However, there will most likely be a significant decline from the levels immediately prior to the start of HSR service. Therefore the airlines will need to reduce capacity in order to maintain load factors at an economically viable level. This could happen by either reducing frequency or using smaller aircraft.

The opportunity to reduce aircraft size is very limited given the airlines that account for the majority of the service in the Corridor. The dominant airline in most of the markets (indeed the only airline currently serving many of the markets) is Southwest, which does not currently have a regional airline partner and has standardized its fleet on the Boeing 737. Virgin America and JetBlue both operate the Airbus A320, although JetBlue began deploying the smaller Embraer 190 in some California Corridor markets in 2008. However, JetBlue's operating plan in the California Corridor markets makes extensive use of aircraft that continue on as transcontinental flights from the Northern California airports or that arrived at those airports as transcontinental flights. This has important scheduling advantages given the time difference between the West and East Coast and the flight time between the two coasts, and allows both a higher aircraft utilization while allowing transcontinental flights to be scheduled at convenient times. However, this makes it difficult to substitute the Embraer 190 for many of the Airbus A320 flights in the California Corridor markets. Virgin America operates its aircraft in a similar way in the California Corridor markets that it serves, and thus far has neither a regional airline partner nor a smaller aircraft in its fleet.

Although the legacy network carriers could in principle substitute flights by their own equipment with flights operated by their regional partners using smaller aircraft, in most of the relatively few Corridor markets that they still serve they have already done so, so the opportunity to further reduce average aircraft size is quite limited.

Therefore it would seem more likely that all the airlines would tend to reduce frequency rather than aircraft size. This would have the effect of making the air service less convenient, particularly for travelers who have less flexibility over when they would prefer to travel.

Because the flight schedules of JetBlue and Virgin America in the Corridor markets that they serve are tied to their transcontinental schedules, the opportunity for those carriers to reduce frequency is more limited than is the case for Southwest. While they could use the aircraft to serve markets for which the HSR service is not a viable alternative, there are very few such markets that would be likely to generate enough traffic to make this economically viable. Also, because these services in the California Corridor currently perform an important role in feeding traffic to the transcontinental flights from the Bay Area, the two airlines might be willing to operate their California Corridor flights at a lower load factor than the rest of their system and accept that these flights may not generate enough revenue from the local passengers to fully cover the cost of operating the Corridor flights. However, as they expand direct service in transcontinental or other long-haul markets from airports in Southern California, the need to flow traffic from those airports through the Bay Area airports will reduce, and with it the ability to use that traffic to support service in the California Corridor markets.

Therefore it seems most likely that Southwest Airlines would be forced to reduce the frequency of its flights in the Corridor markets in order to maintain a viable load factor. The extent of the reduction is likely to vary by market, depending how much diversion to HSR service occurs in each market, and by whether JetBlue and Virgin America have continued to maintain the number of flight departures offered in those markets that they serve. Ideally the extent of any reduction would be assessed through an iterative analysis, in which the flight frequency would be reduced, the effect of this on the diversion of air trips to HSR service would be calculated, and the resulting average load factor calculated. If this is deemed too low to be economically viable, the flight frequency would be adjusted and the process repeated until an equilibrium load factor is obtained.

In the absence of such an approach, it is possible to use prior estimates of the diversion of air trips to HSR made as part of past modeling to develop ridership and revenue forecasts for the planned California HSR system as a basis to estimate the potential effect of the diversion of air trips to HSR on air passenger traffic and hence flight frequency. As part of the current update of the Bay Area Regional Airport System Plan Analysis, an analysis was performed of the potential diversion of air trips between the Bay Area and Southern California, using the results of prior ridership modeling performed for the California High-Speed Rail Authority by a consultant team led by Cambridge Systematics. This gave the diversion estimates for 2030 shown in Table 14,

based on the planned full system, including the segment from Los Angeles to San Diego, and assuming HSR fares at 83% of airfares in the comparable market. Although no estimates were made of the potential diversion of air trips between Sacramento and Southern California, it would seem reasonable that these would be similar to those for SJC, given the similarity of the markets and urban form in Sacramento and Santa Clara County and the relative location of the airport and HSR station in each city.

Table 14. Assumed Diversion of Air Trips to HSR by Market - 2030

	OAK	SFO	SJC	STS	SMF
BUR	50.8%	67.7%	67.7%		67.7%
LAX	49.4%	65.8%	65.8%	31.4%	65.8%
LGB	38.2%	50.9%	50.9%		50.9%
ONT	42.7%	57.0%	57.0%		57.0%
PSP		31.4%	31.4%		31.4%
SNA	38.1%	50.8%	50.8%		50.8%
SAN	24.8%	33.1%	33.1%		33.1%

Source: Bay Area Regional Airport System Plan Analysis

The resulting flight frequency can be calculated using a modified version of Equation (1), as follows:

$$F = P * (1 - D + R) / (L * S) \qquad (2)$$

where D = Proportion of O&D passengers in the market diverted to HSR
and other terms are as defined for Equation (1)

However, the foregoing diversion percentages are obviously influenced by the fare differential between air and HSR. In the previous analysis, it was assumed that average HSR fares would be set at 83% of average airfares in comparable markets. But this raises the question of whether airlines would be willing to let such a situation exist, or would lower their fares to compete. Assuming that airfares in the absence of HSR have been set at profit maximizing levels given the competitive environment, the question is whether they would be better off lowering their fares or accepting the loss of traffic. Answering this question requires an understanding of the dynamics of modal competition between air and HSR.

Not only are the airlines at a fare disadvantage if HSR fares are lower than airfares, but the diversion of air passenger trips to HSR will cause the airlines to reduce flight frequency, further increasing the relative attractiveness of HSR service and increasing the diversion from air to rail. If the diversion elasticity with respect to the fare differential between air and rail (the percentage increase in diversion for each percent increase in the fare differential) is greater than one, then reducing airfares may reduce the diversion of trips by enough to offset the loss of revenue from the lower fares. In this case, airlines may be driven to lower their fares to compete with HSR, violating the assumption about HSR fares being 83% of air fares. (Obviously, the HSR system cannot keep reducing fares in such a situation, since it too has to cover its operating and infrastructure costs).

Analyzing the dynamics of this situation is beyond the scope of this technical memorandum, but is critical to understanding the economic viability of the planned California HSR system. For the purposes of the current analysis, it is assumed that the airlines will continue to offer the same fares as they would in the absence of HSR, and adjust their flight frequencies to match the lower traffic levels.

Summary

Table 15 on the following page summarizes the assumptions proposed for each of the scenarios. The resulting air service levels for each of the major California Corridor markets under each of the three scenarios applying the proposed assumptions and approach are presented in Appendix B, together with the input values to the flight frequency calculations for each market.

Air Service in Minor California Corridor Markets

In addition to the major California Corridor markets discussed above, there are a number of minor markets in the Corridor in which some air trips may be diverted to HSR service. These include markets between Central Valley communities that will be served by the HSR system and the Bay Area, Southern California, and San Diego, as well as air service between LAX and Palm Springs and San Diego, and between Sacramento and SFO. In order to include service assumptions for these markets in HSR ridership modeling, airfares and service frequencies were determined for each of these markets for 2009, as shown in Appendix C.

Table 15. Air Service Assumptions for Use in Future HSR Ridership Forecasts

	Airfares	Average Load Factor	Average Aircraft Size	Flight Frequency
Baseline Scenario	2009 average fares by market in constant 2005 dollars	75%	Increase in average aircraft size in each market with a smaller average aircraft size to the median aircraft size in 2009 for markets from the Northern California airports to the relevant Southern California airport, plus a further increase of 2% in all markets	Determined from flight frequency equation for the assumed market diversion ratio
Low-Fare Scenario	9% reduction in real fares from 2009 levels	78%	A further increase of 6% above the Baseline Scenario	Same
High Fare Scenario	Increase in real fares over 2009 levels by $12 to $18 in 2030 depending on market	70% or 73% depending on market	Same as Baseline Scenario	Same

Since the majority of the air passengers in most of these markets are connecting to other flights at the larger airport, the approach used for developing future air service scenarios for major California Corridor markets cannot be applied to project likely changes in flight frequencies in the minor markets. These markets are mainly served by American Eagle or United Express using smaller regional airline aircraft, primarily to provide connecting service to other flights at either LAX or SFO, with occasional operations by other airlines using larger equipment, mainly between LAX and SAN.

Given the limited passenger demand in these markets, it is unlikely that this situation will change significantly in the future. Whether an increase in overall passenger traffic in the minor markets would lead to additional flights in those markets or the use of larger regional airline aircraft for some flights is unclear, since this is likely to depend on the available fleet and

network strategy of the regional airlines serving the markets. However, for the purpose of projecting future flight frequencies in the markets in 2030, it would be reasonable to assume that flight frequencies would increase proportionally to overall passenger traffic.

The forecasts prepared as part of the Bay Area Regional Airport System Plan Analysis projected the growth in connecting passengers at SFO from 2009 to 2030 from Sacramento and the Central Valley cities, as follows:

- Bakersfield 139%
- Fresno 148%
- Modesto 137%
- Sacramento 152%

It would be reasonable to assume a similar growth in total passengers in each market, and the same growth rate from Fresno to LAX as Fresno to SFO. For the markets from LAX to PSP and SAN, it would be reasonable to assume the same growth rate as the markets between SFO and each airport. Where there was no direct service in a market in 2009 (such as between Bakersfield and SMF), it can be assumed that air travelers would connect through SFO, so the flight frequency between the Central Valley city and SFO would be the governing frequency.

Conclusions

The market entry of Virgin America into several California Corridor markets starting in 2007 provides a useful case study into likely airline response to the introduction of competing service by the planned California HSR system, although there are important differences between the two situations. Perhaps the most important difference is that the two principal low-cost carriers that were serving the California Corridor markets prior to the entry of Virgin America had the ability to also commence competing service from SFO, which significantly affected the competitive position of Virgin America at SFO, as well as attracted air passenger traffic to SFO from the other airports in the Bay Area. In response, United Airlines, which was previously the dominant carriers in these markets from SFO, reduced its fares significantly to levels somewhat above those offered by the low-cost carriers. There are obvious limitations on the ability to repeat this response in the face of competition from HSR.

The response of Southwest Airlines and JetBlue Airways at the other two principal Bay Area airports is perhaps more indicative of how airlines may respond to a loss of traffic due to

competition from HSR. JetBlue significantly reduced both its average fares and flight frequency in the market between OAK and LGB. The response by JetBlue at SJC is less clear because it had only started service there in 2008, so it is hard to separate competitive effects from start-up effects. On the other hand, Southwest maintained fare levels more or less unchanged in most markets from OAK and SJC but reduced flight frequencies in all markets to reflect the diversion of traffic to SFO. However, by adding service at SFO both airlines were able to continue serving much of the traffic that was attracted to SFO from OAK and SJC, so the loss of traffic at OAK and SJC was partially offset by the new traffic at SFO. This would not be the case with the introduction of HSR service, since the airlines would lose all the traffic attracted to HSR.

Unfortunately there is only limited U.S. experience to date to observe how airlines have responded to improvements in rail services. Although there is considerable experience in Europe with airline response to the introduction of high-speed rail services, the differences between the situation faced by airlines serving European markets in competition with high-speed rail and that faced by U.S. airlines serving short-haul domestic markets raises concerns about the transferability of the European experience. However, one opportunity to examine possible airline response to the introduction of HSR service arises from the improvement in train travel times in the Northeast Corridor with the introduction of the Acela service between Boston, New York, Philadelphia, and Washington, D.C. This experience has the appeal that it specifically addresses airline response to improved rail service rather than inferring this from the competitive response to service entry by other airlines. It is suggested that a detailed case study of this experience be considered for future work in order to compare the actual experience in the Northeast Corridor with the conclusions of the analysis of the California Corridor markets presented in this memorandum.

Appendix A

ORIGIN AND DESTINATION SURVEY EXPANSION

The air passenger itineraries reported by U.S. airlines to the U.S. Department of Transportation in the Origin and Destination (O&D) Survey are intended to represent a sample of 10 percent of all passenger itineraries. Therefore the passenger counts from the O&D survey need to be expanded to give the total number of passengers in a given market. If the survey were an accurate 10 percent sample, it would simply be a matter of multiplying the O&D Survey passenger counts by 10 to give the number of passengers with a given itinerary. However, for a variety of reasons, the O&D Survey passenger counts for a given market typically differ from the passenger counts in a given market reported on Schedule T-100 of Form 41 by a factor of more or less than 10.

Perhaps the most significant factor accounting for this difference is the fact that the domestic O&D Survey counts do not include the domestic portion of passenger itineraries involving both domestic and international segments, while the T-100 passenger counts for domestic segments or markets count all passengers on board flights in those segments or markets, and thus do include passengers with an itinerary involving international segments. Since the passengers with itineraries involving domestic and international segments are counted in the T-100 passenger counts but not the domestic O&D Survey passenger counts, this should result in the ratio of the T-100 counts to the domestic O&D Survey counts for a given market being greater than 10. The greater the proportion of passengers with an itinerary involving international segments in the market, the more the ratio should exceed 10.

Other factors that could result in a ratio different from 10 include under- or over-reporting of either the T-100 data or the O&D Survey data.

In order to determine the appropriate expansion factors to use for the California Corridor analysis, a comparison was made between the T-100 market data and the O&D Survey coupon data for each of the airport-pair markets in the Corridor for 2009. Since the T-100 market data is a count of passengers boarding a flight at one airport and deplaning at the other, it includes both local passengers (those for whom the airport-pair represents the origin and destination of their entire air trip) and passengers who are connecting from or to other flights at one or other airport

(or even both airports). The corresponding data in the O&D survey is the coupon database, since both types of passenger will have one ticket coupon for their flight between the two airports in the market, whether this is a nonstop flight or makes one or more intermediate stops.

When comparing T-100 passenger counts with O&D Survey counts it is generally necessary to combine the data for an airline and its regional airline partners. Although the T-100 passenger counts distinguish between a mainline airline and each of its regional airline partners, since each airline reports its T-100 data separately, the distinction can become blurred in the O&D Survey data, since the regional airline flights typically carry the airline code of the mainline partner, so a ticket coupon will show the mainline airline as the operating carrier, even if the flight is in fact operated by the regional airline.

One further complication in the comparison, discussed further below, is that the T-100 market passenger counts include domestic legs of passengers on a combined domestic and international itinerary, while these passengers are excluded from the O&D Survey coupon database as noted above.

Bay Area Markets

Table A-1 shows the O&D survey expansion factors computed from the T-100 market passengers and the O&D survey coupon count for the Corridor markets between Oakland International Airport (OAK) and Mineta San José International Airport (SJC) in the Bay Area and Bob Hope Airport, Burbank (BUR), Los Angeles International Airport (LAX), Long Beach Airport (LGB), Ontario International Airport (ONT), John Wayne Airport, Orange County (SNA), and San Diego International Airport (SAN) in Southern California, together with the market between Sonoma County Airport (STS) and LAX.

It can be seen that the expansion factors vary by quarter and airline. The expansion factors for American Airlines and United Airlines combine passenger and coupon counts for their mainline flights with those for their regional airline partners (American Eagle and SkyWest Airlines). The expansion factors for Southwest Airlines are generally well below 10, with a weighted average value (weighted by coupon counts) for the full year of 9.4 at both airports. The expansion factor for JetBlue Airways for the full year is 10.0 for both airports, while the expansion factors for American Airlines and United Airlines in the market between SJC and LAX are higher than 10, particularly for American. This may well result from the presence of passengers in the market who are connecting to or from international flights at LAX. Such

passengers are more likely to fly on American between SJC and LAX, due to the larger number of international flights offered by American at LAX compared to SFO, the larger market share of American in the SJC to LAX market, and because SFO is a major international gateway for United. Passengers to and from the South Bay flying internationally on United or its Star Alliance partners would be more likely to use SFO than use SJC to connect to an international flight at LAX.. The expansion factors for American flights between SJC and SNA or San Diego are fairly close to 10, which appears consistent with these markets being unlikely to attract a significant number of passengers on international itineraries.

Table A-1. O&D Survey Expansion Factors for California Corridor Markets from OAK, SJC and STS

Market	Airline	2009Q1	2009Q2	2009Q3	2009Q4	2009
OAK-BUR	Southwest	9.5	9.0	9.2	9.1	9.2
OAK-LAX	Southwest	9.7	9.3	9.3	9.3	9.4
OAK-LGB	JetBlue	10.2	9.8	10.1	9.9	10.0
OAK-ONT	Southwest	9.6	9.4	9.6	9.3	9.5
OAK-SNA	Southwest	9.4	9.4	9.3	9.3	9.4
OAK-SAN	Southwest	9.8	9.4	9.6	9.4	9.5
Wt Avg	Southwest	9.6	9.3	9.4	9.3	9.4
SJC-BUR	Southwest	9.5	9.2	9.3	9.3	9.3
SJC-LAX	American	12.0	10.8	11.2	12.3	11.6
	United	11.3	10.3	11.0	10.1	10.6
	Southwest	9.5	9.2	9.2	9.2	9.3
SJC-LGB	JetBlue	10.5	10.1	9.7	9.9	10.0
SJC-ONT	Southwest	9.7	9.6	9.4	9.3	9.5
SJC-SNA	American	9.8	9.4	9.9	13.7	10.0
	Southwest	9.3	9.4	9.2	9.2	9.3
SJC-SAN	American	9.8	10.4	10.0		10.1
	Southwest	9.7	9.4	9.5	9.3	9.5
Wt Avg	Southwest	9.5	9.3	9.3	9.3	9.4
STS-LAX	Horizon Air	11.1	10.4	10.2	10.1	10.4

The expansion factors for Horizon Air flights between STS and LAX are somewhat higher than 10, but not as high as the American and United flights between SJC and LAX. This is consistent with a moderate proportion of passengers connecting to international flights at LAX, particularly to Alaska Airlines flights to Mexico (Horizon Air is the regional airline partner of Alaska Airlines). It is notable that the expansion factor is highest in the first quarter, which is the most popular season for travel to Mexico.

Table A-2 shows the corresponding O&D survey expansion factors for the same Corridor markets from SFO, together with the market from SFO to Palm Springs Airport (PSP), which is not served from either OAK or SJC.

Table A-2. O&D Survey Expansion Factors for California Corridor Markets from SFO

Market	Airline	2009Q1	2009Q2	2009Q3	2009Q4	2009
SFO-BUR	United	10.3	9.8	10.5	9.7	10.0
SFO-LAX	Alaska	28.1	17.9	18.7	19.8	20.4
	American	12.7	12.1	12.7	14.2	12.9
	United	12.5	11.6	11.9	11.5	11.9
	Southwest	9.6	9.3	9.5	9.2	9.4
	Virgin America	9.7	9.5	9.9	9.7	9.7
SFO-LGB	JetBlue	10.2	9.7	9.9	9.7	9.9
SFO-ONT	United	10.5	9.6	8.4	8.3	9.0
SFO-PSP	Alaska	10.2	10.7	10.7	10.1	10.4
	United	11.4	11.5	10.4	10.8	11.1
SFO-SNA	American	9.5	9.4	9.8	13.7	9.7
	United	10.5	10.3	10.6	10.0	10.3
	Southwest		9.2	9.5	9.4	9.4
	Virgin America		9.7	9.9	9.3	9.6
SFO-SAN	United	12.3	11.4	11.4	11.3	11.6
	Southwest	9.7	9.3	9.7	9.2	9.4
	Virgin America	10.0	9.8	10.0	9.3	9.7
Wt Avg	United	11.9	11.1	11.3	10.9	11.3
	Southwest	9.6	9.3	9.6	9.2	9.4
	Virgin America	9.8	9.6	9.9	9.5	9.7

The expansion factors for Southwest Airlines are consistent with those for markets from OAK and SJC, while the expansion factors for Virgin America are somewhat higher but still less than 10. The expansion factors for American Airlines in the LAX market are well over 10 and higher than those from SJC to LAX, consistent with a high proportion of passengers connecting to international flights at LAX, while the American expansion factors in the SNA market are generally somewhat below 10 and quite close to those for Virgin America, except for the fourth quarter

The expansion factors for United Airlines vary widely by market. In the LAX market they vary between 11.5 and 12.5, while in the San Diego market they are slightly lower, varying between 11.3 and 12.3. This is consistent with a significant proportion of passengers connecting to or from international flights at SFO or LAX. The United expansion factors in the BUR, ONT and SNA markets are generally closer to 10, and in some cases below 10, particularly in the ONT market in the second and third quarter, where they are between 8.3 and 8.4, well below anything observed in any of the other markets or for other carriers, suggesting there may be a problem with the data for these quarters. The United expansion factors in the PSP market vary between 10.4 and 11.5, consistent with a significant proportion of passengers in this market connecting to or from international flights at SFO.

The expansion factors for Alaska Airlines in the LAX market are extremely high, varying between about 19 and 28. This is undoubtedly due to a high proportion of passengers in this market connecting to flights to Mexico at LAX. Alaska has extensive service to Mexico from LAX and because LAX is the international gateway, passengers generally have to connect to different flights at LAX. Thus they would be counted in the T-100 data for flights between SFO and LAX but not counted in the domestic O&D data for that market. Consistent with the expansion factors for the Horizon Air service between STS and LAX, the highest expansion factor (implying the highest proportion of international connecting passengers) occurs in the first quarter. The Alaska expansion factors for the PSP market are somewhat above 10 but nowhere near as high as the LAX market. This is consistent with a smaller proportion of passengers connecting to or from international flights at SFO. As could be expected, this proportion appears to be lower than for United Airlines in the same market (actually the service was provided by SkyWest, operating as United Express). Passengers connecting to or from international flights at

SFO are more likely to choose United for the segment between SFO and PSP due to its more extensive international service at SFO.

Sacramento Markets

Table A-3 shows the O&D survey expansion factors for the same California Corridor markets from Sacramento International Airport (SMF), the only airport with passenger airline service in the Sacramento area. Because of the location of SMF to the northwest of the City of Sacramento, this airport also attracts some passengers from the northern counties of the Bay Area (primarily Solano and Napa Counties), for whom it is more convenient to access than the primary airports in the Bay Area, particularly during the morning and evening commute periods, when the freeways between Napa and Solano Counties and OAK are heavily congested.

Table A-3. O&D Survey Expansion Factors for California Corridor Markets from SMF

Market	Airline	2009Q1	2009Q2	2009Q3	2009Q4	2009
SMF-BUR	Southwest	9.6	9.5	9.2	9.1	9.4
SMF-LAX	United	11.2	10.9	12.1	11.2	11.3
	Southwest	9.8	9.5	9.4	9.5	9.5
SMF-LGB	JetBlue	10.2	10.0	10.1	10.0	10.1
SMF-ONT	Southwest	9.5	9.2	9.2	9.1	9.3
SMF-PSP	Horizon Air	10.6	10.2	11.2	9.7	10.4
SMF-SNA	Southwest	9.6	9.6	9.5	9.5	9.5
SMF-SAN	Southwest	9.7	9.4	9.5	9.4	9.5
Wt Avg	Southwest	9.6	9.4	9.4	9.3	9.4

The expansion factors for Southwest Airlines in all the markets served from SMF are similar to those for markets served from the Bay Area airports, and the weighted average value across all markets for the full year is effectively identical. The expansion factors for United Airlines in the LAX market (the only market served by United from SMF) range from 10.9 to 12,1, with a value for the full year of 11.3, perhaps coincidentally the same as the weighted average value for United for the year across all markets served from SFO. This is consistent with a moderately high proportion of passengers connecting to or from international flights at

LAX. This seems reasonable, since SMF had very limited international service, so passengers making international trips would have to fly to a gateway airport such as SFO or LAX and connect there to international flights. Since it is feasible for passengers from the Sacramento area to drive to SFO to catch international flights, the somewhat lower proportion of passengers connecting to or from international flights at LAX implied by the expansion factors compared to those for the market between SFO and LAX seems reasonable.

It is of course entirely possible (and indeed quite likely) that some proportion of the passengers on Southwest flights to LAX are also connecting to international flights there. However, because Southwest does not serve international markets or offer joint ticketing with other airlines, this would not be picked up in the O&D survey. There is no way to know from the O&D survey data whether passengers on Southwest for whom LAX is the destination airport have reached their final destination or are connecting to an international flight at LAX, booked on a separate ticket.

The survey expansion factors for JetBlue in the LGB market varies between 10.0 and 10.2, averaging 10.1 for the full year, slightly higher than observed in the LGB market from the Bay Area airports. The expansion factors for the Horizon Air service in the PSP market range from 9.7 to 11.2, averaging 10.4 for the full year. Since it is implausible that there would be any passengers connecting to international flights at either SMF or PSP, these differences are most likely due to reporting or sampling errors.

Summary

Although the survey expansion factors vary from quarter to quarter for a given market, overall the expansion factors for Southwest Airlines are consistently lower than those for other airlines, averaging around 9.4. Virgin America also has somewhat lower expansion factors than other airlines apart from Southwest, averaging around 9.7. It is unclear why these two carriers have survey expansion factors below 10.

The survey expansion factors for JetBlue are generally around 10. Although the expansion factor for the market between SMF and LGB is slightly higher than 10 for the full year, that between SFO and LGB is slightly lower. Whether these minor differences across the different markets reflect systemic differences between the markets or are simply a consequence of the sampling strategy is unclear. The airlines are supposed to report the itinerary of every passenger with a ticket number ending in zero. Thus depending how reservations in different

markets are assigned ticket numbers (or selected for reporting, since with online reservation systems there are no tickets as such), it is possible that sampling rates vary from 10 percent across different markets.

The survey expansion factors for the network carriers, Alaska Airlines (and its regional partner Horizon Air), American Airlines and United Airlines, are substantially higher than 10 in those markets where there is likely to be a significant proportion of passengers connecting to or from international flights, as would be expected, and generally fairly close to 10 in those markets where the proportion of passengers making international trips is likely to be very small or non-existent. Therefore it appears reasonable to use a survey expansion factor of 10 for true domestic itineraries on these carriers.

Appendix B

AIR SERVICE ASSUMPTIONS FOR 2030 WITH HIGH-SPEED RAIL

Major California Corridor Markets

Table B-1. Baseline Scenario

Market		Airfares (2005 $)	Avg Daily Frequency (each way)	Estimated O&D Pax (both ways) (2009)	Assumed Growth (2030)	Connect & Thru Ratio	Avg Aircraft Size (seats) (current)	(2030)	Avg Load Factor	Assumed Diversion to HSR
OAK	BUR	94.00	12.4	766,718	106%	0.11	137	140	75%	50.8%
	LAX	90.00	21.7	644,502	194%	0.37	137	140	75%	49.4%
	LGB	69.00	3.6	231,190	86%	0.08	150	153	75%	38.2%
	ONT	90.00	9.6	465,069	104%	0.20	137	140	75%	42.7%
	PSP	No Direct Service								
	SNA	98.00	12.1	508,620	150%	0.11	137	140	75%	38.1%
	SAN	90.00	20.7	647,300	150%	0.23	137	140	75%	24.8%
SFO	BUR	93.00	2.0	71,420	373%	0.12	137	140	75%	67.7%
	LAX	81.00	42.1	1,877,739	91%	0.59	142	145	75%	65.8%
	LGB	66.00	2.3	168,780	111%	0.06	150	153	75%	50.9%
	ONT	86.00	1.6	38,800	400%	0.21	137	140	75%	57.0%
	PSP	115.00	5.3	143,810	136%	0.52	90	140	75%	31.4%
	SNA	77.00	13.1	650,727	117%	0.22	120	140	75%	50.8%
	SAN	78.00	33.9	1,119,464	121%	0.38	137	140	75%	33.1%
SJC	BUR	92.00	5.9	410,556	143%	0.13	137	140	75%	67.7%
	LAX	93.00	17.8	529,173	173%	0.60	100	140	75%	65.8%
	LGB	65.00	2.3	147,740	109%	0.08	109	140	75%	50.9%
	ONT	87.00	5.3	273,450	130%	0.21	137	140	75%	57.0%
	PSP	104.00	0.9	10,800	272%	0.23	70	71	75%	31.4%
	SNA	93.00	10.1	524,100	146%	0.11	137	140	75%	50.8%
	SAN	93.00	17.7	603,983	158%	0.20	137	140	75%	33.1%
STS	LAX	99.00	2.9	61,280	129%	0.21	76	78	75%	31.4%
SMF	BUR	91.00	6.4	467,032	136%	0.12	137	140	75%	67.7%
	LAX	95.00	12.0	459,380	129%	0.53	111	140	75%	65.8%
	LGB	80.00	1.8	124,530	100%	0.10	150	153	75%	50.9%
	ONT	91.00	8.8	514,927	131%	0.14	137	140	75%	57.0%
	PSP	110.00	1.9	27,020	146%	0.45	70	71	75%	31.4%
	SNA	98.00	7.5	448,992	136%	0.05	137	140	75%	50.8%
	SAN	95.00	18.6	678,050	139%	0.21	137	140	75%	33.1%

Table B-2. Low-Fare Scenario

Market		Airfares (2005 $)	Avg Daily Frequency (each way)	Estimated O&D Pax (both ways) (2009)	Assumed Growth (2030)	Connect & Thru Ratio	Avg Aircraft Size (seats) (current)	(2030)	Avg Load Factor	Assumed Diversion to HSR
OAK	BUR	86.00	11.3	766,718	106%	0.11	137	148	78%	50.8%
	LAX	82.00	19.7	644,502	194%	0.37	137	148	78%	49.4%
	LGB	63.00	3.3	231,190	86%	0.08	150	162	78%	38.2%
	ONT	82.00	8.7	465,069	104%	0.20	137	148	78%	42.7%
	PSP	No Direct Service								
	SNA	89.00	11.0	508,620	150%	0.11	137	148	78%	38.1%
	SAN	82.00	18.9	647,300	150%	0.23	137	148	78%	24.8%
SFO	BUR	85.00	1.8	71,420	373%	0.12	137	148	78%	67.7%
	LAX	74.00	38.1	1,877,739	91%	0.59	142	154	78%	65.8%
	LGB	60.00	2.1	168,780	111%	0.06	150	162	78%	50.9%
	ONT	78.00	1.5	38,800	400%	0.21	137	148	78%	57.0%
	PSP	105.00	4.9	143,810	136%	0.52	90	148	78%	31.4%
	SNA	70.00	11.9	650,727	117%	0.22	120	148	78%	50.8%
	SAN	71.00	30.8	1,119,464	121%	0.38	137	148	78%	33.1%
SJC	BUR	84.00	5.4	410,556	143%	0.13	137	148	78%	67.7%
	LAX	85.00	16.1	529,173	173%	0.60	100	148	78%	65.8%
	LGB	59.00	2.1	147,740	109%	0.08	109	148	78%	50.9%
	ONT	79.00	4.8	273,450	130%	0.21	137	148	78%	57.0%
	PSP	95.00	0.9	10,800	272%	0.23	70	75	78%	31.4%
	SNA	85.00	9.2	524,100	146%	0.11	137	148	78%	50.8%
	SAN	85.00	16.1	603,983	158%	0.20	137	148	78%	33.1%
STS	LAX	90.00	2.7	61,280	129%	0.21	76	83	78%	31.4%
SMF	BUR	83.00	5.8	467,032	136%	0.12	137	148	78%	67.7%
	LAX	86.00	10.9	459,380	129%	0.53	111	148	78%	65.8%
	LGB	73.00	1.6	124,530	100%	0.10	150	162	78%	50.9%
	ONT	83.00	8.0	514,927	131%	0.14	137	148	78%	57.0%
	PSP	100.00	1.8	27,020	146%	0.45	70	75	78%	31.4%
	SNA	89.00	6.8	448,992	136%	0.05	137	148	78%	50.8%
	SAN	86.00	16.9	678,050	139%	0.21	137	148	78%	33.1%

Table B-3. High-Fare Scenario

Market		Airfares (2005 $)	Avg Daily Frequency (each way)	Estimated O&D Pax (both ways) (2009)	Assumed Growth (2030)	Connect & Thru Ratio	Avg Aircraft Size (seats) (current)	(2030)	Avg Load Factor	Assumed Diversion to HSR
OAK	BUR	107.00	12.6	766,718	106%	0.11	137	148	70%	50.8%
	LAX	103.00	21.9	644,502	194%	0.37	137	148	70%	49.4%
	LGB	82.00	3.6	231,190	86%	0.08	150	162	70%	38.2%
	ONT	103.00	9.7	465,069	104%	0.20	137	148	70%	42.7%
	PSP	No Direct Service								
	SNA	111.00	12.3	508,620	150%	0.11	137	148	70%	38.1%
	SAN	106.00	21.0	647,300	150%	0.23	137	148	70%	24.8%
SFO	BUR	105.00	1.9	71,420	373%	0.12	137	148	73%	67.7%
	LAX	93.00	40.7	1,877,739	91%	0.59	142	154	73%	65.8%
	LGB	78.00	2.3	168,780	111%	0.06	150	162	73%	50.9%
	ONT	98.00	1.6	38,800	400%	0.21	137	148	73%	57.0%
	PSP	127.00	5.2	143,810	136%	0.52	90	148	73%	31.4%
	SNA	89.00	12.7	650,727	117%	0.22	120	148	73%	50.8%
	SAN	93.00	32.9	1,119,464	121%	0.38	137	148	73%	33.1%
SJC	BUR	105.00	6.0	410,556	143%	0.13	137	148	70%	67.7%
	LAX	106.00	18.0	529,173	173%	0.60	100	148	70%	65.8%
	LGB	78.00	2.3	147,740	109%	0.08	109	148	70%	50.9%
	ONT	100.00	5.3	273,450	130%	0.21	137	148	70%	57.0%
	PSP	117.00	1.0	10,800	272%	0.23	70	75	70%	31.4%
	SNA	106.00	10.3	524,100	146%	0.11	137	148	70%	50.8%
	SAN	109.00	17.9	603,983	158%	0.20	137	148	70%	33.1%
STS	LAX	111.00	2.8	61,280	129%	0.21	76	83	73%	31.4%
SMF	BUR	107.00	6.5	467,032	136%	0.12	137	148	70%	67.7%
	LAX	111.00	12.1	459,380	129%	0.53	111	148	70%	65.8%
	LGB	96.00	1.8	124,530	100%	0.10	150	162	70%	50.9%
	ONT	107.00	9.0	514,927	131%	0.14	137	148	70%	57.0%
	PSP	126.00	2.0	27,020	146%	0.45	70	75	70%	31.4%
	SNA	114.00	7.6	448,992	136%	0.05	137	148	70%	50.8%
	SAN	113.00	18.1	678,050	139%	0.21	137	148	73%	33.1%

Appendix C

AIR SERVICE IN MINOR CALIFORNIA CORRIDOR MARKETS

2009

Market		Estimated O&D Pax (both ways)	Average Fare Current $ (one way)	Average Fare 2005$ (one way)	Avg Daily Frequency (both ways)	CPI Factor (2005 = 100)	CPI Source
LAX	PSP	3,980	252.76	228.52	13.7	110.6	*(note 2)*
	SAN	26,720	211.09	191.55	60.0	110.2	*(note 3)*
SMF	SFO	2,280	268.29	242.35	13.7	110.7	*(note 4)*
BFL	SFO	4,630	226.59	204.69	4.9	110.7	*(note 5)*
	SMF	880	217.47	196.45	*(note 1)*	110.7	*(note 5)*
FAT	SFO	4,750	279.65	252.61	12.8	110.7	*(note 4)*
	LAX	26,940	192.08	173.51	22.3	110.7	*(note 5)*
	SNA	910	270.26	244.14	*(note 1)*	110.7	*(note 5)*
	SAN	26,930	143.54	130.13	*(note 1)*	110.3	*(note 6)*
MOD	SFO	2,290	51.82	46.81	8.9	110.7	*(note 4)*
	LAX	6,300	119.70	108.13	*(note 1)*	110.7	*(note 5)*
	SNA	3,330	97.20	87.81	*(note 1)*	110.7	*(note 5)*
	SAN	5,210	107.25	97.24	*(note 1)*	110.3	*(note 6)*

Notes:
1. No direct service
2. Southern California CPI
3. Average CPI for Southern California and San Diego
4. Bay Area CPI
5. Average CPI for Bay Area and Southern California
6. Average CPI for Bay Area and San Diego

Airport codes:
BFL Bakersfield Meadows Field Airport
FAT Fresno Yosemite International Airport
MOD Modesto City-County Airport

Appendix B

Diverging Relationships Between Jobs and Population

B. Diverging Relationships Between Jobs and Population

Most forecast models are predicated on the basic assumption that the future will be much like the present, only more or less so. Past relationships that tie the amount and type of travel with the amount and location of households and different kinds of employment are the basis for estimates of trip frequency and trip distribution. Over the course of many years, these historical relationships can change, and it is difficult to predict the implications that these changes will have on travel. As the U.S. emerges from the recession of 2007-2009 and look into the future, Cambridge Systematics, Inc. (CS) noticed that future forecasts from a variety of sources of the relationship between population and jobs are considerably different from recent trends. This could have significant, yet unknowable implications for future ridership on the California HST system. CS summarizes the issue below.

B.1 Population and Jobs Growth – Historical Linkages

Population and jobs form the foundation for the forecasts that attempt to predict future traffic volumes, transactions, and revenues for transportation systems and individual facilities.

Logically, there is a connection between population and jobs growth. A growing population can feed an expanding jobs base and people are attracted to locations that have plentiful employment opportunities. Although population and jobs are linked, they do not always grow in tandem. Between the 1970s and 1990s, employment frequently grew faster than population as the workforce expanded as more women took jobs. Sensing opportunity, the expanding economy of that same period also encouraged working age people, men and women, who may not have necessarily chosen to be economically active to enter the workforce.

The trend toward greater workforce participation and economic expansion in the latter half of the previous century that generated jobs in excess of population growth stalled in the 2000s. Jobs declined precipitously in the 2007-2009 recession while population continued to grow. This changed dynamic is now translating to different future growth scenarios with population growth rates higher than jobs growth rates. This changed dynamic is finding its way into forecasts used for land use and transportation planning in California, suggesting that this may not be a short-term phenomenon.

B.2 CHANGING LONG-TERM FORECASTS IN CALIFORNIA REFLECT A NEW DYNAMIC IN THE RELATIONSHIP BETWEEN POPULATION AND JOBS

Long-term forecasts in California and elsewhere until recently have shown the rate of increase for population and jobs increasing in tandem, based on the premise that population and jobs growth are closely correlated (or maintain historical relationships in relative growth rates into the future). Based on the population associated with the post-2000 forecasts, the direct and proportional relationships between population and jobs growth in long-term projections is beginning to show signs of breaking down or at least changing.

Why the Population and Jobs Growth Dynamic Is Changing and Is it Sustainable?

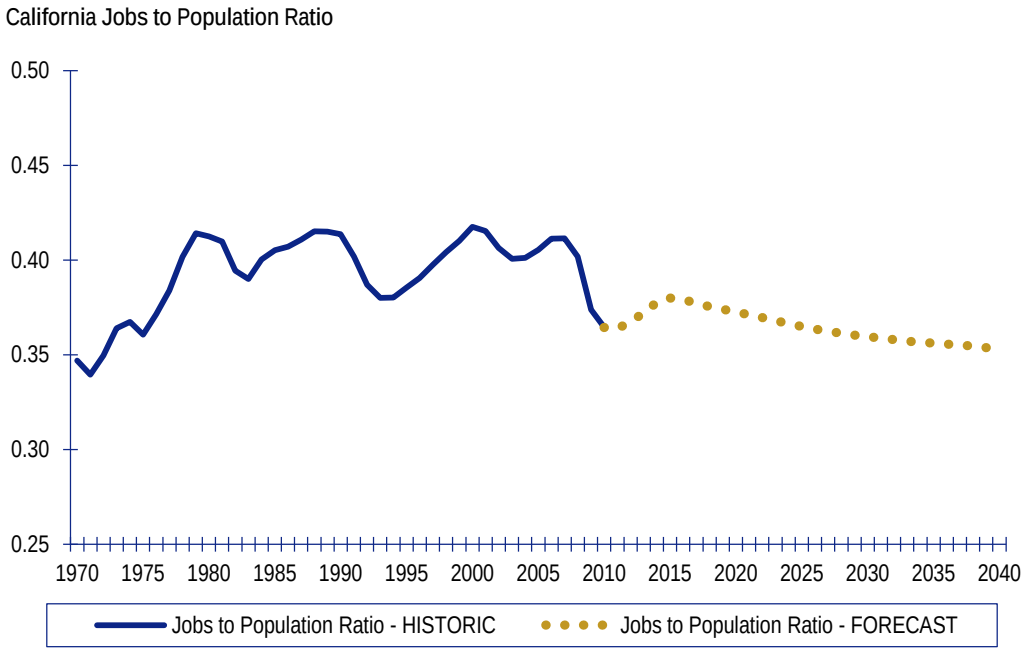
In California, the ratio between jobs and population is at the lowest point it has been in over 30 years (see Figure B.1). After reaching a record high of 0.42 in 2000, the height of the 1990s boom, the ratio declined with tech bubble burst in 2001-2002 and then recovered with the economy through 2007. The effects of the 2007-2009 recession and economic downturn can be readily seen in Figure B.1 and by 2010, the jobs to population ratio had fallen to 0.36. Since 1980, the ratio has followed economic cycles, falling in recessions and rising during periods of growth. However, the forecast for the recent recession appears to be different, with the jobs-population ratio never rising above 0.4, a rate common during recent historical periods of economic expansion.

The decline of the jobs-population ratio indicates that, relative to recent historical norms, a smaller portion of the population will be working. In California, this points to a period of fairly strong population growth accompanied by a slower pace of jobs growth. While this is a national trend, the question must be asked if a relatively lower number of people working can sustain an expanding population in California. If people are not finding economic opportunity, might this translate to lower foreign and domestic in-migration and lower birthrates and thus lower population growth than currently indicated?

The downward shift in the jobs to population ratio may be attributed to factors described below:[8]

[8] Points from an interview with Moody's Analytics' economist, Sophia Koropeckyj.

Figure B.1 Historic and Long-Term Jobs to Population Ratio Forecast in California, 1970-2040



Source: Moody's Analytics, April 2011; the historic jobs data are based on (and the forecast stems from) a combination of the U.S. Department of Labor's Current Employment Statistics (CES) and Quarterly Census of Employment and Wages (QCEW) data series.

- Labor Force Participation
  - Fewer 16- to 24-year olds in workforce. There is a long-term decline in labor force participation with this work group. With fewer jobs available, young people are scaling back their job searches and, instead, enrolling in school. Longer term, this group is expected to continue staying out of the workforce, in part due to job competition from retirees and immigrants as well as to attend school.
  - Working age men are less likely to be working. Men in the core 25 to 55 working ages are experiencing a declining labor force participation rate. The long-term trend is now being exacerbated by high rates of unemployment due to the economic downturn.
  - Older core working age people, between 56 and 65 also are experiencing a significant drop in labor force participation
  - People older than 65 are now increasing their labor force participation rate.
  - The aging of the population contributes to a lower overall labor force participation rate. This trend will lessen future rebounds in the labor force participation rate tied to economic cycles.

- Population Growth
  - International in-migration is expected to remain strong, a key factor in California's long-term population growth.
  - Although birth rates do go down with economic downturns, the United States maintains high-fertility rates compared to other developed countries. This is expected to continue into the future.

B.3 POTENTIAL IMPLICATIONS FOR LONG-DISTANCE TRAVEL

Since the trip generation component of the R&R model is driven primarily from population, fewer jobs per person will not be reflected in a change in long-distance travel. CS expects that this change will affect the frequency of future long-distance travel and as such, the future market for high-speed rail in California. CS does not see an easy way to quantify this, other than to acknowledge this potential trend, and recognize that it could have implications for future travel – probably in the negative direction (although changes in leisure travel may turn out to be on the positive side). For now, the approach to consider a range of potential forecasts should be adequate to capture this risk, but this demographic trend should be explored in more detail in future updates.

Appendix C

Long-Distance Interregional Survey Results

Memorandum

TO: CAHSRA Peer Review Panel Members

FROM: Cambridge Systematics

DATE: September 22, 2011

RE: California High Speed Rail Ridership and Revenue Forecasting
Long Distance Interregional Travel Survey Results – 3rd Draft

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Executive Summary

The 2011 CAHSRA Long Distance Travel Survey was used to collect current long distance travel data for the revalidation of the California High Speed Rail Ridership and Revenue Model (CAHSR R&R Model). The data collected in this survey provide a comprehensive source of data for all trip purposes for home-based interregional travel in California.

Survey responses from the 2011 survey were expanded to match the 2008 population synthesis data for the state of California that will be used as a basis for the recalibration and revalidation. The expanded results provide a different picture of medium and long distance interregional travel in California than those used for the 2000 calibration and validation of the existing CAHSR R&R Model. Key survey findings were:

- The overall number of medium distance (50-99 miles) interregional trips (one-way linked trips) [1] within California estimated for 2008, 478,400, was 36 percent lower than those used for the 2000 model calibration and validation (752,000);
- The overall number of long distance (100+ miles) interregional trips within California estimated for 2008, 526,600, was 5 percent higher than those used for the 2000 model calibration and validation (499,000);
- The overall trip rates for medium and long distance interregional trips within California for 2008 were 0.037 and 0.041 person trips per household per day, respectively. In comparison, the overall 2000 trip rates were 0.065 and 0.044 for the same trip lengths;
- The composition of medium and long distance trips by trip purpose estimated for 2008 are substantially different than the shares used for the 2000 model calibration and validation. The estimated 2008 long distance trip shares for the combined business/commute trip purpose and the combined recreation/other trip purpose were 17 percent and 83 percent,

[1] Unless otherwise noted, the term "trips" is used to describe "linked one-way trips" throughout this document.

respectively. In comparison, the shares for the combined business/commute and recreation/other trip purposes for the 2000 calibration and validation were 50 percent each; and

- Main travel mode shares for medium distance trips (50-99 miles) for 2008 were similar to those used for the 2000 model calibration and validation for the business/commute and recreation/other trip purposes. For long distance travel (100+ miles), the estimated 2008 data show substantially lower auto mode shares for business/commute travel than those used for the 2000 model calibration and validation (64 percent for 2008 and 88 percent for 2000); the decreased auto shares shown for 2008 were balanced by substantially higher air shares for the business/commute trips (33 percent for 2008 versus 11 percent for 2000). Main travel mode shares for recreation/other travel estimated for 2008 were similar to those used for the 2000 model calibration and validation.

Objective and Overview

Cambridge Systematics (CS) conducted a long distance travel survey to estimate interregional medium and long distance travel characteristics of California residents in order to revalidate CS's ridership and revenue forecasting model for the California High Speed Rail (CA HSR) project. CS designed the survey mechanism and hired Harris Interactive to conduct the survey in May and June, 2011. Harris employed a web-based polling methodology to contact California residents and perform the survey on line.

The survey will be used to recalibrate and validate the model to 2008 conditions. Therefore, the 2011 data was factored to 2008 conditions. Throughout this memo, we refer to this survey and factoring effort as the 2011/2008 Trip Frequency Survey.

The 2011 CAHSRA Long Distance Travel Survey collected data for trips to all locations that were at least 50 miles from home, including locations outside of the State of California. However, since the CA HSR R&R Model only models trips within the State of California, all trip records for locations outside of California were deleted from the trip database before the survey expansion tasks. Preliminary examination of the raw survey data shows that approximately 80 percent of the unweighted trips (before survey cleaning and expansion) reported were made to locations within the State of California, and that the remaining 20 percent of long distance trips were made to either interstate (18%) or international (2%) locations.

The survey was restricted to trips made to or from California residents' home region, so it didn't include non-home based medium and long distance trips (medium and long distance trips made between locations outside of the resident's home region), nor did it include visitor medium and long distance trips made by non-residents of the state of California.

"Trip" Naming Conventions

Unless otherwise noted, the term "trips" is used to describe "linked one-way trips" throughout this document.

Following are definitions of the different types of trips analyzed in this document:

- *Long distance trips* are all trips made by California residents to locations greater than 100 miles from home, regardless of whether the destination is inside the State of California.
- *Long distance trips within California* are the subset of long distance trips that are made to locations within the state.
- *Long distance interregional trips* are the subset of long distance trips within California that start and end in different regions (14 identified within the state). These are the long distance trips that we deal with in the CAHSR R&R Model.

- *Long distance intraregional trips* are the subset of long distance trips within California that start and end in the same region. These are mostly within the two largest regions - SCAG and MTC.
- *Medium distance trips* are trips in the 50 to 99 mile range. Interregional and intraregional medium distance trips can be defined using the same logic as used above in defining long distance interregional and intraregional trips.

Changes in 2nd Draft

The 1st draft of this document was presented to the Peer Review Panel meeting held in San Francisco on August 10-11, 2011. This 2nd draft has been amended to address concerns and suggestions of the Peer Review Panel, and to refine the survey processing and analysis.

The most significant change in the approach for the survey analysis is the change to the variables used to aggregate surveys for expansion purposes. The Peer Review Panel expressed concern with the use of vehicle availability as the wealth variable, due to international observations that behavior changes are reducing the status of vehicle availability as a wealth surrogate. The Panel suggested replacing the vehicle availability variable with a combination of household income and age variables.

The most significant changes to the procedures in this 2nd draft include:

- Revised variables used for data expansion from three dimensions (respondent worker status × number of vehicles available to respondent's household × geographic region) to four dimensions (respondent worker status × household income range of respondent's household × respondent age range × geographic region);
- Prepared tabulation of expanded data estimated for all medium and long distance trips in California, not just interregional medium and long distance trips as presented in the 1st draft;
- Included discussion and comparison of effects of using full dataset (all surveys) vs. reduced dataset (surveys with all required variables available);
- Added discussion of relative medium and long distance trip frequencies obtained from other sources;
- Completed more detailed analysis of "Trip Purpose" variable to confirm relative distribution of commute/business vs. recreational/other trips;
- Identified and corrected a mapping problem in GIS process to correct geocoding of trip origin-destination results to appropriate regions, which affected about 500 survey records; and
- Identified and deleted survey records that were determined to be either invalid or fraudulently reported.

Changes in 3rd Draft

The 2nd draft of this document was distributed to the Peer Review Panel on September 9, 2011. This 3rd draft has been amended to address additional concerns and suggestions of the Peer Review Panel and other reviewers. Aside from minor text edits to clarify terminology, the most significant changes to the procedures in this 3rd draft include:

- Added brief analysis of out-of-state travel to allow comparison of survey results to other jurisdictions; and
- Added text and charts illustrating trip length frequency distribution and mode shares by trip lengths.

Description of Survey

The 2011/2008 Trip Frequency survey was designed to collect medium and long distance travel characteristics of adult California residents. We defined medium and long distance trips as trips to locations that were at least 50 miles from home. Since the survey was restricted to trips made to or from the resident's home region, it did not include non-home based medium and long distance trips (medium and long distance trips made between locations outside of the resident's home region), nor did it include visitor medium and long distance trips made by non-residents of the state of California.

The two month time period covered by the survey (essentially April and May, 2011) represents an "average" time of year when most employed residents are working and most students are in school. More medium and long distance trips would be expected during the summer months for vacation travel, and fewer medium and long distance trips would be expected during the winter months. The survey time period includes one of the major holiday weekends (Memorial Day) that is normally associated with recreational weekend travel. The inclusion of one major holiday weekend is appropriate for the two-month survey time frame, since almost any two-month time period on the calendar includes one such major holiday weekend.

In analyzing the survey, we divide the trips into two categories:

- Long distance (greater than or equal to 100 miles from home); and
- Medium distance (50-99 miles from home)

These definitions are compatible with the structure of the existing CA HSR R&R Model; the CAHSR R&R Model focuses on interregional trips, defined as trips traveling between two of the fourteen modeling regions defined for the model. Thus, the CA HSR R&R Model considers all interregional trips less than 100 miles in the "short distance" interregional trip group. However, we recognize that excluding intraregional trips from the tabulation makes it difficult to understand the bigger picture of long distance trip making in the State of California. Therefore, we provide summary tabulations of trip characteristics separately for "medium and long distance trips within California" and for "medium and long distance interregional trips."

To understand the full scope of trip making we present summary tabulations of all "medium and long distance trips." To provide consistency between the 2011/2008 Trip Frequency Survey and the CA HSR R&R Model, the more detailed analyses of medium and long distance trips from the 2011/2008 Trip Frequency Survey exclude intraregional trips (with the regions being defined as the same fourteen regions used in the CA HSR R&R Model).

The survey was designed to collect trip information and personal information for each of the variables used in the ridership and revenue forecasting model. Trip information includes the following details for all medium and long distance trips completed in the previous two months:

- Trip origin and destination (city and/or zip code);
- Trip purpose (was this trip made for business, commuting, recreation, or another purpose);
- Trip frequency (how often was this trip repeated for the same purpose during the past two months);
- Group size (how many people – total and household members – traveled with respondent);
- Trip main travel mode (e.g. auto, air, rail, and bus);
- Access mode (to and from airport or rail/bus station for trips using non-auto modes); and
- Trip duration (return same day or number of nights before return trip).

Personal information collected includes:

- Gender;
- Age;
- Employment status (appended after completion of survey, not available for all respondents);
- Household size (total and adults);
- Number of workers in household;
- Number of vehicles available to household; and
- Household income (optional, not available for all respondents).

Survey Mechanism and Pre-test

CS provided the survey questionnaire to Harris Interactive, who prepared the on-line version of the survey. The on-line version of the survey was designed to restrict the responses to the target audience (California residents at least 18 years of age) and included logic checks to ensure the reasonableness of significant responses, such as household size. The original version of the survey questions were shared with the Peer Review Panel prior to submittal to Harris Interactive and panel suggestions were incorporated to the extent possible.

The allowed responses for significant trip characteristics, such as trip purpose and main travel mode, were sorted in random order to reduce any bias caused by the order of the responses.

For repeated trips, respondents were asked to record the number of times each trip had been completed within the previous two months. This allowed for the collection of recent trip-making by most survey participants, without overly challenging the memory or patience levels of participants.

The survey was designed to allow respondents to describe up to eight unique medium and long distance trips completed in the previous two-month period. Full details were collected for the most recent trip, while a reduced set of details were collected for additional trips completed during the previous two months. Table 1 shows which trip characteristics were collected for the most recent trip and for additional trips completed during the previous two months.

Table 1. Trip Details Collected for Most Recent and Additional Medium and Long Distance Trips

Data Item	Most Recent Trip	Additional Trips
Start Location	X	X
Trip Purpose	X	X
Primary Destination	X	X
Trip Frequency (in Last 2 Months)	X	X
Group Size	X	
Main Travel Mode	X	X
Airports or Transit Stations Used	X	
Access and Egress Modes	X	
Trip Duration (Same Day or Overnight)	X	X
Return Trip	X	

Survey responses were limited to trips made by the respondent, not trips made independently by other household members. For the detailed responses regarding the most recent medium and long distance trip, respondents were asked if the trip was made in a group and, if so, how many of the group members were from the respondent's household. These questions provide information for the estimation and application of a group-size variable in future demand forecasts. The group size variable also allows for the estimation of long distance travel by children accompanying adult household members. This is necessary because the CAHSR R&R Model includes trips made by children ages 5 to 17, and the survey is designed to interview only adults age 18 and above.

CS conducted a review and pre-test of the on-line survey, using both industry professionals and lay people to test the functionality of the survey tool. The survey mechanism was tested to ensure that an average respondent could complete the survey within ten minutes, in order to avoid respondent fatigue. Several significant changes were made during the pre-testing procedure, including restructuring the grid used to report trip characteristics for "additional trips" to simplify the reporting process. The Peer Review Panel was also provided with links to test the on-line survey instrument, albeit after the survey was "opened" for live responses.

The final survey mechanism is presented in Appendix 1.

Sampling Plan

The sampling plan was designed to complete at least 15,000 surveys, with at least 500 completed surveys coming from each of eight different regions within the State of California. The survey sample was limited to California residents who are members of on-line poling panels, such as the panel employed by Harris Interactive.

We recognize that there are biases involved with the restrictions of these panels, however, we are unable to quantify these biases with respect to the desired Long Distance Travel Survey data. Instead, we designed the survey to collect information about variables that are significant to travel behavior that could be compared to statewide data sources, such as wealth, household and work status, so that any biases encountered could be corrected through the application of expansion factors. Given that, we made all efforts possible to contact a representative cross-section of the population. The most obvious bias identified was with regard to the age of respondents. When 30 percent of the sample was completed, we found that there was a substantial bias toward older residents – not surprising for a survey panel. Consequently, we instructed Harris to focus their remaining data collection efforts on the younger members of their panels (ages 18 to 40)[2].

Completed and Acceptable Survey Summary

Harris Interactive returned a database of 15,067 completed surveys. Surveys were considered complete by Harris if all questions were answered and the respondents met qualification standards (e.g. at least 18 years of age and California residents). Upon further analysis of the survey records by CS, 669 of these surveys were deleted from the database for a variety of reasons, including:

- inconsistent or incomprehensible personal data;
- home locations outside of California; or
- fraudulent data (several dozen surveys appear to have been complete by the same person).

The net result of these deletions was a database of 14,398 surveys for the estimation of key trip variables.

Based on Peer Review Panel suggestions regarding expansion procedures, subsequent review and data cleaning identified 2,412 additional surveys that lacked other important information for expansion, such as worker status or income range of the respondent's household. A "reduced" database of 11,986 fully acceptable and geocoded surveys resulted from the additional review and cleaning of the data.

In order to assess the statistical impact of removing the additional 2,412 surveys from the database, we also processed the survey results for an "enhanced" dataset that included the

[2] Age was used as a classification variable for expansion of the survey results to negate the impact of the sampling bias for this variable.

14,398 surveys originally identified as acceptable. For the enhanced dataset, the missing worker status and/or income range variables were imputed using other personal characteristics. The procedure for income imputation was as follows:

- Distributions of the respondents by income group (low, medium, high, or missing) were produced for each *household size* and *number of vehicles available* stratum;
- Respondent records with missing income information were allocated to one of the three income categories (low, medium, high) based on a uniform random distribution with a seed.

For example, for respondents with household size = 1 and number of vehicles = 0, there were 23 observations with missing income data, four observations reported high income levels, 17 observations reported medium income levels, and 225 observations reported low income levels. Each of the 23 observations with missing income data was assigned a uniformly distributed random number which was, in turn, used to assign an income group based on the cumulative marginal distribution of reported incomes within the specified bin (household size=1, number of vehicles=0).

The procedure for worker status imputation is similar to that used for income imputation. In place of the distributions of respondents reporting household income for each household size/number of vehicles stratum, distributions of workers (and implied non-workers) from the 2009 Labor Force Participation shown below in Table 2 were used. Imputation for missing worker status information (worker or non-worker) was performed based on gender and age of the respondent using a uniform random distribution.

Table 2. Year 2009 Labor Force Participation

Gender	Age Range		
	16-24	25-54	55+
Male	55.4%	88.1%	46.4%
Female	53.3%	74.6%	33.6%

Source: US Census Bureau - *Labor Force Participation Rate for Selected Age Groups: 2008 and 2009* (Issued October 2010)

The marginal population characteristics of the survey respondents for the reduced and enhanced databases are summarized in Table 3.

Expansion Factoring

The results of the 2011/2008 Trip Frequency Survey were analyzed by aggregating the survey responses into various personal, household, socioeconomic and geographic strata. Trip rates for different cross-classifications of strata were compared to determine which variables displayed the greatest explanatory power with respect to medium and long distance trip generation rates.

Table 3. Marginal Distributions of Surveys

	Enhanced Dataset (14,398 Records)		Reduced Dataset (11,986 Records)	
Category	**Number**	**Percent**	**Number**	**Percent**
Gender				
Male	6,452	45%	5,485	46%
Female	7,946	55%	6,501	54%
Employment Status (Imputed for Portion of Enhanced Dataset)				
Worker	8,935	62%	7,515	63%
Non-Worker	5,463	38%	4,471	37%
Age Range				
18-29	2,062	14%	1,679	14%
30-39	1,843	13%	1,601	13%
40-49	2,111	15%	1,780	15%
50-64	5,382	37%	4,479	37%
65+	3,000	21%	2,447	20%
Household Size				
1	3,115	22%	2,754	23%
2	6,286	44%	5,216	44%
3	2,224	15%	1,784	15%
4+	2,773	19%	2,232	19%
Mean Size	2.456		2.415	
Workers in Household				
0	3,509	24%	2,957	25%
1	5,198	36%	4,268	36%
2+	5,691	40%	4,761	40%
Mean Value	1.262		1.258	
Household Vehicles				
0	408	3%	367	3%
1	4,193	29%	3,689	31%
2+	9,797	68%	7,930	66%
Mean Value	2.067		2.018	
Household Income Range (Reported – Excluding "Declines")				
Under $10,000	388	3%	382	3%
Between $10,000 and $29,999	1,537	12%	1,500	13%
Between $30,000 and $44,999	1,595	13%	1,548	13%
Between $45,000 and $59,999	1,534	12%	1,464	12%
Between $60,000 and $74,999	1,420	11%	1,369	11%
Between $75,000 and $89,999	1,334	11%	1,292	11%
Between $90,000 and $104,999	1,162	9%	1,107	9%
Between $105,000 and $119,999	786	6%	744	6%
Between $120,000 and $134,999	647	5%	606	5%
Between $135,000 and $174,999	928	7%	875	7%
$175,000 or more	1,204	10%	1,099	9%
Household Income Range (Imputed for Portion of Enhanced Dataset)				
Low (Under $45,000)	3,987	28%	3,430	29%
Medium ($45,000 - $89,999)	4,918	34%	4,125	34%
High ($90,000 or more)	5,493	38%	4,431	37%
Geographic Region				
SACOG	1,289	9%	1,055	9%
SANDAG	1,693	12%	1,388	12%
MTC	2,588	18%	2,125	18%
SCAG	4,764	33%	4,047	34%
Remainder of State	4,064	28%	3,371	28%

The expansion factoring process was completed for two separate datasets – the reduced dataset and the enhanced dataset. As described previously, the reduced dataset includes 11,986 survey records that have complete information for all pertinent variables, and the enhanced dataset includes the full set of 14,398 survey records that have acceptable data for most pertinent variables, and for which missing data are imputed. This dual analysis approach was undertaken in order to document the statistical significance of employing the reduced dataset.

Originally, three variables were identified as possessing the greatest explanatory power: employment status, number of vehicles available within the respondent's household, and geographic location. After consultation with the Peer Review Panel we decided to replace the vehicle availability variable with household income and age group variables.

The Harris panel restricts panel members to one per household. Thus, by design, the survey was a survey of persons, not households. Surveyed trip records were expanded to represent the adult population of California by comparing the population in households for the state to the numbers of observed records (completed surveys) using a four-dimensional cross-classification scheme resulting in 150 possible strata. The four dimensions and strata used were:

- Geographic region (five super-regions in state: SCAG, MTC, SANDAG, SACOG, and the rest of the state);
- Worker status of the respondent (worker or non-worker);
- Household income range of the respondent's household (three groups: low income – less than $45,000, medium income - $45,000-$89,999, and high income – over $90,000); and
- Age range of the respondent (five groups: 18-29, 30-39, 40-49, 50-64, and over 65).

The numbers of observed (surveyed) records for each cell of the population cross-classification are summarized in Tables 4 and 5. Table 4 displays the numbers of observed records for each cell for the reduced dataset (11,986 records) and Table 5 displays the numbers of observed records for each cell for the enhanced dataset (14,398 records). These tables includes boxes drawn around groups of cells representing the aggregations of cells necessary to maintain minimum observations (target=20) for expansion purposes.

University of California-Davis Population Synthesis Data

We used the California Statewide Travel Demand Model (CSTDM) Synthetic Population Database for 2008 as developed by the University of California-Davis (see Appendix 2) to estimate the total adult population in each cell of the four-way cross-classification. This population synthesis includes all residents of California, excluding those living in group quarters. The synthetic data for the adult population are summarized in Table 6.

Table 4. Observed Surveys by Four-Dimensional Cross-Classification - Reduced Dataset

	Household Income Range						
	Non-workers			Workers			
Region/Age Range	< $45k	$45k-$90k	>$90k	< $45k	$45k-$90k	>$90k	Total
SACOG Region (Sacramento)							
18-29	24	14	3	40	38	22	141
30-39	15	11	11	21	37	42	137
40-49	14	9	2	22	36	68	151
50-64	47	50	45	41	93	122	398
65 and over	69	70	45	7	18	19	228
Total	169	154	106	131	222	273	1,055
SANDAG Region (San Diego County)							
18-29	28	13	8	37	66	42	194
30-39	10	16	7	30	64	71	198
40-49	16	7	7	25	64	76	195
50-64	58	46	37	53	123	189	506
65 and over	67	95	55	16	24	38	295
Total	179	177	114	161	341	416	1,388
MTC Region (San Francisco Bay Area)							
18-29	41	21	13	47	65	68	255
30-39	20	8	13	28	69	148	286
40-49	23	17	13	33	73	189	348
50-64	84	66	76	74	181	300	781
65 and over	82	111	103	29	54	76	455
Total	250	223	218	211	442	781	2,125
SCAG Region (Southern California)							
18-29	94	43	32	131	171	128	599
30-39	54	41	19	75	171	203	563
40-49	53	31	25	76	173	247	605
50-64	157	159	141	149	318	547	1,471
65 and over	204	200	174	47	66	118	809
Total	562	474	391	478	899	1,243	4,047
Remainder of California							
18-29	125	37	15	141	114	58	490
30-39	60	31	13	84	130	99	417
40-49	89	30	7	82	136	137	481
50-64	256	170	91	180	305	321	1,323
65 and over	232	191	101	40	49	47	660
Total	762	459	227	527	734	662	3,371
California Total							
18-29	312	128	71	396	454	318	1,679
30-39	159	107	63	238	471	563	1,601
40-49	195	94	54	238	482	717	1,780
50-64	602	491	390	497	1,020	1,479	4,479
65 and over	654	667	478	139	211	298	2,447
Total	1,922	1,487	1,056	1,508	2,638	3,375	11,986

Table 5. Observed Surveys by Four-Dimensional Cross-Classification - Enhanced Dataset

	Household Income Range						
	Non-workers			Workers			
Region/Age Range	< $45k	$45k-$90k	>$90k	< $45k	$45k-$90k	>$90k	Total
SACOG Region (Sacramento)							
18-29	27	23	9	45	49	26	179
30-39	17	14	13	24	40	51	159
40-49	16	10	4	28	43	84	185
50-64	49	66	59	52	110	145	481
65 and over	81	83	67	8	21	25	285
Total	190	196	152	157	263	331	1,289
SANDAG Region (San Diego County)							
18-29	36	19	13	45	77	57	247
30-39	10	18	10	40	75	83	236
40-49	19	8	10	33	75	97	242
50-64	68	56	57	60	143	221	605
65 and over	85	114	71	19	31	43	363
Total	218	215	161	197	401	501	1,693
MTC Region (San Francisco Bay Area)							
18-29	45	27	24	52	77	92	317
30-39	22	12	15	35	79	166	329
40-49	24	21	18	46	91	213	413
50-64	93	81	101	104	210	364	953
65 and over	107	144	139	36	62	88	576
Total	291	285	297	273	519	923	2,588
SCAG Region (Southern California)							
18-29	107	58	51	147	193	156	712
30-39	57	47	25	87	186	224	626
40-49	63	39	32	93	197	287	711
50-64	176	188	175	186	374	632	1,731
65 and over	237	242	228	59	79	139	984
Total	640	574	511	572	1,029	1,438	4,764
Remainder of California							
18-29	140	55	28	165	142	77	607
30-39	65	39	21	97	152	119	493
40-49	94	38	7	94	158	169	560
50-64	282	203	141	212	360	414	1,612
65 and over	255	223	142	45	66	61	792
Total	836	558	339	613	878	840	4,064
California Total							
18-29	355	182	125	454	538	408	2,062
30-39	171	130	84	283	532	643	1,843
40-49	216	116	71	294	564	850	2,111
50-64	668	594	533	614	1,197	1,776	5,382
65 and over	765	806	647	167	259	356	3,000
Total	2,175	1,828	1,460	1,812	3,090	4,033	14,398

Table 6. 2008 Adult Population by Four-Dimensional Cross-Classification

	Household Income Range						
	Non-workers			Workers			
Age Range	< $45k	$45k-$90k	>$90k	< $45k	$45k-$90k	>$90k	Total
SACOG Region (Sacramento)							
18-29	65,688	30,871	14,127	108,667	98,132	44,655	362,141
30-39	39,433	24,032	9,696	75,771	105,319	52,723	306,974
40-49	37,465	20,150	12,252	63,236	99,463	75,663	308,230
50-64	65,301	40,254	23,925	54,404	84,683	78,643	347,209
65 +	123,738	54,991	27,793	11,755	9,910	8,483	236,670
Total	331,626	170,298	87,794	313,833	397,507	260,166	1,561,224
SANDAG Region (San Diego County)							
18-29	88,328	44,062	27,228	150,422	128,392	74,919	513,350
30-39	53,881	30,646	20,326	109,921	141,427	93,541	449,742
40-49	45,791	32,141	23,173	91,180	146,668	128,318	467,273
50-64	75,987	49,417	40,586	75,679	110,480	123,144	475,293
65 +	158,623	78,059	55,534	14,644	14,483	12,304	333,647
Total	422,611	234,325	166,847	441,847	541,449	432,226	2,239,305
MTC Region (San Francisco Bay Area)							
18-29	133,545	91,326	114,645	198,178	264,306	304,982	1,106,982
30-39	89,147	75,244	72,725	166,382	290,863	334,690	1,029,050
40-49	97,704	62,983	78,531	175,359	316,685	433,655	1,164,916
50-64	177,661	122,253	122,579	176,039	292,058	417,574	1,308,163
65 +	382,517	175,258	146,872	40,914	38,134	39,556	823,249
Total	880,573	527,063	535,351	756,871	1,202,046	1,530,456	5,432,360
SCAG Region (Southern California)							
18-29	578,364	346,420	201,221	830,993	838,082	547,257	3,342,336
30-39	392,206	235,210	131,322	704,543	777,848	523,121	2,764,249
40-49	365,342	208,318	125,763	651,996	821,869	690,406	2,863,693
50-64	518,761	294,442	201,452	537,400	688,813	698,230	2,939,097
65 +	977,991	398,314	252,142	119,016	100,264	92,241	1,939,968
Total	2,832,663	1,482,703	911,899	2,843,948	3,226,876	2,551,254	13,849,344
Remainder of California							
18-29	267,253	120,345	43,383	351,845	247,008	107,561	1,137,395
30-39	167,333	71,680	25,329	253,764	246,445	103,509	868,059
40-49	142,684	65,703	26,783	213,137	275,560	161,070	884,937
50-64	242,461	110,948	56,098	191,490	230,201	166,715	997,913
65 +	421,001	129,099	59,402	41,069	29,555	18,608	698,734
Total	1,240,732	497,776	210,994	1,051,305	1,028,768	557,464	4,587,039
California Total							
18-29	1,133,178	633,024	400,603	1,640,105	1,575,919	1,079,374	6,462,203
30-39	742,000	436,812	259,398	1,310,381	1,561,902	1,107,583	5,418,076
40-49	688,986	389,295	266,502	1,194,909	1,660,245	1,489,112	5,689,049
50-64	1,080,171	617,313	444,640	1,035,011	1,406,235	1,484,305	6,067,675
65 +	2,063,870	835,721	541,742	227,398	192,345	171,192	4,032,268
Total	5,708,205	2,912,165	1,912,885	5,407,804	6,396,646	5,331,566	27,669,272

Expansion Factor Calculation

We estimated expansion factors for each cell of the household cross-classification by dividing the synthesized adult population by the number of survey respondents. Thus, in effect, we have used trip making characteristics from 2011 to represent medium and long distance trip making in 2008. The results are summarized in Table 7 and 8, for the enhanced and reduced datasets, respectively. For reference purpose, the average expansion factors are approximately 2,300 for the enhanced dataset and approximately 1,900 for the reduced dataset. As with Tables 4 and 5, these tables also include boxes drawn around groups of cells representing the aggregations of cells necessary to maintain minimum observations (target=20) for expansion purposes.

Table 7. Expansion Factors by Four-Dimensional Cross-Classification – Enhanced Dataset

	Household Income Range					
	Non-workers			Workers		
Region/Age Range	< $45k	$45k-$90k	>$90k	< $45k	$45k-$90k	>$90k
SACOG Region (Sacramento)						
18-29	2,433	1,342	1,388	2,415	2,003	1,717
30-39	2,330	1,841	1,388	3,157	2,633	1,034
40-49	2,330	1,841	1,388	2,258	2,313	901
50-64	1,333	610	406	1,103	770	542
65 +	1,528	663	415	1,103	472	339
SANDAG Region (San Diego County)						
18-29	2,454	2,319	2,143	3,343	1,667	1,314
30-39	3,437	2,512	2,143	2,748	1,861	1,127
40-49	3,437	2,512	2,143	2,763	1,956	1,323
50-64	1,117	882	712	1,261	773	557
65 +	1,888	685	782	732	467	286
MTC Region (San Francisco Bay Area)						
18-29	2,968	3,382	4,777	3,811	3,433	3,315
30-39	4,052	4,189	4,584	4,754	3,682	2,016
40-49	4,071	4,189	4,584	3,812	3,480	2,036
50-64	1,910	1,509	1,214	1,693	1,391	1,147
65 +	3,575	1,217	1,057	1,136	615	449
SCAG Region (Southern California)						
18-29	5,456	5,973	3,946	5,615	4,342	3,508
30-39	6,881	5,004	5,253	8,098	4,182	2,335
40-49	5,799	5,341	3,930	7,011	4,172	2,406
50-64	2,948	1,566	1,151	2,889	1,842	1,105
65 +	4,127	1,646	1,106	2,017	1,269	664
Remainder of California						
18-29	1,909	2,271	1,549	2,132	1,715	1,397
30-39	2,574	1,886	1,861	2,616	1,611	870
40-49	1,518	1,729	1,861	2,267	1,744	953
50-64	860	547	398	903	639	403
65 +	1,651	579	418	913	448	305

Table 8. Expansion Factors by Four-Dimensional Cross-Classification – Reduced Dataset

	Household Income Range					
	Non-workers			Workers		
Region/Age Range	< $45k	$45k-$90k	>$90k	< $45k	$45k-$90k	>$90k
SACOG Region (Sacramento)						
18-29	2,737	2,207	2,255	2,717	2,582	2,030
30-39	2,652	2,207	2,255	3,608	2,846	1,255
40-49	2,652	2,207	2,255	2,874	2,763	1,113
50-64	1,389	805	532	1,378	911	645
65 +	1,793	786	618	1,378	551	446
SANDAG Region (San Diego County)						
18-29	3,155	2,968	3,215	4,065	1,945	1,784
30-39	3,834	2,968	3,215	3,664	2,210	1,317
40-49	3,834	2,968	3,215	3,647	2,292	1,688
50-64	1,310	1,074	1,097	1,428	898	652
65 +	2,368	822	1,010	915	603	324
MTC Region (San Francisco Bay Area)						
18-29	3,257	4,349	6,818	4,217	4,066	4,485
30-39	4,457	5,529	6,818	5,942	4,215	2,261
40-49	4,248	5,529	6,818	5,314	4,338	2,294
50-64	2,115	1,852	1,613	2,379	1,614	1,392
65 +	4,665	1,579	1,426	1,411	706	520
SCAG Region (Southern California)						
18-29	6,153	8,056	6,288	6,343	4,901	4,275
30-39	7,263	5,737	6,912	9,394	4,549	2,577
40-49	6,893	6,720	5,031	8,579	4,751	2,795
50-64	3,304	1,852	1,429	3,607	2,166	1,276
65 +	4,794	1,992	1,449	2,532	1,519	782
Remainder of California						
18-29	2,138	3,253	2,728	2,495	2,167	1,855
30-39	2,789	2,312	2,728	3,021	1,896	1,046
40-49	1,603	2,190	2,728	2,599	2,026	1,176
50-64	947	653	616	1,064	755	519
65 +	1,815	676	588	1,027	603	396

Examination of the expansion factors shows a large variation in the values of the expansion factors. For example, with the reduced dataset, the calculated expansion factors vary from less than 400 to more than 9,000. This wide variation demonstrates the value of calculating and applying expansion factors by the various strata in order to reduce the bias that would be introduced by heavily over-sampled markets.

These ranges required for the expansion factor resulted from several factors, including typical characteristics of the survey panelists employed by Harris Interactive and intentional sampling to achieve minimum quotas in certain geographical regions. We found that the panelists employed by Harris are typically older and wealthier than the population at large. This is

probably due to factors such as access to technology and the relative amount of free time available to different population groups. The intentional oversampling of smaller regions resulted in smaller expansion factors being calculated for the smaller regions, especially in comparison to the two largest regions in the state: SCAG and MTC.

Note that children under age 18 weren't surveyed directly. Their trip-making characteristics were derived from the group size characteristics reported by adults in households. As such, the children trip-makers were not subject to estimation using expansion factors. Adjustments to account for children trip-makers are described in the following section.

Survey Results

Summaries of Expanded Survey Data

Results from the 2011/2008 Trip Frequency Survey, expanded to match the 2008 population as described above, are summarized below. In sub-section a, summaries are presented for total medium and long distance trip making, including intraregional trips, in order to provide a level ground to compare trip-making in all regions of the state. In sub-section b, the summaries are restricted to interregional medium and long distance trips so that the data can be compared and contrasted to data from the 2000 CAHSR R&R Model calibration and validation and to other data, as available.

a. Medium and Long Distance Trip Making within California

Table 9 summarizes expanded trips for all medium and long distance trips in the state, including interregional and intraregional trips, for both the reduced and enhanced datasets. The trips in this table are calculated by multiplying the number of trips reported by respondents during the two month reporting period by the expansion factor for the corresponding population group (worker status, income, age, and geographic region) and by six to convert the expanded trips to annual trips. The resulting annual expanded trips were divided by 365 to convert to daily trips.

The expanded numbers of trips are virtually identical for the two expansion processes. This fact indicates that deleting 2,412 surveys from the enhanced dataset to create the reduced dataset has little impact on the overall trip rates. In fact, the most significant difference between the expanded trips for the two datasets is for commute trips; 296,400 for the reduced dataset versus 277,300 for the enhanced dataset. Since the expansion of commute trips in the enhanced dataset relies on the imputation of the worker status variable, the values obtained from the reduced dataset may be considered more reliable than the values obtained using the enhanced dataset. Therefore, the survey analyses in the remainder of this memo are based on the reduced dataset.

Table 9. Total Medium and Long Distance Trips in California (Daily Adult Person Trips)

Trip Length	Reduced Dataset			Enhanced Dataset		
	Medium (50-99 Mi.)	Long (100+ Mi.)	Total (50+ Mi.)	Medium (50-99 Mi.)	Long (100+ Mi.)	Total (50+ Mi.)
Geographic Region						
SACOG	63,400	26,000	89,400	68,100	25,900	94,000
SANDAG	76,000	39,700	115,700	90,000	39,200	129,200
MTC	182,800	112,600	295,400	175,900	109,700	285,600
SCAG	598,700	252,100	850,800	581,000	249,400	830,400
Remainder of CA	256,300	140,400	396,700	244,500	143,800	388,300
Trip Purpose (Total for All Regions in California)						
Business	157,400	72,800	230,200	158,800	72,000	230,800
Commute	254,600	41,800	296,400	235,000	42,300	277,300
Recreation	241,400	165,500	406,900	245,100	162,100	407,200
Other	523,800	290,700	814,500	520,600	291,600	812,200
Total	1,177,200	570,800	1,748,000	1,159,500	568,000	1,727,500

Medium and long distance trip rates are estimated by dividing the number of trips in the expanded trip database by the number of adults in the corresponding geographic region. Table 10 summarizes trip rates for the major regions in California and for the rest of the state. The overall medium and long distance trip rates (50 miles or more) for the major regions are distributed over a relatively narrow range, between 0.052 and 0.061 trips per person per day. The overall trip rates for the remainder of the state are significantly higher, which can be attributed to the greater travel distances required to meet certain needs in less populated areas.

Table 10. Total Medium and Long Distance Trip Rates in California (Daily Adult Person Trips per Person)

Region	Medium (50-99 Mi.)		Long (100+ Mi.)		Total (50+ Mi.)	
	Trips	Trip Rate	Trips	Trip Rate	Trips	Trip Rate
SACOG	63,400	0.041	26,000	0.017	89,400	0.057
SANDAG	76,000	0.034	39,700	0.018	115,700	0.052
MTC	182,800	0.034	112,600	0.021	295,400	0.054
SCAG	598,700	0.043	252,100	0.018	850,800	0.061
Remainder of CA	256,300	0.056	140,400	0.031	396,700	0.086
Total	1,177,200	0.043	570,800	0.021	1,748,000	0.063

b. Adjustment for Trips Made by Children

The 2011/2008 Trip Frequency Survey collected trip records for adult residents (age 18 and over) only. The HSR R&R Model was validated using data collected in the 2000-2001 California Statewide Travel Survey, which includes trips made by all residents age 5 and over. Therefore,

the results of the 2011/2008 Trip Frequency Survey must be adjusted to account for children age 5-17.

The 2011/2008 survey collected data for additional household members who accompanied adult trip-makers. These data suggest that the trip frequency for children accompanying adult household members on recreational and other trips is 67 percent of the overall trip rates for adult residents. As would be expected, the data also indicate that children do not accompany adult household members on most commute and business trips.

The adjustment for trips made by children is applied as follows:

- calculate the total number of medium and long distance trips made by adults for the *recreational* and *other* trip purposes from the expanded survey data, separately for each geographic region;
- divide these medium and long distance trip totals by the total adult population of the geographic region to calculate the overall trip rate for adults;
- multiply the overall adult trip rates by 0.67 to calculate the medium and long distance trip rates for children for the *recreational* and *other* trip purposes;
- extract the population of children aged 5 to 17 for each region from the population synthesis;
- multiply the child trip rates by the number of children aged 5 to 17 to calculate the number of child medium and long distance trips for the *recreational* and *other* trip purposes;
- add the child trips to the adult trips to calculate the total trips by region and trip purpose;
- no child adjustment is made for the *commute* and *business* trip purposes.

Table 11 summarizes the estimated medium and long distance trips after adjusting for trip-making by children. The adjustment for children increases the overall number of trips in the expanded trip tables by approximately ten percent, from 1,748,000 to 1,925,700.

As a reasonableness check we reviewed *Highlights of the 2001 National Household Travel Survey*, which reported that 25.7 percent of long distance trips are made by persons under 25 years of age. When we expanded our survey data and applied the adjustment for child trip-making for all children age 17 and younger the result was that persons under 25 years of age made 25.5 percent of total statewide medium and long distance trips.

Table 11. Medium and Long Distance Trips with Child Adjustment by Region and by Trip Purpose

Region	2011/2008 Estimate of Trips in 50-99 Mile Distance Range				
	Business	Commute	Recreation	Other	Total
SACOG	5,300	12,700	20,400	31,300	69,700
SANDAG	6,700	15,300	23,900	37,800	83,700
MTC	20,200	37,600	46,000	94,300	198,100
SCAG	98,900	129,100	128,800	297,800	654,600
Remainder of CA	26,300	59,900	57,400	139,000	282,600
Total	157,400	254,600	276,500	600,200	1,288,700
	2011/2008 Estimate of Trips in 100+ Mile Distance Range				
Region	Business	Commute	Recreation	Other	Total
SACOG	4,000	1,500	8,800	14,600	28,900
SANDAG	5,700	2,000	12,900	23,700	44,300
MTC	11,700	5,100	40,400	67,200	124,400
SCAG	31,600	29,600	84,800	134,900	280,900
Remainder of CA	19,800	3,600	42,500	92,600	158,500
Total	72,800	41,800	189,400	333,000	637,000

The 1,925,000 daily trips described above include only medium and long distance trips to or from locations within the State of California. Preliminary examination of the raw survey data show that approximately 80 percent of the unweighted trips (before survey cleaning and expansion) reported were to locations within the State of California. The remaining 20 percent of trip records indicate that between 450,000 and 500,000 additional daily long distance trips were made by California residents to or from interstate or international locations.

c. Interregional Trip Making

Medium and long distance interregional trips are estimated by deleting the intraregional trips from the expanded trip tables. Table 12 summarizes the total medium and long distance interregional trip making for the four major regions in California (MTC, SCAG, Sacramento, and San Diego) and for the rest of California as a whole.

Table 12. Medium and Long Distance Interregional Trips

Region	Medium (50-99 Mi.)			Long (100+ Mi.)		
	All Trips	Interregional	Intraregionals Removed	All Trips	Interregional	Intraregionals Removed
SACOG	69,700	49,000	30%	28,900	28,400	2%
SANDAG	83,700	59,000	30%	44,300	44,100	0%
MTC	198,100	78,200	61%	124,400	96,400	23%
SCAG	654,600	119,200	82%	280,900	202,500	28%
Remainder of CA	282,600	173,000	39%	158,500	155,200	2%
Total	1,288,700	478,400	63%	637,000	526,600	17%

The comparison in Table 12 shows that deleting intraregional trips removes 63 percent of the medium distance trips from the expanded trip tables, and removes 17 percent of the long

distance trips from the expanded trip tables. Most of the intraregional trips are removed from the two largest regions, SCAG and MTC.

Table 13 summarizes the total medium distance interregional trip making by trip purpose for the four major metropolitan regions in California and for the rest of California as a whole as estimated for 2008 from the 2011/2008 Trip Frequency Survey. This table also shows data from the 2000 CAHSR R&R Model calibration / validation. Note that there is a definitional difference for the two different years[3]:

- For 2011/2008, medium distance interregional trips are defined narrowly to include only those trips made to locations 50 – 99 miles from respondents' homes and traveling between any two of the fourteen modeling regions defined for the CAHSR R&R Model,

Table 13. Medium Distance Interregional Trips by Major Region

Region	2011/2008 Estimate of Interregional Trips in 50-99 Mile Distance Range (1)				
	Business	Commute	Recreation	Other	Total
SACOG	3,200	3,300	15,300	27,200	49,000
SANDAG	6,100	6,800	17,600	28,500	59,000
MTC	8,500	3,800	17,600	48,300	78,200
SCAG	21,500	13,300	37,400	47,000	119,200
Remainder of CA	10,400	32,200	45,200	85,200	173,000
Total	49,700	59,400	133,100	236,200	478,400
Region	**2000 Validation Data for Interregional Trips Less Than 100 Miles**				
	Business	**Commute**	**Recreation**	**Other**	**Total**
SACOG (2,3)	–	–	–	–	83,100
SANDAG (2,3)	–	–	–	–	58,800
MTC (2,3)	–	–	–	–	98,900
SCAG (2,3)	–	–	–	–	140,400
Remainder of CA (2,3)	–	–	–	–	627,500
Total (2,3)	–	–	–	–	1,008,700
Total in 50-99 Mile Distance Range (4)	82,800	353,600	146,300	169,300	752,000

Notes: (1) Source: 2011 California Long Distance Survey data expanded to 2008 to match 2008 population.
(2) Source: *Bay Area/California High-Speed Rail Ridership and Revenue Forecasting Study – Statewide Model Validation*, prepared for the Metropolitan Transportation Commission and the California High-Speed Rail Authority, prepared by Cambridge Systematics, Inc. with Mark Bradley Research and Consulting, July 2007, Table 3.1.
(3) Validation of frequency model was to total trips by region.
(4) Results summarized from modeled trip tables produced for the 2000 validation.

[3] There is also a difference in the method for estimating trip distances. Detailed address information was not requested in the 2011 CAHSRA Long Distance Survey. Instead, city and zip code information was used to estimate straight line distances for each trip reported by a survey respondent. For the 2000 validation result summaries, distances were based on TAZ to TAZ roadway network distances. As a result, the distances estimated for the 2011 survey data are slightly shorter than the the 2000 distances. This should only be a minor concern for comparing the 2000 and 2011data sources. This shouldn't impact future efforts to validate the CAHSR R&R Model, since the validation effort can be based on consistent definitions of trips distance, i.e. crow's flight.

- For 2000, medium distance interregional trips are defined more broadly to include all trips less than 100 miles made between any two of the fourteen modeling regions defined for the CAHSR R&R Model—including those less than 50 miles.

As shown in Table 13, and as should be expected, the 2000 validation data show substantially more medium distance interregional trips since interregional trips in the 0 to 50 mile range are included. Table 13 also shows the modeled 2000 trips by trip purpose in the 50 to 99 mile distance range. The total interregional trips in the 50 to 99 mile range for 2008 estimated from the expanded survey results are 36 percent lower than the modeled trips for 2000.

The geographic distribution of medium distance interregional trips changes dramatically between the two data sets. In the year 2000 data the four major metropolitan regions account for fewer than 40 percent of total medium distance interregional trips, in spite of the fact that these metropolitan regions account for more than 80 percent of the state's population. In the year 2011/2008 data the four major metropolitan regions account for 64 percent of total medium distance interregional trips, which is more in line with the distribution of the total population.

The distributions of medium distance interregional trips by purpose for the two years are substantially different. That issue will be covered in *e. Distribution of Trips by Trip Purpose*.

Table 14 summarizes the estimated interregional trips greater than or equal to 100 miles for 2011/2008 and 2000.

Table 14. Long Distance Interregional Trips by Major Region

Region	2011/2008 Estimate of Interregional Trips in 100+ Mile Distance Range (1)				
	Business	Commute	Recreation	Other	Total
SACOG	4,000	1,500	8,400	14,500	28,400
SANDAG	5,600	2,000	12,800	23,700	44,100
MTC	9,700	400	36,700	49,600	96,400
SCAG	25,700	17,600	60,200	99,000	202,500
Remainder of CA	19,700	2,500	41,900	91,100	155,200
Total	64,700	24,000	160,000	277,900	526,600
Region	**2000 Validation Data for Interregional Trips in the 100+ Mile Distance Range**				
	Business	**Commute**	**Recreation**	**Other**	**Total**
SACOG (2,3)	–	–	–	–	44,300
SANDAG (2,3)	–	–	–	–	55,700
MTC (2,3)	–	–	–	–	132,100
SCAG (2,3)	–	–	–	–	140,800
Remainder of CA (2,3)	–	–	–	–	131,900
Total (2,3)	–	–	–	–	504,800
Modeled Results in the 100+ Mile Range (4)	63,400	187,300	203,500	45,200	499,400

Notes: (1) Source: 2011 California Long Distance Survey data expanded to 2008 to match 2008 population.
(2) Source: *Bay Area/California High-Speed Rail Ridership and Revenue Forecasting Study – Statewide Model Validation*, prepared for the Metropolitan Transportation Commission and the California High-Speed Rail Authority, prepared by Cambridge Systematics, Inc. with Mark Bradley Research and Consulting, July 2007, Table 3.2.
(3) Validation of frequency model was to total trips by region.
(4) Results summarized from modeled trip tables produced for the 2000 validation.

The definitions for the distance ranges between the 2011 California Long Distance Survey and the 2000 validation are consistent with the summaries shown in this table. Overall, the 2011/2008 estimate of long distance interregional trips is five percent higher than the 2000 estimate used for model validation.

The geographic distribution of long distance interregional trips changes between the two data sets. In the year 2000 data the SCAG region accounted for only 28 percent of total long distance interregional trips, in spite of the fact that this metropolitan region accounted for approximately half of the state's population. In the year 2011/2008 data the SCAG region accounted for 38 percent of total long distance interregional trips, which was more in line with the total population.

As with the medium distance interregional trips, the 2011/2008 and 2000 distributions of long distance interregional trips by trip purpose are substantially different.

d. Trip Rates

Tables 15 and 16 summarize our estimate of medium and long distance interregional person trips per household for 2008 and 2000. The trip rates use the household unit in order to allow direct comparison to trip rates reported for the CAHSR R&R Model. The trip rates are expressed as *person trips per household* to clarify that the household unit is used to generate person trips (not household trips).

Table 15. Medium Distance Interregional Person Trip Rates per Household by Major Region

Region	2011/2008 Estimate of Interregional Trips in 50-99 Mile Distance Range (1)				
	Business	Commute	Recreation	Other	Total
SACOG	0.004	0.004	0.020	0.035	0.063
SANDAG	0.006	0.006	0.016	0.026	0.053
MTC	0.003	0.001	0.007	0.019	0.030
SCAG	0.003	0.002	0.006	0.008	0.019
Remainder of CA	0.005	0.015	0.021	0.039	0.079
Total	0.004	0.005	0.010	0.018	0.037
Region	**2000 Validation Data for Interregional Trips Less Than 100 Miles**				
	Business	**Commute**	**Recreation**	**Other**	**Total**
SACOG (2,3)	–	–	–	–	0.145
SANDAG (2,3)	–	–	–	–	0.060
MTC (2,3)	–	–	–	–	0.040
SCAG (2,3)	–	–	–	–	0.025
Remainder of CA (2,3)	–	–	–	–	0.326
Total (2,3)	–	–	–	–	0.088
Total in 50-99 Mile Distance Range (4)	0.007	0.031	0.013	0.015	0.065

Notes: (1) Source: 2011 California Long Distance Survey data expanded to match 2008 population and 2008 household estimates.
(2) Source: CS from *Bay Area/California High-Speed Rail Ridership and Revenue Forecasting Study – Statewide Model Validation*, Table 3.1, and 2000 households estimates by region.
(3) Validation of frequency model was to total trips by region.
(4) Results summarized from modeled trip tables produced for the 2000 validation.

The 2000 rates have been estimated from the model output summarized in *Bay Area/California High-Speed Rail Ridership and Revenue Forecasting Study – Statewide Model Validation*, Table 3.2 along with summaries of 2000 households for each of the regions used as input to the model. The 2008 rates have been estimated using the expanded survey data, adjusted to account for children age 5-17, and the households by region for 2008 as estimated from the California Statewide Travel Demand Model (CSTDM) Synthetic Population Database developed by the University of California-Davis.

Table 16. Long Distance Interregional Person Trip Rates per Household by Major Region

Region	2011/2008 Estimate of Interregional Trips in 100+ Mile Distance Range (1)				
	Business	Commute	Recreation	Other	Total
SACOG	0.005	0.002	0.011	0.019	0.037
SANDAG	0.005	0.002	0.012	0.021	0.040
MTC	0.004	0.0002	0.014	0.019	0.037
SCAG	0.004	0.003	0.010	0.016	0.033
Remainder of CA	0.009	0.001	0.019	0.042	0.071
Total	0.005	0.002	0.012	0.022	0.041
Region	**2000 Validation Data for Interregional Trips in the 100+ Mile Distance Range**				
	Business	**Commute**	**Recreation**	**Other**	**Total**
SACOG (2,3)	–	–	–	–	0.077
SANDAG (2,3)	–	–	–	–	0.057
MTC (2,3)	–	–	–	–	0.054
SCAG (2,3)	–	–	–	–	0.025
Remainder of CA (2,3)	–	–	–	–	0.069
Total (2,3)	–	–	–	–	0.044
Modeled Long Distance (4)	0.006	0.016	0.018	0.004	0.044

Notes: (1) Source: 2011 California Long Distance Survey data expanded to match 2008 population and 2008 household estimates
(2) Source: CS from *Bay Area/California High-Speed Rail Ridership and Revenue Forecasting Study – Statewide Model Validation*, Table 3.2, and 2000 households estimates by region.
(3) Validation of frequency model was to total trips by region.
(4) Results summarized from modeled trip tables produced for the 2000 validation.

The comparison of trip rates, rather than total trips, changes the perspective of the differences in long distance interregional trip making for each of the regions. Thus, while the total medium distance interregional trips for 2011/2008 (including the adjustment for children trip-makers) are about 35 percent lower than the number of interregional trips for the same distance range from the 2000 model data (Table 13), the overall medium distance interregional trip rate for 2011/2008 (0.037 medium distance interregional trips per household) is 43 percent lower than the 2000 rate. Likewise, while the total long distance interregional trips for 2011/2008 exceeds the number of long distance interregional trips for 2000 model validation (Table 14), the overall long distance interregional trip rate for 2011/2008 (0.041 long distance interregional trips per household) is seven percent lower than the 2000 rate (0.044 long distance interregional trips per household).

The geographic distribution of the interregional trip rates indicates that the areas with the lowest population densities exhibit the highest rates of medium and, especially, long distance trip making. This is understandable given the greater distances required to reach basic

necessities in sparsely populated areas. The lower trip rates calculated for the SCAG and MTC regions are also impacted by the exclusion of intraregional trips. In the SCAG region, especially, there were significant numbers of intraregional trips reported in the 50-99 mile range.

The distributions of trip rates by trip purpose for the two years are substantially different – we provide a more detailed assessment in *Section e. Distribution of Trips by Trip Purpose*.

Estimates of average annual long distance interregional round trips per capita (rather than per household) resulting from an application of the existing CAHSR R&R Model were summarized in a June 8, 2011 memorandum to the Peer Review Panel[4]. Long distance round trip journeys are calculated as half the number of long distance one-way trips. Table 17 summarizes those results from the 2000 model validation, for 2011/2008, and for a recent 2030 travel forecast using the existing HSR R&R Model.

In the May 2-3, 2011 Peer Review Panel meeting, the overall 2000 and 2030 annual per capita long distance trip rates were deemed acceptable, albeit possibly at the high end of the acceptable range. The estimated 2011/2008 per capita rate for all trips is six percent lower than the per capita rates from the 2000 model validation.

Table 17. Average Annual Long Distance (100+ Miles) Interregional Round Trip Journeys per Capita

Year	Business	Commute	Recreation	Other	Total
2000 Validation	0.38	1.11	1.21	0.27	2.96
2011/2008 Long Distance	0.34	0.13	0.84	1.46	2.77
2030 Model	0.39	1.19	1.34	0.32	3.23

The analysis above only accounts for long distance interregional trips within the State of California. Long distance intraregional trips increase the estimated number to 3.35 annual long distance round trip journeys per capita within the State of California.

The additional trip records for trips to locations outside of the State of California indicate that California residents make between 450,000 and 500,000 trips per day to or from interstate and international locations. These trips account for an additional 2.3-2.6 round trip journeys per capita per year, almost all of which qualify as long distance (over 100 miles). The total annual long distance trip rate can be estimated at between 5.7 and 6.0 long distance round trip journeys per capita.

e. Distribution of Trips by Trip Purpose

As has been discussed in the previous two sections, the distribution of trips by trip purpose estimated for 2011/2008 are substantially different from the distribution resulting from the 2000

[4] "Information Requested in 'Section 3.2 Validation and Documentation' of the Independent Peer Review of the California High Speed Rail Ridership and Revenue Forecasting Process, 2005-10, Draft Report for Internal Review (February 7, 2011)."

model calibration and validation, especially for the long distance interregional trips. In particular, the long distance commute and recreation trips and trip rates estimated for 2008 are substantially lower than the 2000 trips and trip rates, while the 2008 other trips and trip rates are substantially higher.

The distribution of trips by trip purpose used for the 2000 model calibration and validation were compiled from a number of sources including the 1995 American Travel Survey (1995 ATS), the 2001 California Statewide Household Travel Survey (2001 SHTS), and the 2000 Census Transportation Planning Package (2000 CTPP) data. The 1995 ATS was designed to collect information regarding long distance travel while the 2001 SHTS was a typical household travel survey focused on collecting household travel information for an assigned travel day. While the 2001 SHTS did collect long distance travel, long distance travel is a rare phenomenon (in comparison to routine daily trip-making) typically resulting in too few observations to draw meaningful summaries. The 2000 CTPP provided information on "the place where the person normally worked" the previous week and linked that information with the household location of the person. Table 18 shows the surveys used to estimate medium and long distance interregional trips for the 2000 model calibration.

Table 18. Surveys Used to Estimate Trips by Purpose for 2000 Model Calibration

Survey	Medium Distance				Long Distance			
	Business	Commute	Recreation	Other	Business	Commute	Recreation	Other
1995 ATS					x		x	x
2001 SHTS	x		x	x				
2000 CTPP		x				x		

The 2011/2008 Trip Frequency Survey, like the 1995 ATS, was designed to collect information specifically on long distance travel. Data on long distance trips made during a two month time period were collected from each respondent in order to compensate for the issues associated with finding sufficient numbers of long distance trips with a normal, one day travel survey. The survey design, however, introduced some uncertainty into the results. Specifically, the survey collected information from only one respondent from each household contacted and the sample was selected from an internet panel. To the extent possible, the impacts of the survey design issues were mitigated through the expansion factoring process.

f. Comparison to Other Data Sources

Table 19 summarizes the percentages of trips by trip purpose from the 2000 calibrated model results and from the 2011/2008 Trip Frequency Survey factored to match the 2008 population. Results from the 2001 National Household Travel Survey (2001 NHTS) and the 2009 NHTS are also summarized in Table 19 for comparison. Key points from the comparison:

- The 2001 NHTS specifically asked long distance travel questions for trips over 50 miles in length. Travel was summarized into the following purposes: Business, Commute, Pleasure, Personal Business, and Other.

- The 2009 NHTS did not include long distance travel questions. However, since over 100,000 households were included in the survey, reasonable numbers of long distance trips were captured in the survey.
- The 2009 NHTS summarized trips into the following trip purposes: home-based work, home-based social, home-based other, business, and non-home-based. For the purposes of comparison, business trips were assumed to be the same as business in a long distance travel survey, home-based work trips were assumed to be commute, and home-based social, home-based other, and non-home-based trips were combined into a combined recreation/other trip purpose.
- The CA HSR R&R Model and 2011/2008 Trip Frequency Survey are limited to interregional trips within the State of California, while the NHTS data include long distance trips to all locations.

Economic conditions should be considered in analyzing the trips by purpose summarized in Table 19. The 2000 data were based on the observation of conditions at the height of the "dot.com" boom. In California, there was substantial commuting and temporary relocations by workers with residences in the San Joaquin Valley, the Monterey Bay area and Central Coast, and, even, the Los Angeles region, who and worked in San Francisco and the Silicon Valley. In contrast, the 2009 NHTS and the 2011 Long Distance survey were collected either during the "great recession" or during the slow recovery afterwards, where such long distance commuting became less prevalent.

Table 19. Percentages of Trips by Trip Purpose

Survey / Source	Distance Range Summarized	Business	Commute	Business / Commute	Recreation / Other
2000 CA HSR Model Results	50+ Miles	12%	43%	55%	45%
2011/2008 Long Distance Survey	50+ Miles	11%	8%	20%	80%
2001 NHTS	50+ Miles	16%	13%	29%	71%
2009 NHTS	50-500 Miles	9%	9%	18%	82%
2000 CA HSR Model Results	100+ Miles	13%	38%	50%	50%
2011/2008 Long Distance Survey	100+ Miles	12%	5%	17%	83%
2009 NHTS	100-500 Miles	10%	3%	13%	87%

The trips reported in the 2011/2008 Trip Frequency Survey indicate that California residents make trips to approximately 1.2 million medium and long distance destinations per day (including intraregional and out-of-state locations), or 0.093 round trip journeys per household per day. The 2001 National Household Travel Survey (*BTS National Household Travel Survey - Long Distance Travel Quick Facts*) reports that Americans made approximately 2.6 billion long distance trips in 2001, or 0.067 trips per household per day, which indicates that California's long distance trip rate observed from the 2011/2008 Trip Frequency Survey is approximately 40 percent greater than the national statistic. However, a recent long distance travel survey completed in the State of Colorado (*Surveying and Modeling Long Distance Trips* presented at the

13th National TRB Transportation Applications Conference, May 11, 2011) reported an average trip rate similar to the California data: 0.097 trips over 50 miles per household per day.[5]

g. Trip Distribution

Table 20 compares long distance interregional trip distribution results from the 2011/2008 Trip Frequency Survey, factored to match 2008 population and adjusted to account for children age 5-17, to 2000 CAHSR R&R Model calibration targets. The 2000 HSR R&R Model calibration targets were defined for major region to region pairs that could be readily summarized from 1995 ATS data and 2000 CTPP data. **Table 20. Average Daily Long Distance Interregional Trips**

Market	Business	Commute	Recreation	Other	Total
2011/2008 Estimate of Interregional Trips in 100+ Mile Distance Range					
LA to Sacramento	5,600	100	4,800	11,200	21,700
LA to San Diego	7,500	10,400	29,800	42,800	90,500
LA to SF	17,300	400	22,000	40,700	80,400
Sacramento to SF	1,900	1,400	12,300	12,300	27,900
Sacramento to San Diego	700	-	900	1,200	2,800
San Diego to SF	2,300	-	3,600	7,300	13,200
LA/SF to SJV	8,700	9,000	21,600	57,900	97,200
Other to SJV	6,500	400	2,600	9,300	18,800
To/from Monterey/Central Coast	15,000	6,000	40,300	62,800	124,100
To/from Far North	6,100	500	12,200	22,600	41,400
To/from W. Sierra Nevada	1,400	300	11,300	4,700	17,700
Total	73,000	28,500	161,400	272,800	535,700
2000 Validation Data for Interregional Trips in 100+ Mile Distance Range (1)					
LA to Sacramento	5,200	5,100	7,100	1,500	18,900
LA to San Diego	10,300	29,700	61,800	13,600	115,400
LA to SF	17,400	22,100	44,100	6,800	90,400
Sacramento to SF	5,600	17,000	21,400	7,300	51,300
Sacramento to San Diego	1,200	900	1,200	200	3,500
San Diego to SF	6,000	4,800	16,400	2,300	29,500
LA/SF to SJV	4,400	53,700	19,800	5,700	83,600
Other to SJV	12,500	11,000	12,900	4,700	41,100
To/from Monterey/Central Coast	8,300	28,800	19,800	6,800	63,700
To/from Far North	3,100	17,000	12,400	2,400	34,900
To/from W. Sierra Nevada	500	9,700	7,500	1,500	19,200
Total	74,500	199,800	224,400	52,800	551,500

Notes: (1) Source: *Bay Area/California High-Speed Rail Ridership and Revenue Forecasting Study – Final Report*, prepared for the Metropolitan Transportation Commission and the California High-Speed Rail Authority, prepared by Cambridge Systematics, Inc., July 2007, Table 3.3.

[5] The Colorado survey data is preliminary and not yet weighted to correct for observed biases. The difference in the trip rates reported for the national (NHTS) and statewide (California and Colorado) surveys is most likely due to the different survey mechanisms employed. The NHTS survey employed a daily diary while the California and Colorado surveys employed longer term survey mechanisms to capture long distance travel over a longer time frame – 14 days for Colorado and two months for California. The Colorado long distance survey was conducted in conjunction with a household travel survey that employed a daily diary, which resulted in an underestimate of long distance travel similar to the NHTS result: 0.68 trips per household per day.

Table 20 provides information about the absolute levels of interregional trip making for the 2000 model calibration and based on the 2011/2008 estimate of interregional trips. While this table provides information on the absolute numbers of trips, the differences in the numbers of trips by purpose obscure the relative differences in the distributions. To provide information on the relative similarities and differences in the trip distributions, Table 21 shows the percentages of trips for each interchange market for each trip purpose.

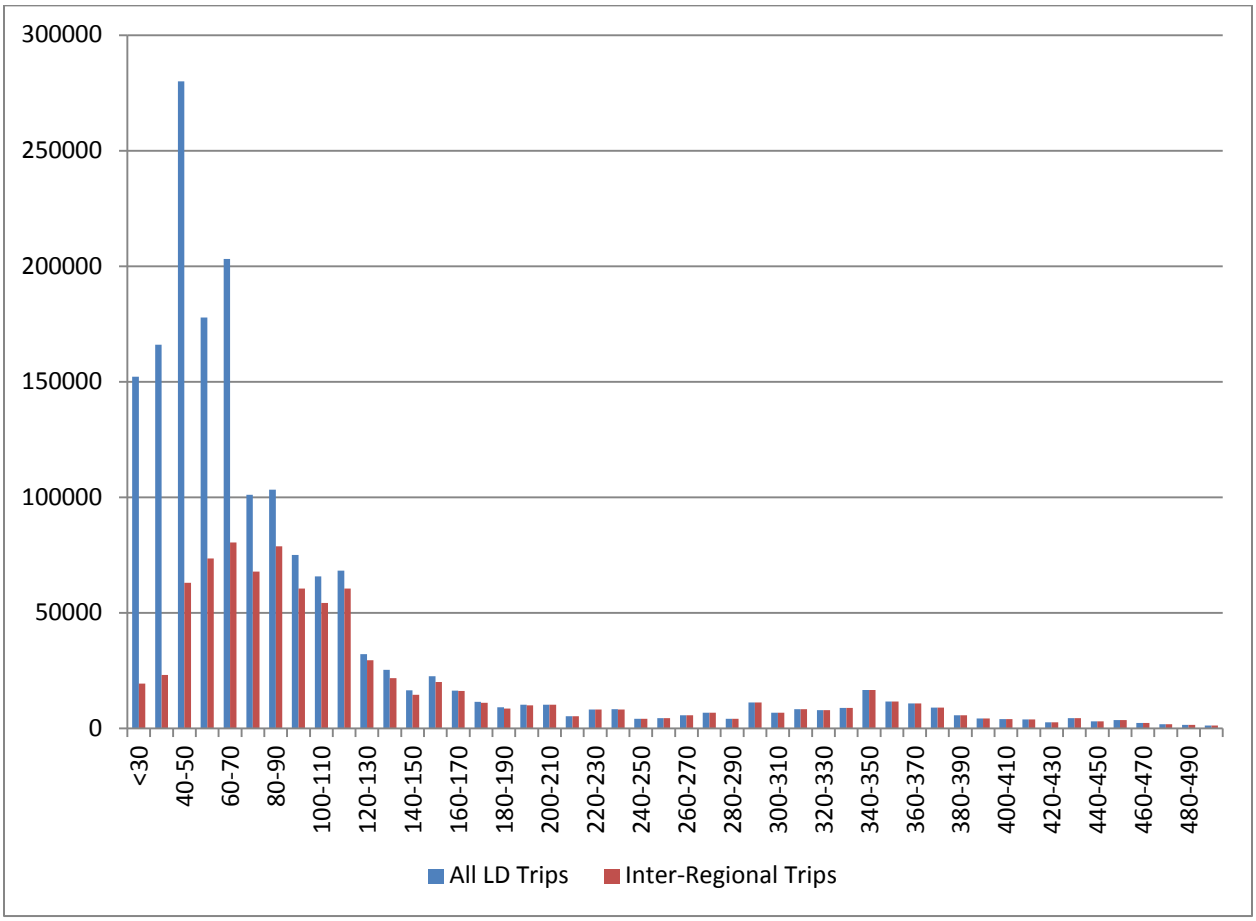
Table 21. Percent of Daily Long Distance Interregional Trips by Trip Purpose and Major Market Pairs

Market	Business		Commute		Recreation		Other		Total	
	2000	2008	2000	2008	2000	2008	2000	2008	2000	2008
LA to Sacramento	7%	8%	3%	0%	3%	3%	3%	4%	3%	4%
LA to San Diego	14%	10%	15%	36%	28%	18%	26%	16%	21%	17%
LA to SF	23%	24%	11%	1%	20%	14%	13%	15%	16%	15%
Sacramento to SF	8%	3%	9%	5%	10%	8%	14%	5%	9%	5%
Sacramento to San Diego	2%	1%	0%	0%	1%	1%	0%	0%	1%	1%
San Diego to SF	8%	3%	2%	0%	7%	2%	4%	3%	5%	2%
LA/SF to SJV	6%	12%	27%	32%	9%	13%	11%	21%	15%	18%
Other to SJV	17%	9%	6%	1%	6%	2%	9%	3%	7%	4%
To/from Monterey/Central Coast	11%	21%	14%	21%	9%	25%	13%	23%	12%	23%
To/from Far North	4%	8%	9%	2%	6%	8%	5%	8%	6%	8%
To/from W. Sierra Nevada	1%	2%	5%	1%	3%	7%	3%	2%	3%	3%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

The trip length frequency distributions for medium and long distance trips within California are displayed in Exhibit 1. This graphic displays the number of daily trips by California adults stratified by 10-mile trip length ranges. The trip length distributions are displayed for both interregional trips and for all trips within the state (including intraregional trips).

The distribution curve for interregional trips is relatively flat between 50 miles and 120 miles, drops quickly between 120 and 200 miles, and exhibits a very long tail that includes a distinct peak at the 350 mile range. This distribution pattern is directly attributable to the geography and demographics of the State of California, with the two largest metropolitan centers (SCAG and MTC) being separated by approximately 350 miles. The large numbers of trips in the range up to 120 miles are due to the proximity of the adjacent metropolitan regions, such as SCAG and SANDAG or MTC and SACOG.

Exhibit 1. Trip Length Frequency Distribution for Medium and Long Distance Trips in California



The trip distribution appears to include many trips that are less than the 50-mile threshold required for the trips to qualify as a medium or long distance trip. This is a result of the GIS-based methodology used to estimate trip lengths: straight line distance between polygon centroids for zip codes and cities, and doesn't reflect the impacts of geographic barriers and

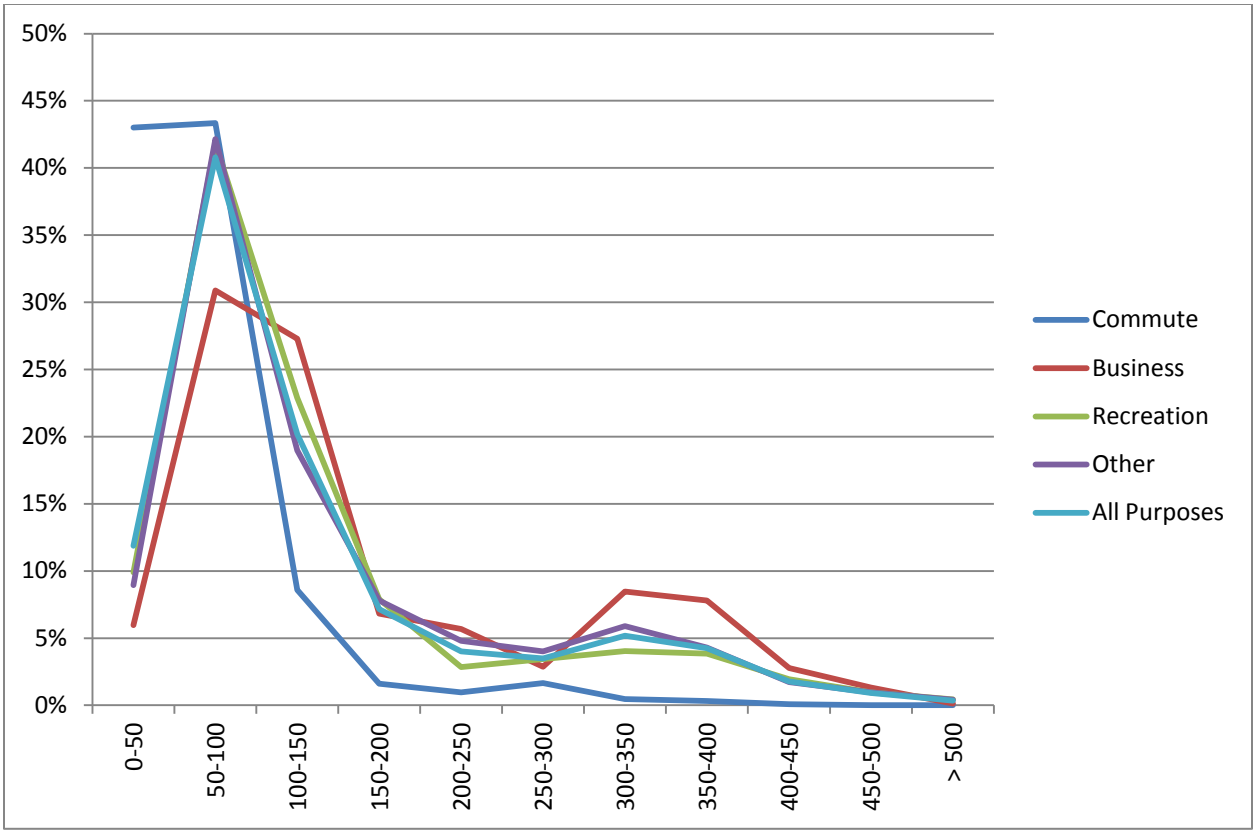
highway path choices. Most of the shorter trips are intraregional in nature, and therefore not a concern for the purposes of the validation of the CA HSR R&R Model.

The trip length frequency distributions for medium and long distance interregional trips are displayed for the various trip purposes in Exhibit 2. This graphic, which aggregates the trips into 50-mile ranges, shows that the trip length distributions for the commute and business trip purposes are very different from the distributions for the recreational and other trip purposes.

The trip distribution for the commute trips is weighted heavily to the shorter trip lengths, with fewer than five percent of the medium and long distance commute trips being over 150 miles in length.

The trip length distribution for the business trip purpose includes a significant share of trips of very long trip length, including approximately 20 percent of the medium and long distance business trips being over 300 miles in length. This is due to the large amount of business travel between the major metropolitan regions of the state.

Exhibit 2. Trip Length Frequency Distribution for Medium and Long Distance Interregional Trips by Trip Purpose



h. Mode Shares

Table 22 summarizes the medium and long interregional main travel mode shares by trip purpose from the 2000 CAHSR R&R Model validation results and the mode shares estimated from the 2011/2008 Trip Frequency Survey, factored to match the 2008 population synthesis data and adjusted to account for children age 5-17. Year 2000 model validation results have been summarized rather than the 2000 model validation targets. In this way, medium distance interregional trips (in the 50 to 99 mile distance range) could be estimated. The 2000 model validation targets for interregional trips less than 100 miles included trips in the 0 to 50 mile range.

The 2008 mode shares for medium distance interregional trips reflect higher mode use of rail and bus for the travel. The increase in the medium distance commute, rail mode share between 2000 and 2008 may be reflective of real increases in interregional commuter rail use, especially the Amtrak services (Capitol Corridor and San Joaquins in northern California and the San Joaquin Valley, and the Surfliner in southern California).

For long distance travel, the air mode shares for 2008 are substantially higher than for 2000 for business and commute trips, and slightly lower for recreation/other trips. Due to the differences in trips by purpose, overall air travel estimated for 2008 is almost identical to that for 2000, even though the business and commute mode shares are higher. The average daily long distance air travel for 2000 was estimated to be 55,100 trips and for 2008 was estimated to be 55,200 trips. The 55,200 estimate for 2008 compares to 36,900 daily intrastate air trips by California residents estimated by Geoff Gosling.[6] Gosling's estimate included only travel between the Bay Area and Southern California and between Sacramento and Southern California with the smaller markets excluded.

Table 22. Percent of Daily Long Distance Interregional Trips by Trip Purpose and Mode

Mode	Business		Commute		Business / Commute		Recreation / Other		Total	
	2000	2011/ 2008	2000	2011/ 2008	2000	2011/ 2008	2000	2011/ 2008	2000	2011 2008
Medium Distance (50-99 Miles)										
Auto	99%	97%	99%	96%	99%	96%	100%	97%	99%	97%
Air	0%	1%	0%	0%	0%	1%	0%	0%	0%	0%
Rail	1%	1%	1%	3%	1%	2%	0%	1%	1%	2%
Other, including bus	–	1%	–	0%	–	0%	–	2%	–	1%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Long Distance (100+ Miles)										
Auto	86%	61%	89%	79%	88%	64%	88%	88%	88%	84%
Air	13%	35%	11%	21%	11%	33%	11%	8%	11%	12%
Rail	0%	1%	0%	0%	0%	1%	1%	2%	1%	2%
Other, including bus	–	2%	–	0%	–	2%	–	2%	–	2%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

[6] *Potential Airline Response to High-Speed Rail Service in California*, prepared for Cambridge Systematics by Aviation System Consulting, LLC, April 29, 2011, Tables 1 and 2.

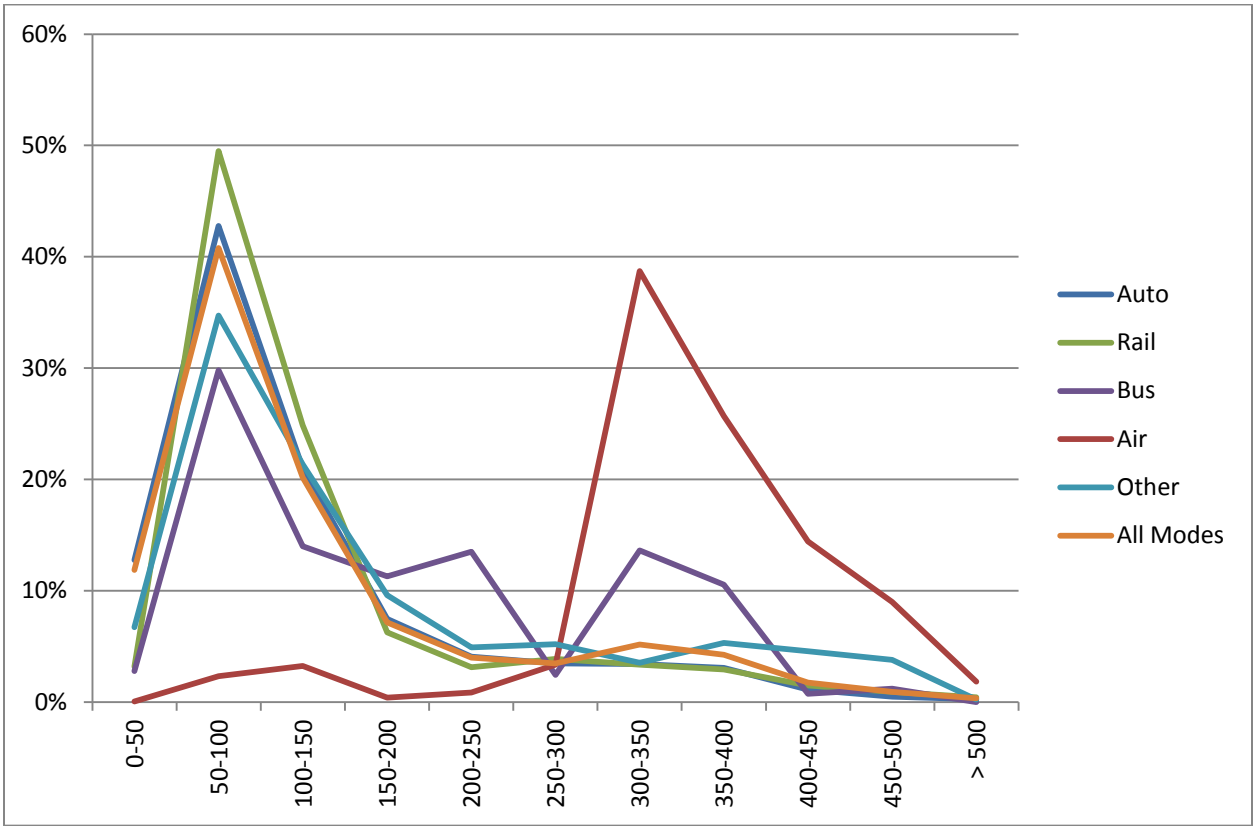
The trip length frequency distributions for medium and long distance interregional trips are displayed for the various main travel modes in Exhibit 3. This graphic, which aggregates the trips into 50-mile ranges, shows that the trip length distributions for the auto and rail travel modes are quite different from the distributions for the air and bus modes.

The trip length frequency curves for the auto and rail modes both exhibit a steep drop from the shorter trip lengths until approximately 250 miles, and then the frequencies stabilize until approximately 400 miles.

The trip length frequency curves for the bus mode shows relatively few trips in the shorter trip lengths (as compared to the auto and rail modes) and higher percentages of trips in the trip lengths over 200 miles.

The trip length frequency curves for the air mode is dramatically different from all other modes, as there are very few trips in the shorter trip lengths (below 300 miles) and significant percentages of trips in the trip lengths over 300 miles. This graphic shows that almost two-thirds of all air trips in California are between 300 and 400 miles in length.

Exhibit 3. Trip Length Frequency Distribution for Medium and Long Distance Interregional Trips by Main Travel Mode



The total number of daily trips estimated for each travel mode are displayed in stacked bar format in Exhibit 4. This exhibit shows that virtually all of the trips less than 300 miles are made using auto mode and the air mode becomes significant for trips over 300 miles in length.

Exhibit 4. Travel Modes by Trip Length for Medium and Long Distance Interregional Trips

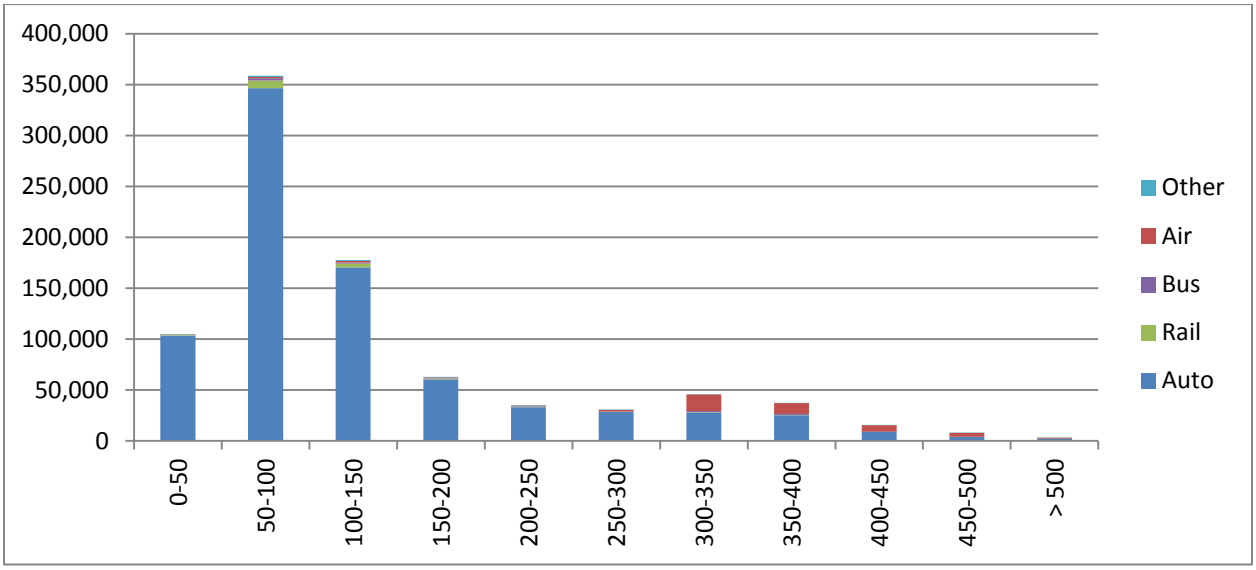
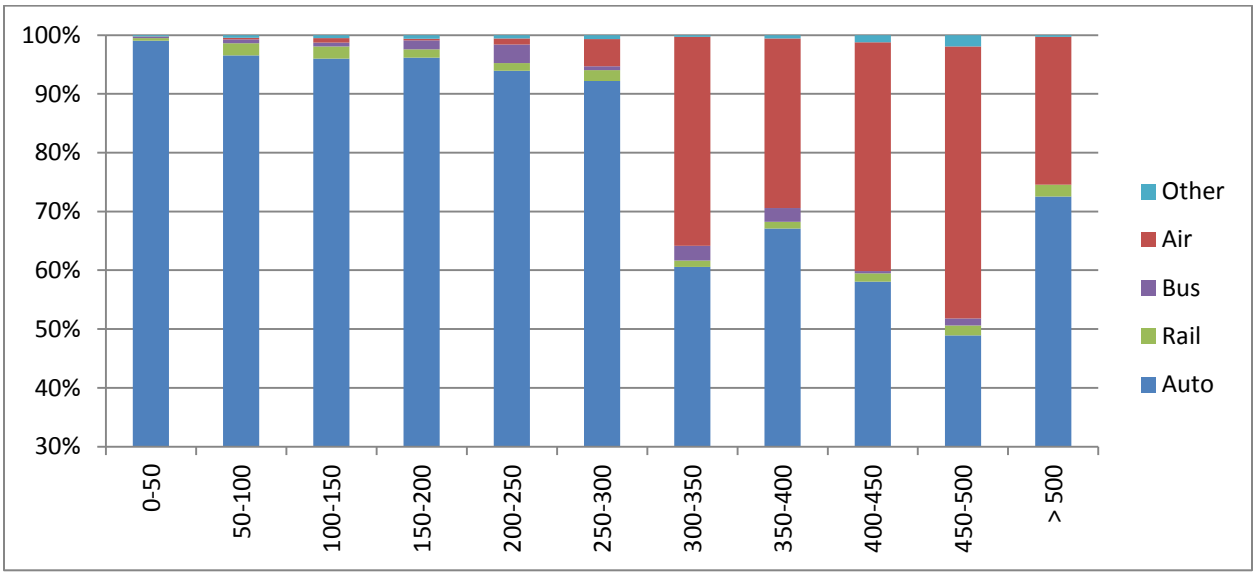


Exhibit 5 provides a more readable way to show the mode shares of medium and long distances travel in California for different trip distances. The modal shares of daily trips estimated for each travel mode are displayed in stacked bar format. This exhibit shows dramatically how the air mode becomes significant for trips over 300 miles in length. This exhibit also shows that the rail modal share remains virtually constant (near two percent) for most trip lengths.

Exhibit 5. Travel Mode Shares by Trip Length for Medium and Long Distance Interregional Trips



Some Considerations Regarding Survey Results

Several issues regarding the state of the economy in 2000 and 2011 should be considered in interpreting the results reported above:

- The 2000 data were based on the observation of conditions at the height of the "dot.com" boom. In California, there was substantial commuting by workers living in the San Joaquin Valley, the Monterey Bay area and Central Coast, and, even, the Los Angeles region and the Silicon Valley.
- In contrast, the 2009 NHTS and the 2011 Long Distance survey were collected either during the "great recession" or during the slow recovery afterwards, where such long distance commuting became less prevalent.
- The 2008 population synthesis data used for the survey expansion are based on underlying population characteristics from the 2000 Census and are, in essence, pre-great recession data.
- If the 2011 CAHSRA Long Distance Survey data were expanded to reflect the California population for 2010/2011, different results might be obtained. There are about one million more unemployed workers for 2010/2011 than in 2008.

Appendix 1 – Final Survey Mechanism

BASE: ALL RESPONDENTS
Q75 (QV7) PRELOAD – SAMPLE SUPPLIER
1 HPOL
5 Partner 2
36 Partner

BASE: ALL RESPONDENTS
Q5 (QV8) PRELOAD – INCENTIVE TYPE
[NUMERIC 5 DIGIT]
|_|_|_|_|_|

Q610 Welcome and thank you for agreeing to take part in our survey! Your time and opinions are greatly valued!

First, we would like to start by asking you some classification questions so that we can customize the survey for you.

Are you…?

1 Male
2 Female

Q615 In what year were you born? Please enter as a four-digit number, for example, 1963.

|__|__|__|__| [RANGE: 1890-2000]

Q620 [BEHIND THE SCENES: AGE COMPUTE THAT RECODES THE DATA AT Q615]

1 Under 13 [IMMEDIATELY TERMINATE TO "UNDER 13" PAGE]
2 13-17 [ASK Q624-Q630, THEN TERMINATE TO Q98]
3 18-29
4 30-39
5 40-49
6 50-64
7 65 and older

[BASE:ALL RESPONDENTS]
Q264 In what country or region do you currently reside?
[DROP DOWN MENU —SEE STANDARD RESPONSES FOR SHORT LIST]

[ASK IF Q264/244]
Q625 In what state or territory do you currently reside?
[DROP DOWN MENU WITH CHOICES LISTED-SEE STANDARD RESPONSES]

Q800
Q18. In what city do you live?

1. City _____

[BASE:ALL US RESPONDENTS]
Q630 What is your zip code? Please enter only the first five digits.
|_|_|_|_|_| [ALLOW ONLY A 5 DIGIT, NUMERIC CODE]

[TERMINATE IF NOT FROM CA (CODE 105)]

Q635 [DMA ASSIGNMENT – USE ZIP CODE TO ASSIGN DMA]

1. Los Angeles, CA = DMA 803 [QMS=99999]
2. San Francisco-Oakland-San Jose, CA = DMA 807 [QMS=99999]
3. Sacramento-Stockton-Modesto, CA = DMA 862 [QMS=99999]
4. San Diego, CA = DMA 825 [QMS=99999]
5. Fresno-Visalia, CA = DMA 866 [QMS=99999]
6. Santa Barbara-Santa Maria-San Luis Obispo, CA = DMA 855 [QMS=99999]
7. Monterey-Salinas, CA = DMA 828 [QMS=99999]
8. Bakersfield, CA = DMA 800 [QMS=99999]
9. Anywhere else in the state of CA [QMS=11,000]

Q640 [DMA ASSIGNMENT BY SAMPLE SOURCE]

1. HPOL Los Angeles, CA = DMA 803 (Q75/1 AND Q635/1) [QMS=99999]
2. HPOL San Francisco-Oakland-San Jose, CA = DMA 807 (Q75/1 AND Q635/2) [QMS=99999]
3. HPOL Sacramento-Stockton-Modesto, CA = DMA 862 (Q75/1 AND Q635/3) [QMS=99999]
4. HPOL San Diego, CA = DMA 825 (Q75/1 AND Q635/4) [QMS=99999]
5. HPOL Fresno-Visalia, CA = DMA 866 (Q75/1 AND Q635/5) [QMS=99999]
6. HPOL Santa Barbara-Santa Maria-San Luis Obispo, CA = DMA 855 (Q75/1 AND Q635/6) [QMS=99999]
7. HPOL Monterey-Salinas, CA = DMA 828 (Q75/1 AND Q635/7) [QMS=99999]
8. HPOL Bakersfield, CA = DMA 800 (Q75/1 AND Q635/8) [QMS=99999]
9. HPOL Anywhere else in the state of CA (Q75/1 AND Q635/9) [QMS=99999]
10. Partner Los Angeles, CA = DMA 803 (Q75/36 AND Q635/1) [QMS=99999]
11. Partner San Francisco-Oakland-San Jose, CA = DMA 807 (Q75/36 AND Q635/2) [QMS=99999]
12. Partner Sacramento-Stockton-Modesto, CA = DMA 862 (Q75/36 AND Q635/3) [QMS=99999]
13. Partner San Diego, CA = DMA 825 (Q75/36 AND Q635/4) [QMS=99999]
14. Partner Fresno-Visalia, CA = DMA 866 (Q75/36 AND Q635/5) [QMS=99999]
15. Partner Santa Barbara-Santa Maria-San Luis Obispo, CA = DMA 855 (Q75/36 AND Q635/6) [QMS=99999]
16. Partner Monterey-Salinas, CA = DMA 828 (Q75/36 AND Q635/7) [QMS=99999]
17. Partner Bakersfield, CA = DMA 800 (Q75/36 AND Q635/8) [QMS=99999]
18. Partner Anywhere else in the state of CA (Q75/36 AND Q635/9) [QMS=99999]
19. Partner 2 Los Angeles, CA = DMA 803 (Q75/5 AND Q635/1) [QMS=99999]

20. Partner 2 San Francisco-Oakland-San Jose, CA = DMA 807 (Q75/5 AND Q635/2) [QMS=99999]
21. Partner 2 Sacramento-Stockton-Modesto, CA = DMA 862 (Q75/5 AND Q635/3) [QMS=99999]
22. Partner 2 San Diego, CA = DMA 825 (Q75/5 AND Q635/4) [QMS=99999]
23. Partner 2 Fresno-Visalia, CA = DMA 866 (Q75/5 AND Q635/5) [QMS=99999]
24. Partner 2 Santa Barbara-Santa Maria-San Luis Obispo, CA = DMA 855 (Q75/5 AND Q635/6) [QMS=99999]
25. Partner 2 Monterey-Salinas, CA = DMA 828 (Q75/5 AND Q635/7)[QMS=99999]
26. Partner 2 Bakersfield, CA = DMA 800 (Q75/5 AND Q635/8) [QMS=99999]
27. Partner 2 Anywhere else in the state of CA (Q75/5 AND Q635/9) [QMS=99999]

Q695 Initially Qualified

1 Qualified (Q620/3-7 AND Q264/244 AND Q625/105) [QMS = 15,020]
2 Not Qualified [TERMINATE]

Q98 Screener Termination
Not 18+ (Q620/1-2)
Not from the US (Q264/NE 244)
Not from CA (Q625/NE 105)
Not initially qualified (Q695/2)

Q99 Screener Qualified
Must be 18+ (Q620/3-7)
Must be from the US (Q264/244)
Must be from CA (Q625/105)
Must be initially qualified (Q695/1)

Section A: Travel Information

Q700

We are gathering information on long distance travel made by California residents. We define long distance trips as a trip to a location 50 or more miles from your home. We will ask you to provide separate information about your outbound long distance trip (from your home) and your long distance trip to return home.

(Please note that brief stops for gas, rest, food, picking up passengers or changing vehicles are considered parts of the long distance trip, and are not considered separate trips. For example, imagine that you drove from your home in Sacramento to Fresno with a stop along the way for gas. This would be considered one long distance trip – from Sacramento to Fresno. Your return home to Sacramento would be another long distance trip – from Fresno to Sacramento.)

Q1. Did you make any trips to a location 50 miles or more from your home (a "long distance trip") during the past two months?

1. Yes

2. No

Q705, Q706, Q707

Q2. When did you make your most recent outbound (away from home) long distance trip? (Please respond even if this trip occurred more than two months ago.)

Enter date that you started this trip (i.e. mm/dd/yy): _____

Q708 Enter day of week: _____ [INSERT DROP DOWN WITH DAYS OF THE WEEK]

[FORCE RESPONDENT TO ENTER THE DAY OF THE TRIP (Q706) OR THE DAY OF THE WEEK (Q708). ERROR MESSAGE: If you don't remember the exact date of this long distance trip, please enter the year, month, and day of the week that you made this trip (to the best of your recollection).]

Q710

Q3. Where were you when you actually started this trip?

1. Your home [Skip to Q720 (Q5)]

2. Work

3. School

4. Somewhere else (please specify): Q711 _____

Q715, Q716, Q717, Q718 [ASK IF Q710/2-4]

Q4. Where was this place located (where you started this long distance trip)?

1. City: _____ [MANDATORY TEXT BOX]

2. Country: _____ [DROP DOWN WITH SHORT LIST, ANCHOR US AT THE TOP]

3. State: _____ [DROP DOWN WITH STATES ONLY IF Q716 IS US, ANCHOR CA AT THE TOP]

4. Zip Code (if known): _____ [NON-MANDATORY]

Q720

Q5. What was the primary purpose for this long distance trip? Please select only one response. [RANDOMIZE]

1. Commuting to or from my place of work

2. Business (work-related, but to a location other than your usual workplace)

3. School or school-related activity

4. Visit friends, family, or relatives

5. Medical

6. Vacation, recreation, or entertainment

7. Other (specify): Q721 _____

[DISPLAY Q725, Q726, Q727, Q728 AND Q775 ON THE SAME SCREEN]
Q725, Q726, Q727, Q728
Q6. Where was the primary destination for this trip?

1. City: _____ [MANDATORY TEXT BOX]

2. Country: _____ [DROP DOWN WITH SHORT LIST, ANCHOR US AT THE TOP]

3. State: _____ [DROP DOWN WITH STATES ONLY IF Q726 IS US, ANCHOR CA AT THE TOP]

4. Zip Code (if known): _____ [NON-MANDATORY]

Q775 [ASK IF Q700/1]
Q16. How many times have you traveled to this same destination for the same reason during the past two months?

□ Just this one time

More than once (Record number): _____ [RANGE=2-999]

[DISPLAY Q730 AND Q735 ON THE SAME SCREEN]
Q730
Q7. Now, thinking back to the last time you made this trip, how many people traveled with you on this trip (not including yourself)?

Record Number: _____ [RANGE=0-999]

Q735
Q8. How many of these people were members of your household (not including yourself)?

Record Number: _____ [RANGE=0-999] [MUST BE LESS THAN OR EQUAL TO Q730]

Q740
Q9. How did you travel? Please select your primary travel mode. [SINGLE] [RANDOMIZE]

1. Car, truck, van, or motorcycle (either owned or rented by you or a traveling companion) [Skip to Q765 (Q14)]

2. Commercial airline (e.g. Southwest, United, Alaska Air…)

3. Train (e.g. Amtrak)

4. Bus (e.g. Greyhound, Amtrak Thruway Motorcoach)

5. Other (specify): Q741 _____

Q745 [ASK IF Q740/2-5]

Q10. What is the name or location of the airport, train or bus station you used for your departure?

[NON-MANDATORY TEXT BOX]

Q750 [ASK IF Q740/2-5]

Q11. How did you travel to your departure airport, train, or bus station? [RANDOMIZE AND KEEP CODES 1-3 TOGETHER]

1. Drove a personal vehicle directly to airport or train station parking lot

2. Drove a personal vehicle to a remote parking lot

3. Drove a rental car

4. Got a ride from a friend or relative

5. Took a taxi

6. Used public transit

7. Used a hotel van, private van, limousine

8. Walked or bicycled

9. Other (specify): Q751_____

Q755 [ASK IF Q740/2-5]

Q12. What is the name or location of the airport, train or bus station you used at your destination?

[NON-MANDATORY TEXT BOX]

Q760 [ASK IF Q740/2-5]

Q13. How did you travel from your destination airport, train or bus station to your final destination? [RANDOMIZE IN SAME ORDER AS Q750]

1. Drove a personal vehicle directly from airport, train or bus station parking lot

2. Drove a personal vehicle from a remote parking lot

3. Drove a rental car

4. Got a ride from a friend or relative

5. Took a taxi

6. Used public transit

7. Used a hotel van, private van, limousine

8. Walked or bicycled

9. Other (specify): Q761_____

Q765
Q14. Did you return the same day?

1. Yes [Skip to Q1109]

2. No, this trip included an overnight stay of one or more nights.

Q770 [ASK IF Q765/2]
Q15. How many nights were you gone before returning home?

Record number: _____ [RANGE=1-999]

Q1105, Q1106, Q1107 [ASK IF Q765/2]
Thank you for providing that information about your most recent outbound long distance trip. We will now ask you to provide similar information for the long distance trip you made when you returned home after that outbound trip.

Q17. When did you make the return trip?

Enter date that you started this trip (i.e. mm/dd/yy): _____

Q1108 Enter day of week: _____ [INSERT DROP DOWN WITH DAYS OF THE WEEK]

[FORCE RESPONDENT TO ENTER THE DAY OF THE TRIP (Q1106) OR THE DAY OF THE WEEK (Q1108). ERROR MESSAGE: If you don't remember the exact date of this

long distance trip, please enter the year, month, and day of the week that you made this trip (to the best of your recollection).]

Q1109 [BASE: ALL QUALIFIED RESPONDENTS]

[DISPLAY IF Q765/1: Thank you for providing that information about your most recent outbound long distance trip. We will now ask you to provide similar information for the long distance trip you made when you returned home after that outbound trip.]

Did you return home from the same location (which you described earlier as your primary destination)?

1. Yes [SKIP TO Q1130]

2. No, I made an intermediate trip to another location before returning home

Q1115, Q1116, Q1117, Q1118 [ASK IF Q1109/2]
Q18. Where were you when you started this return trip?

1. City: _____ [MANDATORY TEXT BOX]

2. Country: _____ [DROP DOWN WITH SHORT LIST, ANCHOR US AT THE TOP]

3. State: _____ [DROP DOWN WITH STATES ONLY IF Q1116 IS US, ANCHOR CA AT THE TOP]

4. Zip Code (if known): _____ [NON-MANDATORY]

[DISPLAY Q1130 AND Q1135 ON THE SAME SCREEN]
Q1130
Q19. How many people traveled with you on this return trip (not including yourself)?

Record Number: _____ [RANGE=0-999]

Q1135
Q20. How many of these people were members of your household (not including yourself)?

Record Number: _____ [RANGE=0-999] [MUST BE LESS THAN OR EQUAL TO Q1130]

Q1140
Q21. How did you travel? Please select your primary travel mode. [SINGLE] [RANDOMIZE (same order as before)]

1. Car, truck, van, or motorcycle (either owned or rented by you or a traveling companion) [Skip to Q1110 (Q26)]

2. Commercial airline (e.g. Southwest, United, Alaska Air…)

3. Train (e.g. Amtrak)

4. Bus (e.g. Greyhound, Amtrak Thruway Motorcoach)

5. Other (specify): Q941 _____

Q1145 [ASK IF Q1140/2-5]
Q22. What is the name or location of the airport, train or bus station you used for your departure?

[NON-MANDATORY TEXT BOX]

Q1150 [ASK IF Q1140/2-5]
Q23. How did you travel to your departure airport, train, or bus station? [RANDOMIZE IN SAME ORDER AS Q750 AND KEEP CODES 1-3 TOGETHER]

1. Drove a personal vehicle directly to airport or train station parking lot

2. Drove a personal vehicle to a remote parking lot

3. Drove a rental car

4. Got a ride from a friend or relative

5. Took a taxi

6. Used public transit

7. Used a hotel van, private van, limousine

8. Walked or bicycled

9. Other (specify): Q1151_____

Q1155 [ASK IF Q1140/2-5]
Q24. What is the name or location of the airport, train or bus station you used at your destination?

[NON-MANDATORY TEXT BOX]

Q1160 [ASK IF Q1140/2-5]
Q25. How did you travel from your destination airport, train or bus station to your final destination? [RANDOMIZE IN SAME ORDER AS Q750]

1. Drove a personal vehicle directly from airport, train or bus station parking lot

2. Drove a personal vehicle from a remote parking lot

3. Drove a rental car

4. Got a ride from a friend or relative

5. Took a taxi

6. Used public transit

7. Used a hotel van, private van, limousine

8. Walked or bicycled

9. Other (specify): Q761_____

Q1110
Q26. Where were you when you actually ended this trip?

1. Your home

2. Work

3. School

4. Somewhere else (please specify): Q1111 _____

Q779 [DISPLAY IF Q700/1]
Thank you for providing information about your most recent outbound and return long distance trips. We would now like you to summarize (in much less detail than before) the other long distance trips you have made from your home in the past two months.

Q780 [ASK IF Q700/1]

Q27. Please summarize all long distance trips to a location 50 miles or more from your home during the past two months. Please use separate lines to record long distance trips made to the same destination for different reasons (for example: if you made one trip to San Francisco for a business meeting, and two trips to San Francisco to visit family, please fill in two lines in the table below).

Please scroll to the right to view the entire row. Please use only as many lines as you need to document trips made in the past two months and leave other lines blank.

When you have finished entering information for locations visited in the past two months, please proceed to the next screen.

Trip Number	Q925, Q927 Traveled to City: : Traveled to State (or Foreign Country):	Q920 Reason for Travel	Q921 How did you travel?	Q922 Did this trip include an overnight stay?	Q975 How many times did you make a trip to this destination for the same reason during the past two months?
1	[INSERT Q725 AND Q727]	[INSERT Q720]	[INSERT Q740 USING SHORTENED LIST BELOW]	[INSERT "No" IF Q765/1, INSERT "Yes" IF Q765/2]]	[INSERT Q775]
2	[TEXT BOX FOR CITY AND DROP DOWN FOR STATE]	Drop down menu from Q720 (Q5)	[DROPDOWN] 1. Private auto, truck, etc. 2. Commercial airline 3. Train 4. Bus 5. Other	[Yes/No DROPDOWN]	RANGE=0-999]
...8					

[DISPLAY Q28a AND Q28b ON THE SAME SCREEN]
Q980 (28a) [ASK IF RESPONDENT FILLED OUT ALL ROWS IN Q780]
How many other long distance trips did you make to locations 50 miles or more from your home during the past two months (not including the trips summarized previously)?
|_|_|_| [RANGE=0-999]

Q985 (28b) [ASK IF RESPONDENT FILLED OUT ALL ROWS IN Q780]
How many of these long distance trips were to locations in the State of California?
|_|_|_| [RANGE=0-999]

Section B: Demographic Information

[DISPLAY Q805 AND Q810 ON THE SAME SCREEN]
Q805 We now have some questions about your household.

Q29. How many people live in your household (including yourself)?

Record Number _____ [RANGE=1-20]

Q810 [ASK IF AGE 18+]
Q30. How many people in your household are aged 18 or above?

Record Number _____ [RANGE=1-20]

Q815
Q31. How many operational vehicles (autos, trucks, vans, and motorcycles) are owned, leased, or generally available for regular use by people who live in your household?

Record Number _____ [RANGE=1-20]

Q820, Q821, Q822
Q32. How many members of your household? (The numbers of household members entered below should add up to the total number of people living in your household, including yourself. If someone works at both a full-time and a part-time job, include that person only under full-time.) [ALLOW BLANK ENTRIES, TOTAL SHOULD NOT EXCEED Q805]

1. Work full-time for pay _____ [RANGE=0-20]

2. Work part-time for pay _____ [RANGE=0-20]

3. Do not work at a paid job ____ [RANGE=0-20]

Q825
Q33. Approximately, what is the total annual income (year 2010) of all individuals who reside in your household?

1. Under $10,000

2. Between $10,000 and $29,999
3. Between $30,000 and $44,999
4. Between $45,000 and $59,999
5. Between $60,000 and $74,999
6. Between $75,000 and $89,999
7. Between $90,000 and $104,999
8. Between $105,000 and $119,999
9. Between $120,000 and $134,999
10. Between $135,000 and $174,999
11. $175,000 or more
12. Decline to answer

Q59 Screener Termination
Not 18+ (Q620/1-2)
Not from the US (Q264/NE 244)
Not from CA (Q625/NE 105)
Not initially qualified (Q695/2)

Q60 Screener Qualified
Must be 18+ (Q620/3-7)
Must be from the US (Q264/244)
Must be from CA (Q625/105)
Must be initially qualified (Q695/1)

Appendix 2 – CSTDM Synthetic Population Database

Cali.sqlite is the CSTDM synthetic population database; it is a SQLite database contained in a single file. A SQLite database does not need a server to be run; the file can be accessed by a number of techniques. The CSTDM uses Python code and the standard sqlite3 library. A Firefox plugin, available at https://addons.mozilla.org/en-US/firefox/addon/sqlite-manager/ can be used to view the database in an interactive window environment. The database contains a number of tables, along with associated views and indices for ease of use and speed.

The three key tables needed to do a run are the pums_hh, pums_per and one or more synthpop_XX tables where _XX is the scenario name; currently _00 for 2000 and _08 for 2008, but other scenarios can be created with a suffix, such as 15 for a 2015 base scenario and 15a for an alternate 2015 scenario. These _XX scenario names are specified in the paths.py file created by Cube using the YearShort key. (This will be called the "scenario key" in this document.)

The pums_hh table is the 2000 Census 5% Public Use Microdata Sample for California housing units. Each row contains one housing unit, with a large number of columns containing their properties. The majority of these columns - the first 112 - are imported directly from the PUMS dataset, and the Census documentation at http://www.census.gov/prod/cen2000/doc/pums.pdf describes these fields in detail. The additional fields added for use in the CSTDM are:

- hhtype: the household type using the California PECAS typology. The first character indicates the number of persons in the household, with 3=3 or 4, 5=5+ persons and S being an all-senior household. The final character is the income group: 1=<$15K, 2=$15-50K, 3=$50-100K, 4=$100-150K, 5=$150K+

- num_workers: the number of workers in the household

- num_students: the number of students in the household

- hhtype_expan: a numerical code categorizing households in groups for the expansion process (see the documentation on travel behaviour surveys for a detailed schematic of the groups)

- num_lic: the number of licensed drivers in the household derived from a base license model (since deprecated; the SDPTM calculates driver's license status for each person on each run)

- hhtype_hsr: the household type for the LDPTM model (groupings described in detail in the LDPTM documentation)

- unic: unit income (the household income for records representing Census households, the individual person's income for records representing Group Quarters residents -- the base PUMS income fields have 0 income for GQ residents, as they are not households)

- p03, p15, p16: the number of persons under 3, 15 and 16 years of age respectively.

The pums_per table is the 2000 Census 5% Public Use Microdata Sample for California persons. Each row contains one person, with a large number of columns describing their properties. The first 162 of these are described in the same Census PUMS document described above. The additional columns added for use in the CSTDM are:

- state: the FIPS code for the state of the records
- pertype: the person type, as used in SDPTM the day pattern model, and described in detail in part 2 of the SDPTM documentation
- occCode5: the person's occupation, coded into a set of 5 occupation groups originally used to develop targets for the population synthesis process, but not used in the CSTDM for active running of the model
- occGroup: the person's occupation, coded into the 8 occupation groups used to run the SDPTM, with the detailed groups described in the Zonal Properties documentation. This field is blank for persons who are not workers.
- licutil: the "base" utility of holding a driver's license, from the SDPTM driver's license model described in part 1 of that model's documentation. This is the utility for the person from the estimated model in table 1a, excluding the two work logsums (since the same PUMS record will have copies located in multiple zones with different work logsums, due to the population synthesis process.) This does not include the calibration parameters in tables 1b and 1c.
- pertype_base: the person type in 7 base groups; this is the initial part of the pertype code and the groups are described in the SDPTM day pattern documentation (part 2 of the SDPTM documentation).

There are multiple synthpop tables, with suffixes to this name. These describe the different synthetic populations that have been created, one per table. Each row of this table is one synthetic household, and links to one PUMS household and the persons within that PUMS household. (A PUMS household will be represented multiple times in the synthpop table.) The table contains the following fields:

- zoneid: the TAZ the synthetic household lives in
- unitid: the sample ID for the household from the population synthesis process
- puma5: the Public Use Microsample Area the household lives in
- statename and state: the state the household lives in (not important for the CSTDM)
- serialno: the serial number of the PUMS household represented by this synthetic household; this is the unique identifier of each PUMS household, and is also in the PUMS person table identifying the persons in the household.

- uniqueid: a unique identifier for each synthetic population household, which is written out in the CSTDM driver's license and auto ownership output files. This enables the decisions to be traced to a specific instance of a household, and thus to their zone as well as to the associated PUMS records.

In addition to these key tables, there are several views that are used by the CSTDM. A view is a query that joins multiple tables, saved so that the resulting query can be referenced as if it is a table itself. The views, and the SQL statements that create them are:

per_hh: joins the PUMS person and household tables together to create a composite table, where each record is a person but contains their household's properties as well.

```
CREATE VIEW per_hh AS SELECT * FROM pums_per p JOIN pums_hh h
WHERE (h.serialno = p.serialno)
```

synth_hh_XX: joins the synthetic population to the PUMS household table, where _XX is the scenario key.

```
CREATE VIEW synth_hh_08 AS SELECT * FROM synthpop_08 s JOIN
pums_hh h WHERE (s.serialno = h.serialno AND s.state = h.state)
ORDER BY zoneid
```

synth_per_XX: joins the synthetic population to the PUMS person table, where _XX is the scenario key.

```
CREATE VIEW synth_per_08 AS SELECT * FROM synthpop_08 s JOIN
pums_per p WHERE (s.serialno = p.serialno AND s.state = p.state)
ORDER BY zoneid
```

synth_per_hh_XX: joins the synthetic population to the composite per_hh view, where _xx is the scenario key.

```
CREATE VIEW synth_per_hh_08 AS SELECT * FROM synthpop_08 s JOIN
per_hh p WHERE (s.serialno = p.serialno AND s.state = p.state)
ORDER BY zoneid
```

Indexes help speed up database operations. The specific names used are not important; the tables and fields indexed are. The ones used in the CSTDM are:

pums_hh_id and pums_per_id are indexes on the unique identifiers for each PUMS household and person record.

```
CREATE UNIQUE INDEX pums_hh_id ON pums_hh(serialno)

CREATE UNIQUE INDEX pums_per_id ON pums_per(serialno, pnum)
```

synthpop_ser_st_XX indexes the synthpop_XX table, with each record uniquely identified.

```
CREATE INDEX synthpop_ser_st_08 on synthpop_08(serialno, state)
```

zoneID_XX is an index on the synthpop_XX table, identifying each zone, so that all synthetic households of a zone can be rapidly identified.

```
CREATE INDEX zoneID_08 on synthpop_08(zoneid)
```

Appendix D

Compendium of Memoranda Documenting Model Runs

Memorandum

TO: Nick Brand

FROM: Jeff Buxbaum, Roberto Alvarado, Michael Snavely, David Kurth

DATE: July 27, 2011

RE: HSR Ridership and Revenue 2030 Model Runs (10-001 through 10-005)

This memorandum describes five high speed rail (HSR) ridership and revenue model runs. Run 10-001 tested a differential fare pricing concept for the Phase I System. Run 10-002 tests the impact of removing the Redwood City/Palo Alto station from the Full System. Runs 10-003 through 10-005 test Initial Operating Segment (IOS) runs with a southern terminus at Bakersfield and northern terminus in San Francisco (SF) with slight variations. Below are summary descriptions of each run:

- **10-001 Differential Fares Scenario –** Based on the May 2009 Operating Plan Phase I System; base fare set at 50 percent of average airfare, off-peak fares at 75 percent of base fare, and peak fares set at 125 percent of base fare.

- **10-002 No Redwood City/Palo Alto Station Scenario –** Based on the May 2009 Full System; fares set at 50 percent of average airfare; no Redwood City/Palo Alto station.

- **10-003 SF (Transbay Terminal) to Bakersfield Scenario –** 50 percent of average airfare; five peak trains per hour with northern termini at Transbay Terminal.

- **10-004 SF (4th/King)** to **Bakersfield Scenario –**50 percent of average airfare; five peak trains per hour with northern termini split between 4th/King and San Jose.

- **10-005 SF (4th/King)** to **Bakersfield Higher Fare Scenario –** 83 percent of average airfare; no Millbrae station; three peak trains per hour with northern termini split between 4th/King and San Jose.

The next section summarizes the major findings of each run. Hourly operating plan details for each run are provided in the Appendix.

Individual Model Run Findings

Refer to Table 1 for the Differential Fares Scenario and the No Redwood City/Palo Alto Station Scenarios. Refer to Table 2 for the three IOS runs.

10-001 Differential Fares Scenario

Objective

Test the implications of higher peak and lower off-peak fares on ridership and revenue.

Run Details

- Stations: Identical to May 2009 Phase I System
- Hourly Peak Trains: Identical to May 2009 Phase I Operating Plan
- Fares: Off-peak fares set at 75 percent of May 2009 Operating Plan levels; peak fares at 125 percent.

Annual Ridership Results (millions)

	May 2009 Phase 1 System	10-001	Change
System-wide	54.4	55.9	+2.8%
Interregional	40.3	42.0	+4.2%
Intraregional Bay Area	6.4	6.3	-1.5%

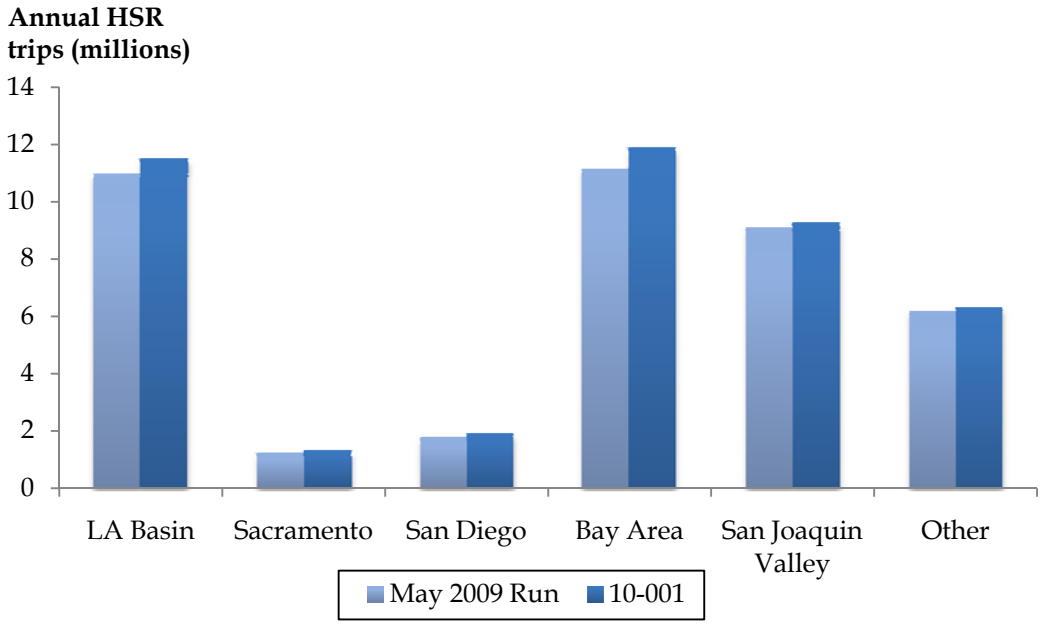
Annual Revenue Results (millions)

	May 2009 Phase 1 System	10-001	Change
System-wide	$2,343	$2,308	-1.5%
Interregional	$2,183	$2,126	-2.6%
Intraregional	$160	$182	+13.7%

Summary Notes

- **Differential fares increase ridership.** System-wide ridership increases 2.8 percent due to higher capture of recreation/other trips. Recreation/other trips are highly sensitive to price, while business/commute trips are more likely to pay a higher price to travel at convenient times. When peak fares are raised, some business/commute trips will shift to other modes featuring more competitive costs, but lower off-peak fares cause recreational travelers to shift to HSR at a rate that more than makes up for the loss of business/commute travelers. Recreation/other trips increase by 15 percent while business/commute trips decrease by eight percent.
- **Differential fares result in lower revenue**. Since the new riders pay lower average fares, overall revenue drops slightly (1.5 percent). Fine-tuning of fare differentials could potentially minimize and/or reverse revenue loss due to split fares.
- **Important note on limitations of the model:** Given the choice to travel midday, it is likely that some business/commute travelers would switch to off-peak travel to take advantage of lower fares, which would increase the ability of HSR to compete with air for these trips and have a positive impact on revenue over the results shown above. However, note that the ridership and revenue model's ability to represent traveler response to these changes is limited in that it does not include a time-of-day choice component. This has the potential to overstate the number of business/commute travelers who shift to other modes.
- **Annual sources of HSR ridership.** Figure 1 shows the interregional HSR trips by origin region for the two runs. Annual trips increase in every region.

Figure 1. Annual Interregional HSR Ridership by Origin Region.



10-002 – No Redwood City/Palo Alto Station

Objective

Test the implications of removing the Redwood City/Palo Alto station in the 2030 Full System.

Run Details

- Stations: The May 2009 Full System without a Redwood City/Palo Alto stop
- Hourly Peak Trains: Identical to the May 2009 Full System
- Fares: 50 percent of average airfare (identical to May 2009 Full System)

Annual Ridership Results (millions)

	May 2009 Full System	10-002	Change
System-wide	93.7	92.4	-1.4%
Interregional	73.6	73.7	+0.1%
Intraregional Bay Area	6.5	5.0	-23.0%

Annual Revenue Results (millions)

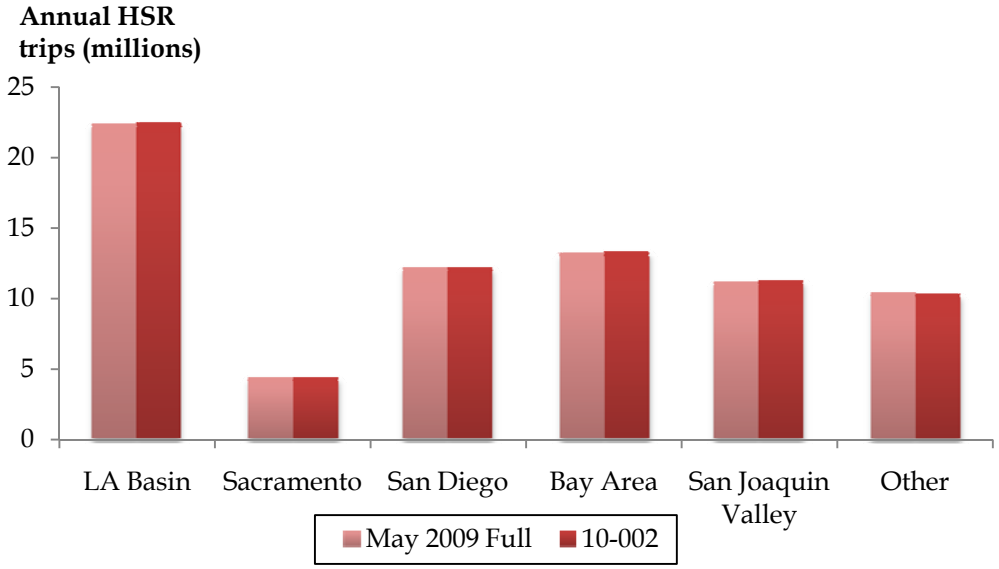
	May 2009 Full System	10-002	Change
System-wide	$3,806	$3,810	-1.5%
Interregional	$3,577	$3,596	-2.6%
Intraregional Bay Area	$71	$56	-21.1%

Summary Notes

- **Travel time benefits raise interregional ridership**. With the peninsula stop eliminated, travel times through the Redwood City area shorten by five minutes. This increases ridership in long-distance markets such as Bay Area – LA Basin.
- **Interregional ridership gains are more than offset by intraregional ridership loss in the Bay Area**. The station removal results in a significant loss in intraregional Bay Area trips due to inconvenient access/egress in the peninsula. Station boardings within the Bay Area decrease by about 23 percent, largely due to commute trips between the Transbay Terminal and Redwood City switching to other modes.

- **Millbrae/San Jose stops attract some former Redwood City/Palo Alto riders.** Millbrae shows a 140 percent increase in interregional boardings, the highest of any stop. Others access at San Jose, which features a 22 percent increase in interregional boardings. SF Transbay also sees a three percent increase in interregional trips due to the five minute decrease in travel times to all inter-regional stations.
- **Annual sources of HSR ridership.** Figure 2 shows the interregional HSR trips by origin region for the two runs.

Figure 2. Annual Interregional HSR Ridership by Origin Region



10-003 – SF (Transbay Terminal) to Bakersfield Scenario

Objective

Test various IOS scenarios terminating in Bakersfield in the south and San Francisco in the north. Run 10-003 features a northern terminus at the Transbay Terminal. None of the IOS scenarios in this group has a Redwood City/Palo Alto station.

Run Details

- Stations: SF Transbay Terminal, Millbrae, San Jose, Gilroy, Fresno, Bakersfield
- Hourly Peak Trains: five local trains each terminating at SF Transbay Terminal
- Fares: 50 percent of average airfare (May 2009 assumption)
- Train speed between San Francisco and San Jose: 125 mph

Annual Ridership Results (millions)

	10-003
System-wide	15.7
Interregional	11.2
Intraregional Bay Area	4.4

Annual Revenue Results (millions)

	10-003
System-wide	$524
Interregional	$474
Intraregional Bay Area	$50

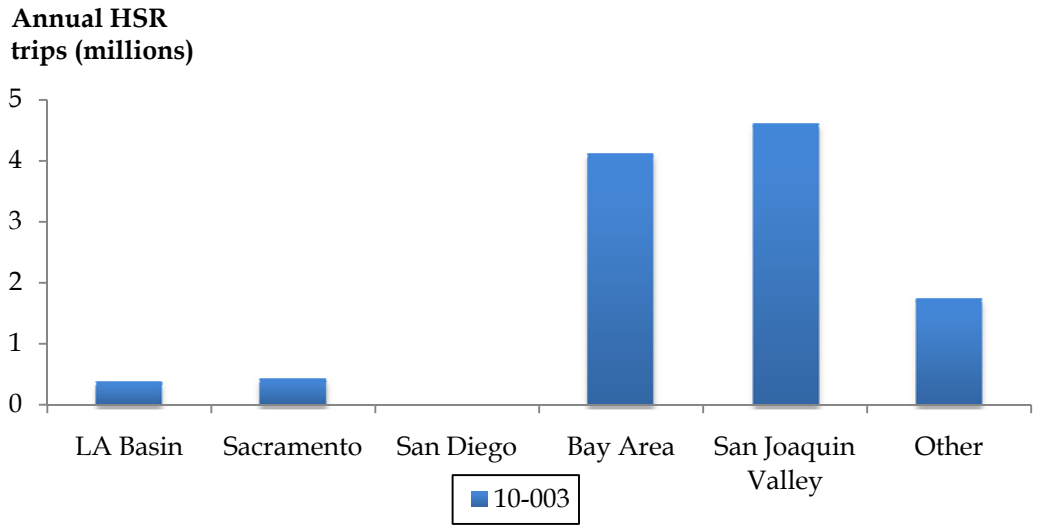
Summary Notes

- **Limited IOS system results in considerably lower ridership and revenue compared to May 2009 Phase I system**. Loss of express service between SF Transbay and San Jose results in lower frequency of service and higher travel times for intraregional Bay Area trips. Furthermore, travel between the highest Phase I market segment (Bay Area–LA Basin) is strongly discouraged due to the Bakersfield terminus and no assumed feeder service.
- **Slight increase in Bay Area–San Joaquin and Sacramento–San Joaquin markets compared to May 2009 Phase I system.** The increases in these markets can be attributed to improved frequency of service for specific interchanges offered by the IOS system. For example, peak

period headways between the Transbay Terminal, Millbrae, and San Jose stations and the Fresno and Bakersfield stations decrease by 12 minutes versus the Phase I system. Increases in average station-to-station travel times between Sacramento/Bay Area and San Joaquin markets resulting from the elimination of express service is more than offset by improved frequency.

- **Boardings increase at Bakersfield**. The new southern terminus at Bakersfield is the only other station with increased boardings versus the Phase I System, since some riders who would otherwise access more southerly stations must now access the HSR system directly at Bakersfield.
- **Annual sources of HSR ridership.** Figure 3 shows the interregional HSR trips by origin region. A plurality of annual HSR trips originates from the San Joaquin Valley.

Figure 3. Annual Interregional HSR Ridership by Origin Region



10-004 - SF (4th/King) to Bakersfield Scenario

Objective

Test a scenario terminating in Bakersfield in the south and San Francisco in the north. Run 10-004 features a northern terminus at 4th/King, but 60 percent of northbound trains terminate in San Jose.

Run Details

- HSR Stations: SF Transbay, Millbrae, San Jose, Gilroy, Fresno, Bakersfield
- Hourly Peak HSR Trains: five (two terminate at SF 4th/King, three terminate at San Jose)
- Fares: 50 percent of average airfare
- Train speed between San Jose and San Francisco: equal to current Caltrain speeds (79 mph)

Annual Ridership Results (millions)

	10-003	10-004	Change
System-wide	15.7	11.8	-24.8%
Interregional	11.2	10.0	-10.7%
Intraregional Bay Area	4.4	1.9	-56.8%

Annual Revenue Results (millions)

	10-003	10-004	Change
System-wide	$524	$432	-17.5%
Interregional	$474	$412	-13.0%
Intraregional Bay Area	$50	$21	-58.0%

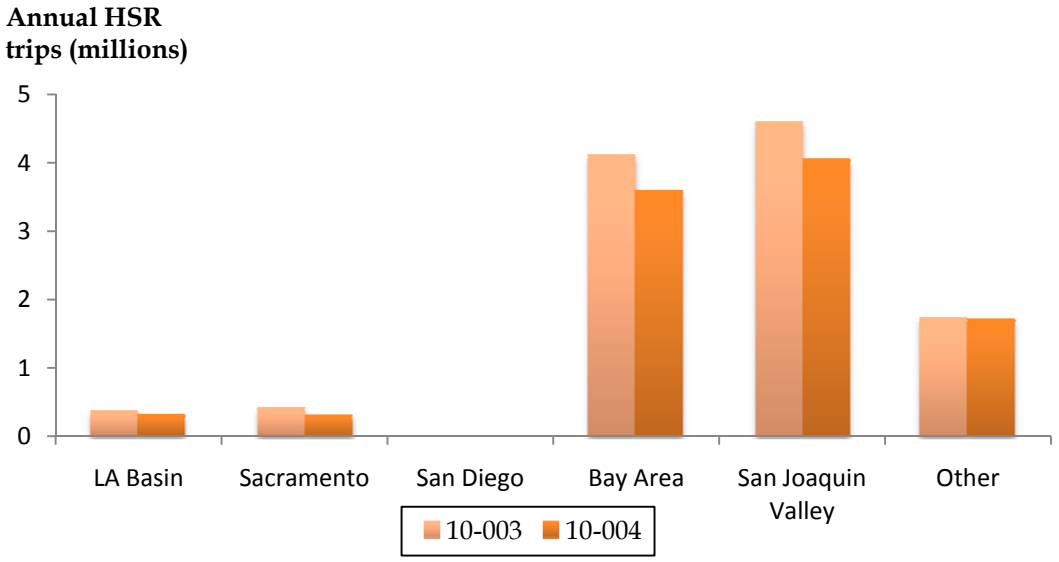
Summary Notes

- **Limited service and longer run times to San Francisco drive lower ridership**. Compared to 10-003, peak trains to San Francisco decline by 60 percent. In addition, run times increase from 10-003 between San Jose and San Francisco due to a decrease in train speed to 79 mph.
- **Elimination of San Francisco service on two runs results in a steep decline in intraregional ridership.** Within the Bay Area, daily station boardings decrease by 8,600 (55 percent) due largely to the exclusion of stations north of San Jose on peak hourly trains 1, 3

and 5. This impact is also felt in interregional travel between the San Francisco area and points south.

- **San Francisco station location impacts.** Switching San Francisco station locations from the Transbay Terminal to 4th/King appears to have a small but negative impact on ridership.
- **Increase in interregional boardings at San Jose.** San Jose shows a slight increase in interregional station boardings bound for the San Joaquin Valley, due to limited accessibility at more northerly Bay Area stations. In the absence of 4th/King and Millbrae stops, a portion of Bay Area – San Joaquin Valley trips are shifted to San Jose access/egress points.
- **Annual sources of HSR ridership.** Figure 4 shows the interregional HSR trips by origin region for the two runs. Ridership decreases in every region, but Bay Area trip origins decrease at the highest rate (over 12 percent) due to the elimination of San Francisco service during peak hours.

Figure 4. Annual Interregional HSR Ridership by Origin Region



- **Modeling Note: Specification procedure causes a slight increase in recreation trips between Merced and the Bay Area.** A specification in the ridership and revenue model dictates that passengers will not use HSR if their drive time to access an HSR station exceeds the HSR in-vehicle travel time. This leads to a somewhat counterintuitive result. Since HSR in-vehicle travel time *increases* in run 10-004, the model allows *more* travelers access to HSR between these markets. Since HSR in-vehicle travel time is raised higher than some potential vehicle access drive times in the Merced to Bay Area market, a slight increase in HSR trips between Merced and the Bay Area is observed.

10-005 –SF (4th/King) to Bakersfield Higher Fare Scenario:

Objective

Test various IOS scenarios terminating in Bakersfield on the south and San Francisco on the north. Run 10-005 features fewer trains than 10-004 (three versus five), a northern terminus at 4th/King, and one third of northbound trains terminating in San Jose. It also has no stops between San Francisco and San Jose.

Run Details

- Stations: SF 4th/King, San Jose, Gilroy, Fresno, Bakersfield (Millbrae eliminated)
- Hourly Peak Trains: three (two terminate at SF 4th/King, one at San Jose)
- Fares: 83 percent of average airfare
- Train speed between San Jose and San Francisco: equal to current Caltrain speeds (79 mph)

Annual Ridership Results (millions)

	10-003	10-004	10-005	Change 10-003 vs. 10-005	Change 10-004 vs. 10-005
System-wide	15.7	11.8	7.6	-51.6%	-35.6%
Interregional	11.2	10.0	7.1	-36.6%	-30.0%
Intraregional Bay Area	4.4	1.9	0.5	-88.6%	-73.6%

Annual Revenue Results (millions)

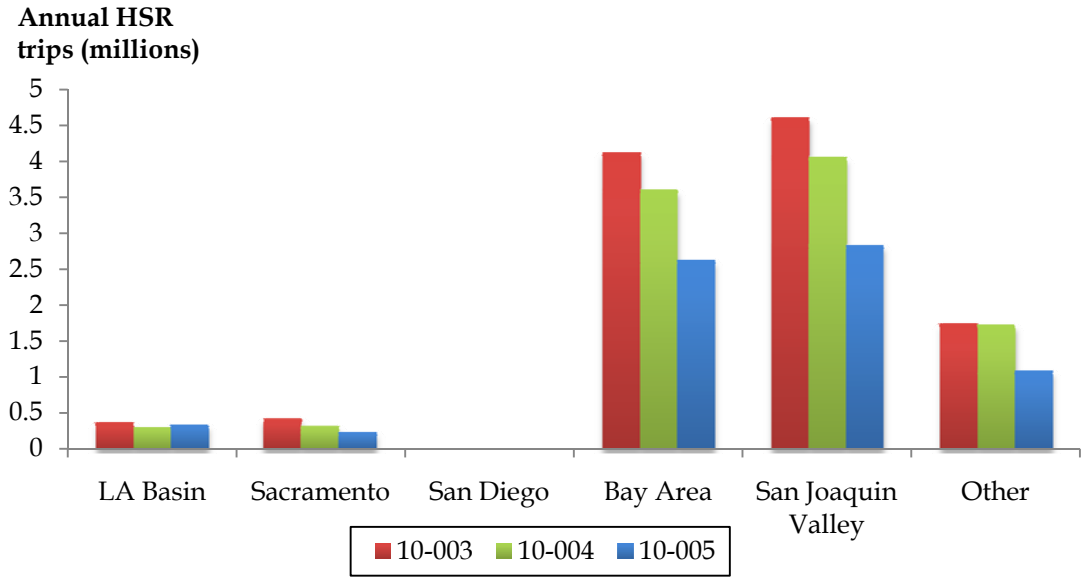
	10-003	10-004	10-005	Change 10-003 vs. 10-005	Change 10-004 vs. 10-005
System-wide	$524	$432	$501	-4.4%	+16.0%
Interregional	$474	$412	$490	+3.3%	+19%
Intraregional Bay Area	$50	$21	$11	-78.0%	-47.6%

Summary Notes

- **Higher fares, lower frequencies, longer Bay Area run times, and lower connectivity reduces ridership.** Compared to 10-003 and 10-004, ridership is significantly lower due to four key factors: 1) the increase in fares to 83 percent of airfare; 2) the reduction in peak hour trains from five to three per hour (only two of which terminate in San Francisco); 3) run times averaging 20-25 minutes longer from San Jose to San Francisco due to the reduction in train speeds from 125 mph to 79 mph; and 4) loss of the Millbrae station access point in the Bay Area. All interregional and intraregional markets show a decline in ridership.

- **Lower travel times due to Millbrae exclusion**. Although travel times decrease by three minutes with the elimination of the Millbrae stop, these benefits to through travelers are more than outweighed by the additional inconveniences noted above. For instance, compared to 10-004, peak headways increase by eight minutes and fares increase 66 percent.
- **system-wide revenue only slightly affected by ridership loss.** The increase in system-wide HSR fares offsets the decrease in interregional trips, resulting in increased interregional revenue. However, the steep decline in intraregional Bay Area trips, due in large part to the loss of the Millbrae access point within the Bay Area, causes overall system-wide revenue to fall slightly versus run 10-003.
- **Bay Area – San Joaquin Valley market sees largest decrease in interregional ridership, but highest increase in revenue**. Despite the loss of 2.1 million riders compared to 10-004, the significant fare increase results in an additional $43 million in revenue.
- **Intraregional Bay Area station boardings decrease.** Intraregional boardings decrease by 71 percent (4,900 boardings daily) in the Bay Area due to reduced connectivity (the elimination of Millbrae station) and aforementioned headway and fare increases.
- **Ridership decreases across most origin regions.** The Bay Area and San Joaquin Valley regions experience the greatest decreases in ridership due to higher fares, lower frequencies, and the loss of the Millbrae station.

Figure 5. Annual Interregional HSR Ridership by Origin Region



Overall Findings Summary

- **Differential peak/off-peak fares result in increased ridership**. Recreational travelers are more sensitive to lower fares and ride in much greater numbers with lower fares, but they generate lower per capita revenue. However, revenue loss in the Differential Fares Scenario has the potential to be eliminated and/or reversed through further refinement of fare levels. The model's lack of a time-of-day choice component may overstate the number of business/commute travelers who shift to other modes, thereby under-representing potential ridership and revenue resulting from differential fares.

- **Elimination of the peninsula stop benefits interregional trips at the expense of intraregional Bay Area trips**. Long distance trips benefit from reduced travel times to San Francisco but ridership and revenue benefits are slightly outweighed by lack of local connectivity.

- **Ridership appears to be sensitive to the frequency and run time of trains terminating at San Francisco in the IOS system.** IOS runs that reduce the number of hourly trains arriving/departing from San Francisco and those that increase run times show significant declines in ridership.

- **Ridership is sensitive to HSR speeds and assumed run times through the Bay Area**. In runs 10-004 and 10-005, run times increase by 20-25 minutes from San Jose to San Francisco due to a change in modeling assumptions related to the speed of HSR trains. These runs assume HSR trains will travel at 79 mph (Caltrain speeds) rather than at 125 mph, contributing to reduced ridership through the Bay Area.

- **Ridership is sensitive to higher fares, but revenue could benefit.** While ridership (particularly among recreational/other travelers) is likely to suffer in the event of a fare increase, overall revenue may be maximized through refinement of fare levels.

Table 1 Annual Region-to-Region Ridership and Revenue, Differential Fares and No Redwood City/Palo Alto Station Scenarios

	10-001 Differential Fares		May 2009 Phase I*		10-002 No Redwood City/Palo Alto Station		May 2009 Full System*	
	HSR Ridership (millions)	HSR Revenue** (millions)	HSR Ridership (millions)	HSR Revenue** (millions)	HSR Ridership (millions)	HSR Revenue** (millions)	HSR Ridership (millions)	HSR Revenue** (millions)
LA basin - Sacramento	2.0	$122	1.8	$124	3.8	$252	3.8	$252
LA basin - San Diego	0.2	$2	0.2	$2	20.8	$646	20.8	$645
LA basin- Bay Area	12.4	$746	11.7	$786	12.3	$843	12.2	$837
Sacramento - Bay Area	0.0	$0	0.0	$0	2.9	$130	2.8	$129
San Diego- Sacramento	0.1	$3	0.0	$2	0.1	$7	0.1	$7
San Diego- Bay Area	3.4	$205	3.2	$221	3.4	$281	3.4	$277
Bay Area - San Joaquin Valley	7.9	$328	7.4	$344	7.9	$364	7.8	$358
San Joaquin Valley - LA Basin	8.4	$357	8.3	$348	8.2	$365	8.2	$365
Sacramento - San Joaquin Valley	0.5	$34	0.6	$29	2.0	$87	2.0	$87
San Diego - San Joaquin Valley	0.1	$4	0.1	$4	0.1	$5	0.1	$5
within Bay Area	6.3	$75	6.4	$71	5.0	$56	6.5	$71
within North LA Basin	3.3	$49	3.6	$44	5.0	$62	5.0	$62
within South LA Basin	1.3	$17	1.2	$12	2.9	$30	2.9	$30
North LA - South LA	3.0	$41	3.0	$33	5.5	$62	5.5	$62
within San Diego region	0.0	$0	0.0	$0	0.3	$3	0.3	$3
within San Joaquin Valley	0.8	$30	0.9	$29	2.1	$63	2.1	$63
Other	6.3	$295	6.1	$291	10.2	$554	10.3	$553
Total	**55.9**	**$2,308**	**54.4**	**$2,343**	**92.4**	**$3,810**	**93.7**	**$3,806**
within San Diego region	0.0	$0	0.0	$0	0.3	$3	0.3	$3
within entire LA basin	7.5	$107	7.7	$89	13.3	$154	13.3	$154
within Bay Area	6.3	$75	6.4	$71	5.0	$56	6.5	$71
Total between regions	**42.0**	**$2,126**	**40.3**	**$2,183**	**73.7**	**$3,596**	**73.6**	**$3,577**

*May 2009 figures include increased parking cost assumptions.

**All figures in this document are in $2010. Note that May 2009 revenue figures have changed slightly from previous HSR documentation due to more precise inflation factor information via the Bureau of Labor Statistics. Some prior HSR documentation reported these values in $2008.

Table 2. Annual Region-to-Region Ridership and Revenue, SF (Transbay) to Bakersfield, SF (4th/King) to Bakersfield , and SF (4th/King) to Bakersfield Higher Fare Scenarios

	Total Market Trips (millions)	10-003 SF (Transbay) to Bakersfield Scenario		10-004 SF (4th/King) to Bakersfield Scenario		10-005 SF (4th/King) to Bakersfield Higher Fare Scenario	
		HSR Ridership (millions)	HSR Revenue (millions)	HSR Ridership (millions)	HSR Revenue (millions)	HSR Ridership (millions)	HSR Revenue (millions)
LA basin - Sacramento	8.1	0.2	$8	0.1	$7	0.1	$7
LA basin- Bay Area	22.2	0.5	$27	0.4	$21	0.5	$44
Bay Area - San Joaquin Valley	71.2	7.7	$350	6.8	$305	4.7	$348
San Joaquin Valley - LA Basin	70.1	0.0	$2	0.0	$2	0.1	$4
Sacramento - San Joaquin Valley	22.0	0.7	$32	0.5	$23	0.4	$30
within Bay Area	7,709.3	4.4	$50	1.9	$21	0.5	$11
within San Joaquin Valley	6,338.0	0.4	$17	0.4	$17	0.3	$19
Other	7,346.0	1.7	$38	1.7	$37	1.1	$37
Total	**52,508.1**	**15.7**	**$524**	**11.8**	**$432**	**7.6**	**$501**
within Bay Area	7,709.3	4.4	$50	1.9	$21	0.5	$11
Total between regions	**14,102.9**	**11.2**	**$474**	**10.0**	**$412**	**7.1**	**$490**

Appendix – Operating Plans

10-001 –Differential Fares Scenario

Phase 1 train patterns at 6 peak hours, one-way

Pattern#	0	1	2	3	4	5	6	7	8	
Frequency of service (mins)	60	120	60	120	30	60	120	40	40	
	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	9	9	57

Stopping time at stations included per operating plan and 3.5% recovery time

Phase 1 train patterns for 10 off-peak hours, one-way

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	80

Stopping time at stations included per operating plan and 3.5% recovery time

10-002 – No Redwood City/Palo Alto Station Scenario

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			
Millbrae	|	|	|	|	15	15	15			15	|			
San Jose	|	30	30	30	35	35	35			35	30			
Gilroy	|	46	|	46	51	51	|			51	|			
Merced										86	|			
Modesto										103	|			
Stockton										119	99			
Sacramento										141	121	0	0	0
Stockton												22	22	22
Modesto												|	38	|
Merced												|	55	|
Fresno	|	|	|	|	92	92	88					68	78	68
Bakersfield	|	|	|	|	|	133	129					|	119	|
Palmdale	|	|	|	146	159	167	|					135	153	|
Sylmar	|	|	|	168	|	189	178					157	175	|
Burbank	|	|	|	|	|	198	|					166	184	|
Los Angeles Union Station	160	170	163	183	193	208	193	0	0			176	194	154
City of Industry		|		203	213	|		19	|					174
Ontario		198		215	225	236		31	|					186
Riverside		211		228	238	249		44	35					199
Murrieta		|		245	255	|		61	|					216
Escondido		|		263	273	|		79	|					234
University City		253		278	288	291		94	|					249
San Diego		265		290	300	303		106	85					261
Norwalk	173		176				206					189	207	
Anaheim	184		187				217					200	218	
# of trains	6	12	6	6	6	6	6	6	6	6	6	6	6	6

Includes dwell and 3.5% recovery time
Where timetable shows separate arrival and departure times, midpoint of dwell shown
"0" pattern replaces "21" pattern

Full System train patterns for 10 off-peak hours, one-way

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
Millbrae	|	|	15		|	15	15	15
San Jose	30	30	35		30	35	35	35
Gilroy	46	46	51		46	51	51	51
Merced								86
Modesto								103
Stockton								119
Sacramento				0				141
Stockton				22				
Modesto				38				
Merced				55				
Fresno	|	|	92	78	|	92	92	
Bakersfield	|	|	133	119	|	133	133	
Palmdale	|	146	|	153	146	167	|	
Sylmar	|	168	|	175	168	189	|	
Burbank	|	177	|	184	177	198	|	
Los Angeles Union Station	170	187	189	194	187	208	189	
City of Industry	|	207	209			|		
Ontario	198	219	221			236		
Riverside	211	232	234			249		
Murrieta	|	249	251			|		
Escondido	|	267	269			|		
University City	253	282	284			291		
San Diego	265	294	296			303		
Norwalk				207	200		202	
Anaheim				218	211		213	
# of trains	10	10	10	10	10	10	10	10

10-003 - SF (Transbay Terminal) to Bakersfield Scenario

Peak

Pattern#	1	2	3	4	5
Frequency (mins)	60	60	60	60	60
SF (Transbay)	0	0	0	0	0
Millbrae	17	17	17	17	17
San Jose	37	37	37	37	37
Gilroy	53	53	53	53	53
Merced					
Fresno	94	94	94	94	94
Bakersfield	133	133	133	133	133
# of trains (daily)	6	6	6	6	6

Off-peak

Pattern#	1	2	3	4	5
Frequency (mins)	60	60	60	60	60
SF (Transbay)	0	0	0	0	0
Millbrae	17	17	17	17	17
San Jose	37	37	37	37	37
Gilroy	53	53	53	53	53
Merced					
Fresno	94	94	94	94	94
Bakersfield	133	133	133	133	133
# of trains (daily)	10	10	10	10	10

10-004 – SF (4th/King) to Bakersfield Scenario

Peak

Pattern#	1	2	3	4	5
Frequency (mins)	60	60	60	60	60
SF (4th/King)		0		0	
Millbrae		17		17	
San Jose	0	52	0	52	0
Gilroy	16	68	16	68	16
Merced					
Fresno	57	109	57	109	57
Bakersfield	96	148	96	148	96
# of trains (daily)	6	6	6	6	6

Off-peak

Pattern#	1	2	3	4	5
Frequency (mins)	60	60	60	60	60
SF (4th/King)		0		0	
Millbrae		17		17	
San Jose	0	52	0	52	0
Gilroy	16	68	16	68	16
Merced					
Fresno	57	109	57	109	57
Bakersfield	96	148	96	148	96
# of trains (daily)	10	10	10	10	10

10-005 – SF (4th/King) to Bakersfield Higher Fare Scenario

Peak

Pattern#	1	2	3
Frequency (mins)	60	60	60
SF (4th/King)	0		0
Millbrae	-		-
San Jose	49	0	49
Gilroy	65	16	65
Merced			
Fresno	106	57	106
Bakersfield	145	96	145
# of trains (daily)	6	6	6

Off-peak

Pattern#	1	2
Frequency (mins)	60	60
SF (4th/King)	0	0
Millbrae	-	-
San Jose	49	49
Gilroy	65	65
Merced		
Fresno	106	106
Bakersfield	145	145
# of trains (daily)	10	10

Memorandum

TO: Nick Brand

FROM: Jeff Buxbaum, Michael Snavely, David Kurth, and Roberto Alvarado

DATE: June 12, 2011

RE: HSR Ridership and Revenue 2030 Model Runs (10-006, 10-007, 10-009, and 10-022)

This memorandum describes four high-speed rail (HSR) ridership and revenue initial operating segment (IOS) model runs. Each scenario tests IOS segments with a southern terminus at Bakersfield and variations on northern termini and operations. Below are summary descriptions of each run:

- **10-006 San Francisco 4th/King to Bakersfield Scenario –** Eighty-three percent of average airfare; three peak trains per hour (TPH); dedicated coach connection from Bakersfield to Los Angeles (LA) Basin destinations.

- **10-007 Merced to Bakersfield Scenario –** Eighty-three percent of average airfare; one peak TPH; Amtrak connections from Merced to Oakland and Sacramento; dedicated coach connection from Bakersfield to LA Basin destinations, from Merced to San Jose, and from Emeryville to San Francisco.

- **10-009 San Jose to Bakersfield Scenario –** Eighty-three percent of average airfare; three peak TPH; Caltrain connection from San Jose to San Francisco; dedicated coach connection from Bakersfield to LA Basin destinations.

- **10-022 San Jose to Bakersfield (Amtrak Service to Sacramento) Scenario –** Eighty-three percent of average airfare; three peak trains per hour; Caltrain connection from San Jose to San Francisco, Amtrak connection between Merced and Sacramento; dedicated coach connection from Bakersfield to LA Basin destinations.

The next section summarizes the major findings of each run. Hourly operating plan details for each run are provided in the Appendix.

Individual Model Run Findings

10-006 – San Francisco (4th/King) to Bakersfield Scenario

IOS with three peak TPH between San Francisco and Bakersfield and dedicated coach connections from Bakersfield to LA Basin destinations.

Objective

Test the effects on ridership and revenue of adding dedicated coach service between Bakersfield and Los Angeles to an initial HSR service between San Francisco and Bakersfield. Run 10-006 features the same HSR operating plan as run 10-005.[1]

Run Details

- HSR Stations: San Francisco (4th/King), San Jose, Gilroy, Fresno, and Bakersfield.
- Hourly Peak HSR Trains: Three (two terminate at SF 4th/King, one at San Jose).
- Fares: Eighty-three percent of average airfare; $25 for coach transfer to LA Basin.

Annual Ridership Results (millions)

	10-005	10-006	Change
System-wide	7.6	11.4	+50%
Interregional	7.1	10.9	+54%
Intraregional (Bay Area)	0.5	0.5	0%

Annual Revenue Results (millions)

	10-005	10-006	Change
System-wide	$501	$802	+60%
Interregional	$490	$790	+61%
Intraregional (Bay Area)	$11	$11	0%

[1] **10-005 Bakersfield to SF (4th/King) Higher Fare Scenario** – IOS 83 percent of average airfare; no Millbrae station; three peak trains per hour with northern termini split between 4th/King and San Jose. For details see *HSR Ridership and Revenue 2030 Model Runs (10-001 through 10-005)*.

Summary Notes

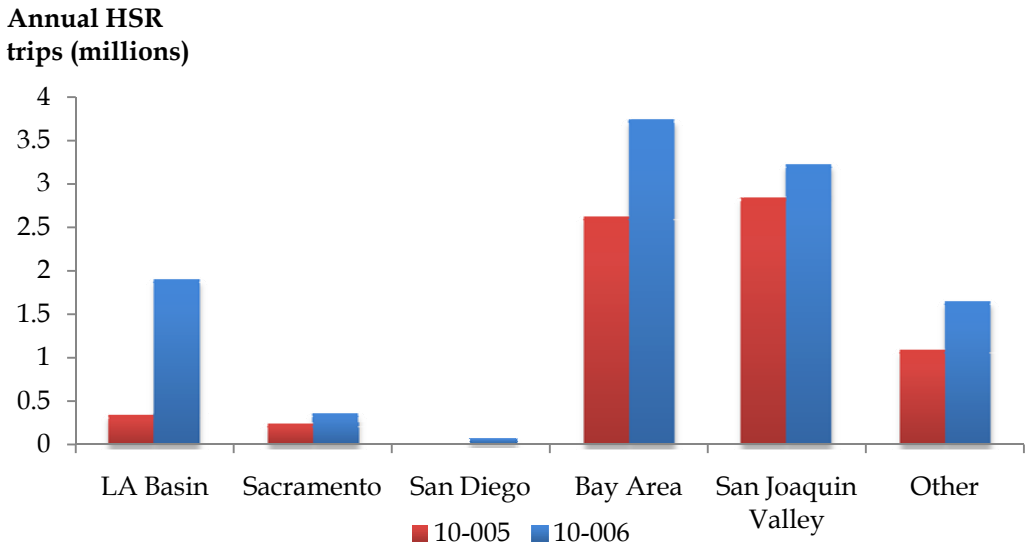
- **Compared to Run 10-005 –** Operating plan is identical except for the addition of dedicated coach service to San Fernando, Burbank Airport, LA Union Station, Van Nuys, West LA, and Santa Anita from Bakersfield.

- **Dedicated coach service to LA Basin boosts ridership –** Interregional HSR travel increases by about 54 percent annually (business trips increase by 87 percent, recreational trips by 29 percent). The increase in interregional trips is primarily attributed to the LA Basin – Bay Area and LA Basin – San Joaquin travel markets. Trips originating at coach stations in the LA Basin account for 17 percent of daily boardings system-wide. Station boardings for trips to/from the LA Basin increase by 10,400.

- **Dedicated coach service extension to LA Basin increases HSR revenues –** The addition of dedicated coach service to the LA Basin increases annual HSR trips originating in the LA Basin region by more than 500 percent, and contributes significantly to a 61 percent increase in system-wide interregional HSR revenues.

- **Annual sources of HSR ridership by origin region –** Figure 1 shows the interregional HSR trips by origin region for the two runs. Ridership increases from every region, but trips originating in the LA Basin increase at the greatest rate.

Figure 1. 10-006 – Annual Interregional HSR Ridership by Origin Region.



10-007 – Merced to Bakersfield Scenario

IOS with one peak TPH; Amtrak connections from Merced to Oakland and Sacramento treated as extensions of HSR service; dedicated coach connection from Bakersfield to LA Basin destinations, from Merced to San Jose, and from Emeryville to San Francisco.

Objective

Test IOS from Merced to Bakersfield with Amtrak feeder service between Merced and Oakland, and between Merced and Sacramento. Coach service from Bakersfield to San Fernando, Burbank Airport, LA Union Station, Van Nuys, West LA, and Santa Anita; from Emeryville to San Francisco; and from Merced to San Jose.

Run Details

- HSR Stations: Merced, Fresno, Visalia, and Bakersfield.
- Hourly Peak HSR Trains: One.
- Fares: Eighty-three percent of average airfare; $25 for dedicated coach transfers; original fares on Amtrak.

Annual Ridership Results (millions)

	10-007 HSR Passengers	10-007 Total Passengers[a]
System-wide	6.8	13.4

[a] Includes ridership from Amtrak-only passengers on feeder routes.

Annual Revenue Results (millions)

	10-007 HSR Revenues	10-007 Total Revenues [b]
System-wide	$549	$683

[b] Includes revenue from Amtrak-only passengers on feeder routes.

Summary Notes

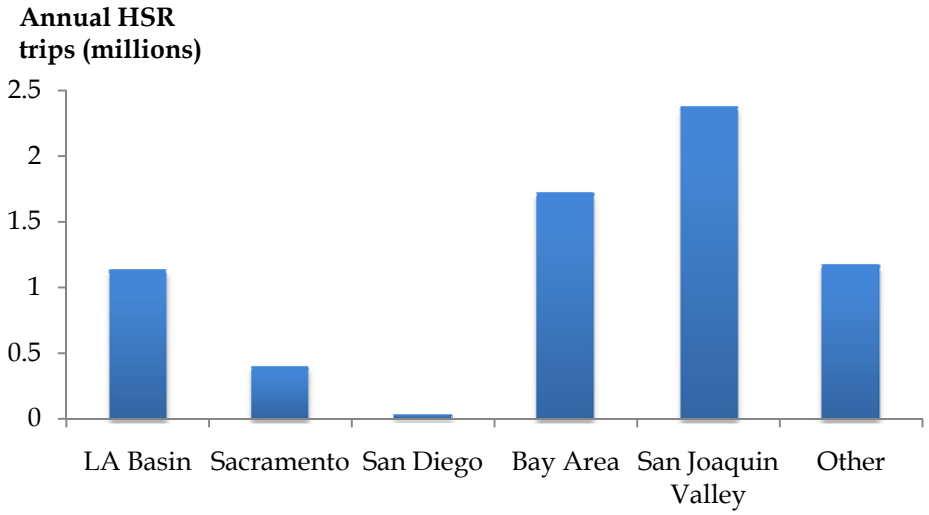
- **Amtrak feeder services to Oakland and Sacramento provide only minor offset to loss of San Francisco terminus.** HSR ridership within the San Joaquin Valley benefits from the inclusion of Amtrak transfer points in northern San Joaquin Valley, however HSR ridership lags significantly from prior IOS runs due to the elimination of HSR service to San Francisco.

- **Revenues include Amtrak-only ridership**. The addition of Amtrak service contributes to an increase in overall Amtrak and HSR trips, including new Amtrak-only trips between Merced, Oakland, and Sacramento. Boardings at Amtrak stations comprise 69 percent of all system-wide boardings in this scenario, and nearly half of total ridership consists of Amtrak riders who do not access HSR during their trip.

- **Elimination of Bay Area HSR stations contributes to significant reduction in interregional travel to/from the Bay Area**. Overall, rail travel from the Bay Area to the LA Basin and San Joaquin Valley declines significantly with the elimination of HSR stations in the Bay Area, since this travel now requires HSR passengers to transfer using Amtrak and/or bus, resulting in much slower travel times..

- **Annual sources of HSR ridership:** Figure 2 shows the interregional HSR trips by origin region, excluding Caltrain-only trips. A plurality of annual HSR trips originate from the San Joaquin Valley.

Figure 2. 10-007 – Annual Interregional HSR Ridership by Origin Region



10-009 – San Jose to Bakersfield Scenario

IOS with three peak TPH between San Jose and Bakersfield; dedicated Caltrain feeder service from San Jose to San Francisco; dedicated coach connection from Bakersfield to LA Basin destinations.

Objective

Test IOS between San Jose and Bakersfield with connection to Caltrain service between San Jose and San Francisco and dedicated coach connection from Bakersfield to LA Basin destinations. HSR access is added at Visalia. No feeder service offered to Sacramento. Run is compared to 10-006.

Run Details

- HSR Stations: San Jose, Gilroy, Fresno, Visalia, Bakersfield.
- Hourly Peak HSR Trains: Three.
- Fares: Eighty-three percent airfare on HSR; $25 for coach transfer; original fares on Caltrain.

Annual Ridership Results (millions)

	10-006	10-009[a]	Change
System-wide	11.4	10.1	-11%
Interregional	10.9	10.0	-8%
Intraregional Bay Area	0.5	0.1	-80%

[a] Excludes ridership from Caltrain-only passengers.

Annual Revenue Results (millions)

	10-006	10-009[b]	Change
System-wide	$802	$705	-12%
Interregional	$790	$702	-11%
Intraregional Bay Area	$11	$3	-73%

[b] Excludes revenue from Caltrain-only passengers.

Summary Notes

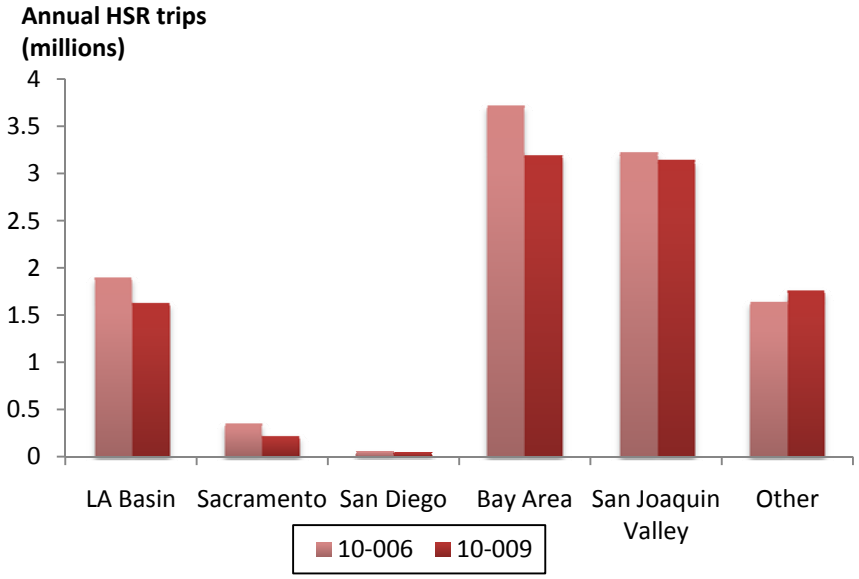
- **Compared to Run 10-006**. HSR service to San Francisco 4th/King has been replaced by Caltrain feeder service from San Jose to San Francisco as an extension of HSR service. A new HSR stop is added at Visalia. Dedicated coach connection services from Bakersfield to San

Fernando, Burbank Airport, LA Union Station, Van Nuys, West LA, and Santa Anita are identical for both scenarios (three BPH).

- **Elimination of HSR service to San Francisco reduces interregional HSR trips**. Longer travel times on the peninsula via Caltrain result in a decrease in ridership between the Bay Area and points south. In addition, the new Visalia station results in slightly greater travel times through the San Joaquin Valley, making long-distance trips less attractive. Daily interregional HSR boardings decrease by about eight percent compared to the 10-006 scenario.

- **Annual sources of HSR ridership**: Figure 3 shows the interregional HSR trips by origin region for the two runs. Figures exclude Caltrain-only trips. Nearly all regions experience a decrease in trips as a consequence of longer travel times through the peninsula and the San Joaquin Valley. The Sacramento, LA Basin, and Bay Area regions experience the greatest decreases in annual trips (37 percent, 14 percent, and 14 percent, respectively).

Figure 3. 10-009 – Annual Interregional HSR Ridership by Origin Region.



10-022 – San Jose & Merced to Bakersfield Scenario

IOS with three peak TPH; dedicated Caltrain feeder service from San Jose and Merced to San Francisco, dedicated Amtrak feeder connection between Merced and Sacramento; dedicated coach connections from Bakersfield to LA Basin destinations.

Objective

Test IOS scenario from San Jose and Merced to Bakersfield with dedicated Amtrak connection from Merced to Sacramento; dedicated Caltrain connection from San Jose to San Francisco peninsula destinations; and dedicated coach connection from Bakersfield to LA Basin destinations. Run is compared to 10-009.

Run Details

- HSR Stations: San Jose, Gilroy, Merced, Fresno, Visalia, and Bakersfield.
- Hourly Peak HSR Trains: Three (two terminate at San Jose; one at Merced).
- Fares: Eighty-three percent airfare on HSR; $25 for coach transfer to the LA Basin; original fares on Caltrain and Amtrak.

Annual Ridership Results (millions)

	10-009 [a]	10-022[a]	Change
System-wide	10.1	11.4	+13%
Interregional	10.0	10.2	+2
Intraregional Bay Area	0.1	1.2	+1,100

[a] Excludes ridership from Amtrak- and Caltrain-only passengers.

Annual Revenue Results (millions)

	10-009 [b]	10-022[b]	Change
System-wide	$705	$746	+6%
Interregional	$702	$737	+5%
Intraregional Bay Area	$3	$10	+233%

[b] Excludes revenue from Amtrak- and Caltrain-only passengers.

Summary Notes

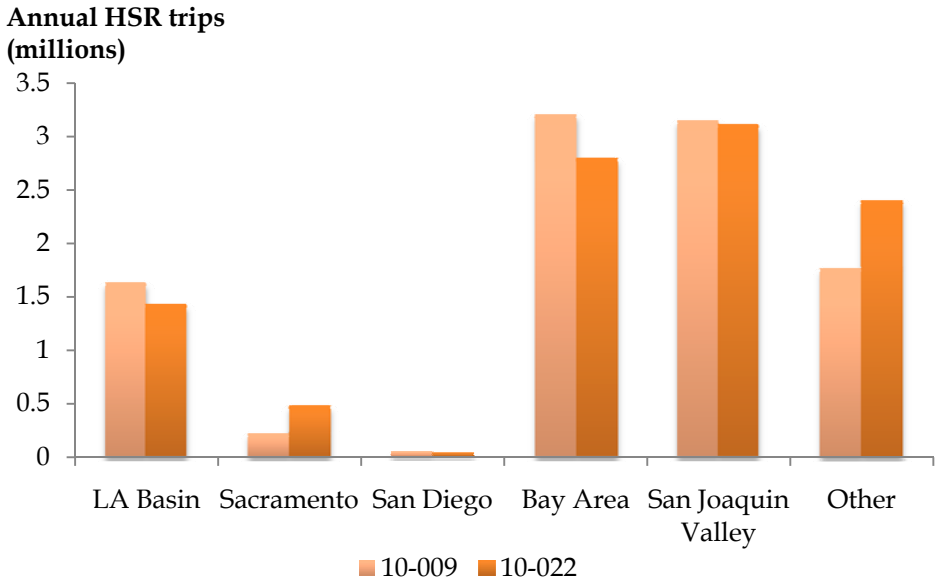
- **Compared to Run 10-009 –**A new HSR stop is added at Merced and new Amtrak service is offered from Merced to Sacramento. HSR service to San Jose and Gilroy decreases from three peak TPH to two peak TPH. A San Fernando dedicated coach stop has been added.

- **Merced station and connections boost ridership –** The increase in interregional ridership is due in large part to the addition of the Merced HSR station and transfer options to Sacramento via the Amtrak San Joaquin Valley line, which increases annual HSR trips from Sacramento to the LA Basin (136 percent), and the San Joaquin Valley (47 percent).

  The addition of the Merced station increases annual HSR ridership within the San Joaquin Valley by 58 percent. Daily interregional boardings at Sacramento and San Joaquin Valley account for about 22 percent of all system-wide boardings. New boardings at Merced and Fresno offset boarding decreases at Gilroy and San Jose stations, which decline due to a reduction from three to two peak TPH.

- **Annual sources of HSR ridership –** Figure 4 shows interregional HSR trips by origin region for the two runs. Figures exclude Amtrak- and Caltrain-only trips. The Sacramento region experiences the greatest increase in annual trips (121 percent).The decrease in trips in the rest of the regions is due in large part to frequency reductions between the Bay Area and San Joaquin Valley.

Figure 4. 10-022 – Annual Interregional HSR Ridership by Origin Region.



Overall Findings Summary

- **Dedicated coach connection from Bakersfield to LA Basin destinations attracts new riders –** Interregional trips increase when dedicated coach connections are provided to LA Basin destinations. In run 10-006, these trips increased by 54 percent, accounting for approximately 17 percent of total daily boardings system-wide.

- **Integrating Amtrak feeder service from Merced to Oakland and Sacramento results in improved system-wide ridership –** The inclusion of Amtrak service as an extension of HSR increases interregional system ridership.

- **Replacing HSR with Caltrain service in the peninsula negatively affects HSR interregional ridership –** When Caltrain feeder service is treated as an extension of HSR service, interregional trips to/from the Bay Area decrease due to longer travel times and transfer requirements.

Table 1. 2030 Annual Region-to-Region Ridership and Revenue

Ridership and Revenue in Millions per Year

Market	Total Market Trips (millions)	10-006 San Francisco 4th/King to Bakersfield Scenario		10-007 Merced to Bakersfield Scenario		10-009 San Jose to Bakersfield Scenario		10-022 San Jose & Merced to Bakersfield Scenario	
		HSR Ridership	HSR Revenues ($2010)	HSR Ridership	HSR Revenues ($2010)	HSR Ridership	HSR Revenues ($2010)	HSR Ridership	HSR Revenues ($2010)
LA Basin – Sacramento	8	0.3	$27	0.4	$36	0.2	$14	0.4	$36
LA Basin – San Diego	143	0.0	$0	0.0	$0	0.0	$0	0.0	$0
LA Basin – Bay Area	22	2.6	$219	1.2	$104	2.2	$182	1.8	$148
Sacramento – Bay Area	72	0.0	$0	0.0	$0	0.0	$0	0.2	$13
San Diego – Sacramento	2	0.0	$0	0.0	$0	0.0	$0	0.0	$0
San Diego – Bay Area	8	0.1	$9	0.0	$4	0.1	$7	0.1	$5
Bay Area – San Joaquin Valley	71	4.7	$348	2.2	$187	4.1	$307	3.6	$266
San Joaquin Valley – LA Basin	70	0.8	$59	0.7	$48	0.9	$61	0.7	$43
Sacramento – San Joaquin Valley	22	0.4	$30	0.4	$32	0.3	$21	0.4	$32
San Diego – San Joaquin Valley	0	0.0	$0	0.0	$1	0.0	$0	0.0	$1
within Bay Area Peninsula	7,708	0.5	$11	0.0	$0	0.1	$3	1.2	$10
within North LA Basin	8,685	0.0	$0	0.0	$0	0.0	$0	0.0	$0
within South LA Basin	10,790	0.0	$0	0.0	$0	0.0	$0	0.0	$0
North LA – South LA	2,943	0.0	$0	0.0	$0	0.0	$0	0.0	$0
within San Diego Region	8,277	0.0	$0	0.0	$0	0.0	$0	0.0	$0
within San Joaquin Valley	6,338	0.3	$19	0.7	$38	0.5	$30	0.8	$40
Other	7,346	1.6	$79	1.2	$99	1.8	$79	2.4	$152
Total	**52,507**	**11.4**	**$802**	**6.8**	**$549**	**10.1**	**$705**	**11.4**	**$746**
within Bay Area	7,708	0.5	$11	0	$0	0.1	$3	1..2	$10
Total between Regions	910	10.9	$790	6.8	$549	10.0	$702	10.2	$737

Appendix – Operating Plans

10-006 San Francisco 4th/King to Bakersfield Scenario

IOS with three peak TPH between San Francisco and Bakersfield; dedicated coach connection from Bakersfield to LA Basin destinations.

6 Peak Hours

Pattern #	1	2	3
Frequency in service (min)	60	60	60
San Francisco (4th/King)	0	-	0
San Jose	49	0	49
Gilroy	65	16	65
Fresno	106	57	106
Bakersfield	145	96	145
# of trains	6	6	6

10 Off Peak Hours

Pattern #	1	3
Frequency in service (min)	60	60
San Francisco (4th/King)	0	0
San Jose	49	49
Gilroy	65	65
Fresno	106	106
Bakersfield	145	145
# of trains	6	6

Pattern #	4	5	6
Frequency in service (min)	20	60	60
Bakersfield	0	0	0
San Fernando Bus	-	110	-
Burbank Airport Bus	127	-	-
Los Angeles Bus	152	-	-
Van Nuys Bus	-	-	127
West Los Angeles Bus	-	-	147
Santa Anita Bus	-	150	-
# of buses	18	6	6

Pattern #	4	5	6
Frequency in service (min)	30	60	60
Bakersfield	0	0	0
San Fernando Bus	-	110	-
Burbank Airport Bus	127	-	-
Los Angeles Bus	152	-	-
Van Nuys Bus	-	-	127
West Los Angeles Bus	-	-	147
Santa Anita Bus	-	150	-
# of buses	20	10	10

10-007 Merced to Bakersfield Scenario

IOS with one peak TPH; dedicated Amtrak connections from Merced to Oakland and Sacramento; dedicated coach connection from Bakersfield to LA Basin destinations, from Merced to San Jose, and from Emeryville to San Francisco.

6 Peak Hours

Pattern#	1A
Frequency of service (mins)	60
San Francisco (bus)	0
Oakland	
Emeryville	30
# of buses	6
Transfer Time @ Emeryville	10

Pattern#	1	2	3
Frequency of service (mins)	60	60	60
Oakland	0		
Emeryville	10		
Richmond	19		
Martinez	49		
Antioch	69		
Stockton	107		
San Jose (bus)		0	
Sacramento			0
Lodi			28
Stockton			45
Modesto			79
Denair/Turlock			92
Merced	135	150	121
# of buses/CVR	6	6	6
Transfer Time @ Merced	10	15	10

Pattern#	1
Frequency of service (mins)	60
Merced	0
Fresno	23
Visalia	38
Bakersfield	68
# of trains	6
Transfer Time @ Bakersfield	15

10 Off Peak Hours

Pattern#	1A
Frequency of service (mins)	60
San Francisco (bus)	0
Oakland	
Emeryville	30
# of buses	10
Transfer Time @ Emeryville	10

Pattern#	1	2	3
Frequency of service (mins)	60	60	60
Oakland	0		
Emeryville	10		
Richmond	19		
Martinez	49		
Antioch	69		
Stockton	107		
San Jose (bus)		0	
Sacramento			0
Lodi			28
Stockton			45
Modesto			79
Denair/Turlock			92
Merced	135	135	121
# of buses	10	10	10
Transfer Time @ Merced	10	15	10

Pattern#	1
Frequency of service (mins)	60
Merced	0
Fresno	23
Visalia	38
Bakersfield	68
# of trains	10
Transfer Time @ Bakersfield	15

Express Bus Service Between Bakersfield and LA Basin

Peak

Pattern #	1	2	3
Frequency in Service (min)	20	60	60
Bakersfield	0	0	0
San Fernando Bus	-	110	-
Burbank Airport Bus	127	-	-
Los Angeles Bus	152	-	-
Van Nuys Bus	-	-	127
West Los Angeles Bus	-	-	147
Santa Anita Bus	-	150	-
# of buses	18	6	6

Off-Peak

Pattern #	1	2	3
Frequency in Service (min)	30	60	60
Bakersfield	0	0	0
San Fernando Bus	-	110	-
Burbank Airport Bus	127	-	-
Los Angeles Bus	152	-	-
Van Nuys Bus	-	-	127
West Los Angeles Bus	-	-	147
Santa Anita Bus	-	150	-
# of buses	20	10	10

10-009 San Jose to Bakersfield Scenario

IOS with three peak TPH between San Jose and Bakersfield, with cross platform transfer to dedicated Caltrain feeder service at San Jose and coach connections to the LA Basin at Bakersfield.

6 Peak Hours

Pattern#	10	20
Frequency of service (mins)	60	60
San Francisco	0	0
South San Francisco		
Millbrae	16	16
San Mateo	-	24
Hillsdale	24	-
Redwood City	-	33
Palo Alto	35	39
Mountain View	42	-
Sunnyvale	-	48
San Jose	57	59
# of trains	6	6

Transfer Time @ Merced 10

Pattern#	10
Frequency of service (mins)	20
San Jose	0
Gilroy	18
Fresno	62
Visalia	78
Bakersfield	109
# of trains	18

10 Off Peak Hours

Pattern#	10	20
Frequency of service (mins)	60	60
San Francisco	0	0
South San Francisco		
Millbrae	16	16
San Mateo	-	24
Hillsdale	24	-
Redwood City	-	33
Palo Alto	35	39
Mountain View	42	-
Sunnyvale	-	48
San Jose	57	59
# of trains	10	10

Transfer Time @ Merced 10

Pattern#	10
Frequency of service (mins)	30
San Jose	0
Gilroy	18
Fresno	62
Visalia	78
Bakersfield	109
# of trains	20

Express Bus Service Between Bakersfield and LA Basin

Peak

Pattern #	1	2	3
Frequency in Service (min)	20	60	60
Bakersfield	0	0	0
San Fernando Bus	-	110	-
Burbank Airport Bus	127	-	-
Los Angeles Bus	152	-	-
Van Nuys Bus	-	-	127
West Los Angeles Bus	-	-	147
Santa Anita Bus	-	150	-
# of buses	18	6	6

Off-Peak

Pattern #	1	2	3
Frequency in Service (min)	30	60	60
Bakersfield	0	0	0
San Fernando Bus	-	110	-
Burbank Airport Bus	127	-	-
Los Angeles Bus	152	-	-
Van Nuys Bus	-	-	127
West Los Angeles Bus	-	-	147
Santa Anita Bus	-	150	-
# of buses	20	10	10

10-022 San Jose to Bakersfield (Amtrak Service to Sacramento) Scenario

IOS with three peak TPH; dedicated feeder service to HST by Caltrain between San Jose & San Francisco, Amtrak between Merced and Sacramento; dedicated coach between Bakersfield & LA Basin destinations.

6 Peak Hours

Pattern#	10	20
Frequency of service (mins)	60	60
San Francisco	0	0
Millbrae	16	16
San Mateo	-	24
Hillsdale	26	-
Redwood City	-	33
Palo Alto	37	39
Mountain View	44	-
Sunnyvale	-	48
San Jose	59	59
# of trains	6	6

Transfer Time @ San Jose 10 10

Pattern#	3
Frequency of service (mins)	60
Oakland	
Emeryville	
Richmond	
Martinez	
Antioch	
Stockton	
San Jose (bus)	
Sacramento	0
Lodi	28
Stockton	45
Modesto	79
Denair/Turlock	92
Merced	121
# of buses/CVR	6

Transfer Time @ Merced 15

Pattern#	10	25
Frequency of service (mins)	30	60
San Jose	0	-
Gilroy	18	-
Merced	-	0
Fresno	62	23
Visalia	78	38
Bakersfield	109	88
# of trains	12	6

Transfer Time @ Bakersfield 15 15

Pattern#	1	2	3
Frequency of service (mins)	20	60	60
Bakersfield	0	0	0
San Fernando (bus)		110	110
Burbank Airport (bus)	127		
Los Angeles Union Station (bus)	152		
Van Nuys (bus)		127	
West Los Angeles (bus)		147	
Santa Anita (bus)			150
# of buses	18	6	6

Includes dwell and 7% recovery time
Where timetable shows separate arrival and departure times, midpoint of dwell shown

10 Off Peak Hours

Pattern#	10
Frequency of service (mins)	60
San Francisco	0
Millbrae	16
San Mateo	24
Hillsdale	28
Redwood City	35
Palo Alto	41
Mountain View	48
Sunnyvale	53
San Jose	64
# of trains	10

Transfer Time @ San Jose 10

Pattern#	3
Frequency of service (mins)	60
Oakland	
Emeryville	
Richmond	
Martinez	
Antioch	
Stockton	
San Jose (bus)	
Sacramento	0
Lodi	28
Stockton	45
Modesto	79
Denair/Turlock	92
Merced	121
# of buses/CVR	10

Transfer Time @ Merced 15

Pattern#	10	20
Frequency of service (mins)	60	60
San Jose	0	-
Gilroy	18	-
Merced	-	0
Fresno	62	23
Visalia	78	38
Bakersfield	109	88
# of trains	10	10

Transfer Time @ Bakersfield 15 15

Pattern#	1	2	3
Frequency of service (mins)	30	60	60
Bakersfield	0	0	0
San Fernando (bus)		110	110
Burbank Airport (bus)	127		
Los Angeles Union Station (bus)	152		
Van Nuys (bus)		127	
West Los Angeles (bus)		147	
Santa Anita (bus)			150
# of buses	20	10	10

Includes dwell and 7% recovery time
Where timetable shows separate arrival and departure times, midpoint of dwell shown

Memorandum

TO: Nick Brand

FROM: Jeff Buxbaum, Roberto Alvarado, Michael Snavely, David Kurth

DATE: July 12, 2011

RE: HSR Ridership and Revenue 2030 Model Runs (10-011, 10-020, and 10-023)

This memorandum describes three high-speed rail (HSR) ridership and revenue model run initial operating segment (IOS) alternatives located in the Central Valley. Each scenario includes a combination of dedicated feeder coach service from the Palmdale terminus to Los Angeles (LA) Basin destinations, and Amtrak connection service from the northern terminus to the Bay Area and Sacramento. Run 10-011 evaluates an IOS segment between Fresno and Palmdale; run 10-020 evaluates the same segment with split Amtrak and HSR stations in Fresno; and 10-023 tests the impact of extending the northern terminus to Merced. Below are summary descriptions of each run:

- **10-011 – Fresno to Palmdale Scenario –** 83 percent of average airfare; one peak train per hour (TPH); dedicated Amtrak connections from Fresno to the Bay Area and Sacramento; dedicated feeder coach connection from Palmdale to LA Basin destinations, from Fresno to San Jose, and from Emeryville to San Francisco (Transbay).

- **10-020 – Fresno to Palmdale (Split Fresno Station) Scenario –** 83 percent of average airfare; one peak TPH; dedicated Amtrak connections from Fresno to the Bay Area and Sacramento; dedicated feeder coach connection from Palmdale to LA Basin destinations, from Fresno to San Jose, and from San Francisco (Transbay) to Emeryville. Same operating plan as 10-011 except 15 minutes added to transfer time from HSR to Amtrak feeder service to simulate separate HSR and Amtrak station locations.

- **10-023 – Merced to Palmdale Scenario –** 83 percent of average airfare; two peak TPH; dedicated Amtrak connections from Merced to the Bay Area and Sacramento; dedicated feeder coach connection from Palmdale to LA Basin destinations, from Merced to San Jose, and from Emeryville to San Francisco.

The next section summarizes the major findings of each run. Refer to Table 1 for run result summaries. Hourly operating plan details for each run are provided in the Appendix.

Individual Model Run Findings

10-011 – Fresno to Palmdale Scenario

IOS with one peak TPH between Fresno and Palmdale; dedicated Amtrak connections from Fresno to the Bay Area and Sacramento treated as extensions of HSR service; dedicated feeder coach connection from Palmdale to LA Basin destinations, from Fresno to San Jose, and from Emeryville to San Francisco (Transbay).

Objective

Test an IOS scenario connecting Fresno and Palmdale, with dedicated Amtrak service from Fresno to Oakland and Sacramento treated as extensions to HSR service, and bus service from: 1) Palmdale to San Fernando, Burbank Airport, LA Union Station, Van Nuys, West LA, and Santa Anita; 2) Fresno to San Jose; and 3) Emeryville to San Francisco. Run is compared to run **10-007 – Merced to Bakersfield Scenario.**[1]

Run Details

- HSR Stations: Fresno, Visalia, Bakersfield, Palmdale.
- Hourly Peak HSR Trains: One.
- Fares: 83 percent airfare on HSR; $20 for coach transfer to the LA Basin; $25 for coach transfer to San Jose; original fares on Amtrak.

Annual Ridership Results (millions)

	10-007 [a]	10-011[a]	Change
System-wide Ridership	6.8	8.3	+22%

[a] Excludes ridership from Amtrak-only passengers.

Annual Revenue Results (millions)

	10-007[b]	10-011[b]	Change
System-wide Revenue	$549	$776	+41%

[b] Excludes revenue from Amtrak-only passengers.

[1] **10-007 – Merced to Bakersfield Scenario**. A previous IOS scenario featuring 83 percent of average airfare; one peak TPH; Amtrak connection from Merced to Oakland and Sacramento; dedicated coach-connection from Bakersfield to LA Basin, from Merced to San Jose, and from Emeryville to San Francisco. For details, see *HSR Ridership and Revenue 2030 Model Runs (10-006, 10-007, 10-009, and 10-022)*.

Summary Notes

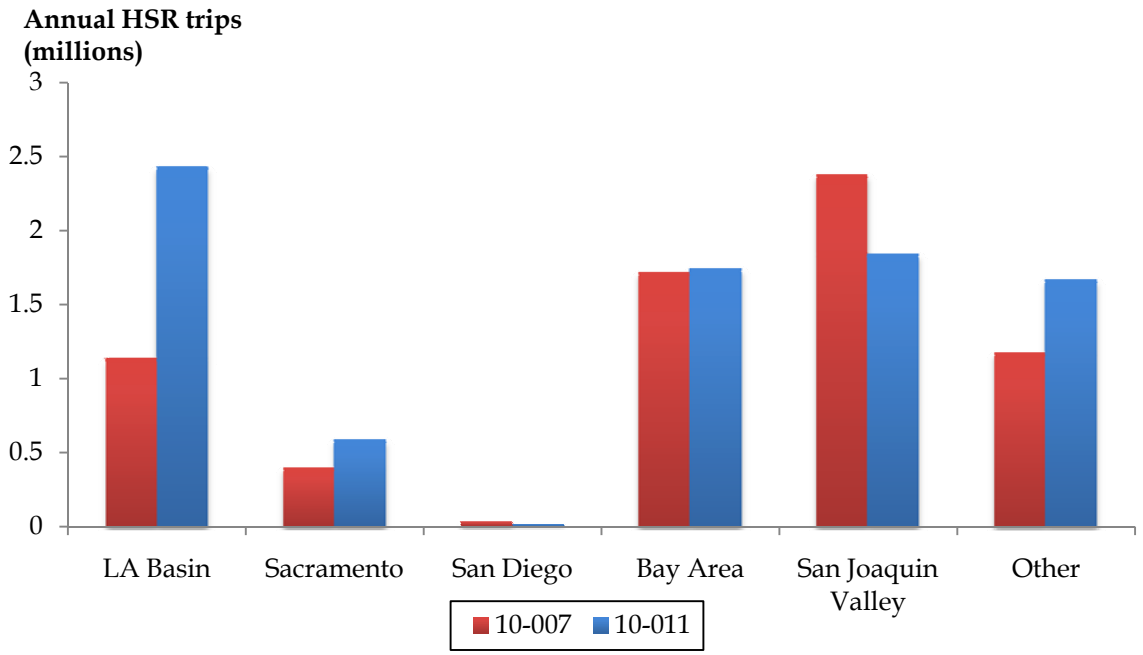
- **Compared to Run 10-007 –** HSR service to Merced has been eliminated. HSR service has been extended south to Palmdale. Dedicated connecting Amtrak service extends north from Fresno to Oakland and Sacramento. HSR service frequency did not change between scenarios (one peak TPH). Dedicated feeder coach service departs from Palmdale (rather than Bakersfield) to San Fernando, Burbank Airport, LA Union Station, Van Nuys, West LA, and Santa Anita. Coach service to Burbank Airport and LA Union Station has been reduced from three per hour to one per hour in the peak period. Coach service frequencies to the other LA Basin destinations and from Emeryville to SF Transbay are identical for both scenarios. Coach service to San Jose originates at Fresno, instead of Merced.

- **Service extension to Palmdale and Amtrak service frequency enhancement increases ridership –** The increase in ridership is due in large part to the extension of HSR service south to Palmdale where it is accessible by a larger portion of LA Basin travelers. Although runs 10-007 and 10-011 both feature one HSR train per hour, Amtrak feeder frequency in 10-011 increases from one to two TPH at stations in the northern San Joaquin Valley (from Merced and Madera to Oakland and Sacramento). The combined effects of these two factors attracts more riders even though travel times from the Bay Area and Sacramento to Fresno average about 60 minutes longer than travel times to Merced.

- **HSR share of LA Basin travel market increases –** The most notable HSR travel market ridership increases include: LA Basin to Bay Area (94 percent), LA Basin to Sacramento Area (140 percent), and LA Basin to San Joaquin Valley (134 percent). These increases more than offset the adverse effects of reduced feeder coach service levels and a northern terminus (at Fresno) located farther from the Bay Area.

- **Ridership increases across most regions –** Figure 1 shows the HSR ridership by origin region for the two runs. Figures exclude Amtrak-only trips. Trips originating in the LA Basin increase by 100 percent due to the extension of service to Palmdale while trips from the San Joaquin Valley decrease by 22 percent due to the elimination of service at Merced. Slight increases occur from the Bay Area and Sacramento regions.

Figure 1. Annual Interregional HSR Ridership by Origin Region



- **LA Basin feeder coach ridership is low due to availability of competitive transit access options –** On both 10-007 and 10-011 runs, ridership on buses to/from southern termini is typically very low due to the presence of existing regional transit services that operate at competitive fares. However, extending the southern terminus to Palmdale allows for more convenient access on background bus transit and Metrolink services to the rest of the LA Basin region. This contributes a small amount to increased ridership versus run 10-007.

10-020 – Fresno to Palmdale (Split Fresno Station) Scenario

IOS with one TPH between Fresno and Palmdale; dedicated Amtrak connections from Fresno to the Bay Area and Sacramento treated as extensions of HSR service; dedicated feeder coach connections to LA Basin destinations, from Fresno to San Jose, and from San Francisco to Emeryville.

Objective

Test the effect of an IOS scenario connecting Fresno and Palmdale with split Amtrak and HSR stations at Fresno. Same operating plan as 10-011 except: 1) 15 minutes added to transfer time from HSR to Amtrak feeder service to simulate separate HSR and Amtrak station locations; and 2) additional feeder coach service from Palmdale to San Fernando and Santa Anita. Run is compared to 10-011.

Run Details

- HSR Stations: Fresno, Visalia, Bakersfield, and Palmdale.
- Hourly HSR Peak Trains: One.
- Fares: 83 percent airfare on HSR; $20 for bus transfer to LA Basin; $25 for bus transfer to San Jose; original fares on Amtrak.

Annual Ridership Results (millions)

	10-011 [a]	10-020 [a]	Change
System-wide	8.3	7.7	-7%

[a] Excludes ridership from Amtrak-only passengers.

Annual Revenue Results (millions)

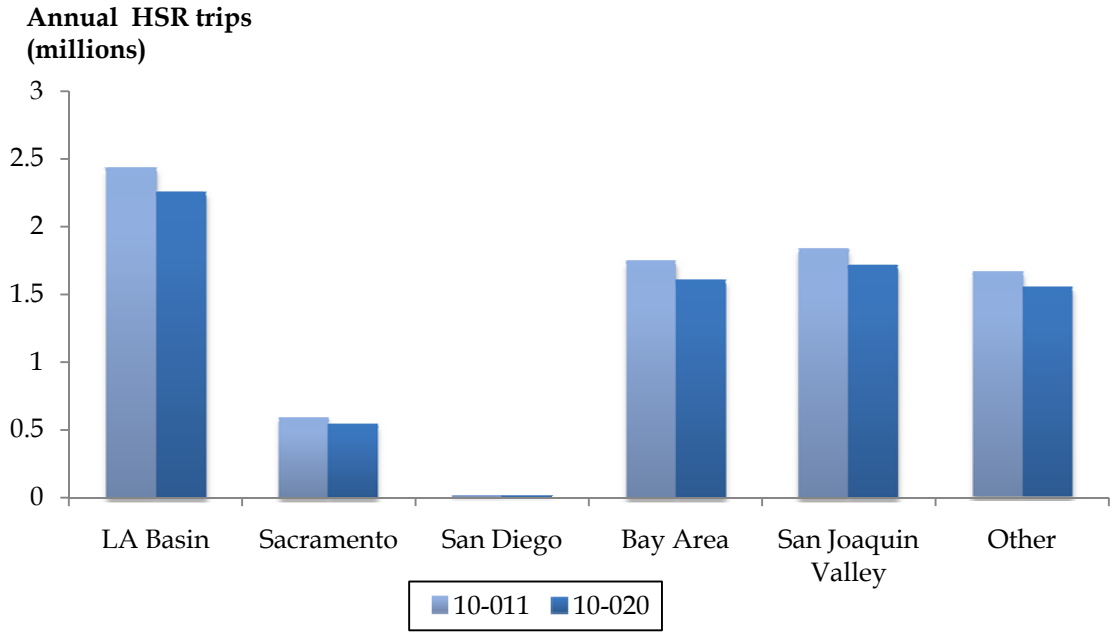
	10-011 [b]	10-020 [b]	Change
System-wide	$776	$717	-8%

[b] Excludes revenue from Amtrak-only passengers.

Summary Notes

- **Compared to Run 10-011 –** Fresno Amtrak station and Fresno HSR station are treated as separate stations with a dedicated coach provided between stations. HSR service frequency did not change between scenarios. In addition, coach service from Palmdale to San Fernando and Santa Anita has been added in the off-peak period with a frequency of one bus per hour.
- **Split HSR and Amtrak stations lower interregional ridership –** Annual system-wide HSR boardings decrease by 0.6 million compared to the 10-011 alternative due in large part to a 15-minute increase in transfer time for passengers transferring from HSR to Amtrak in Fresno (an increase from 15 minutes to 30 minutes versus 10-011).
- **Ridership decreases slightly across all origin regions –** Figure 2 shows the HSR ridership by origin region for the two runs. Figures exclude Amtrak-only passengers. Ridership decreases slightly in all regions

Figure 2. Annual Interregional HSR Ridership by Origin Region



10-023 – Merced to Palmdale Scenario

IOS with two peak TPH and one off-peak TPH between Merced and Palmdale; dedicated Amtrak connections to the Bay Area and Sacramento treated as extensions of HSR service; dedicated feeder coach connection from Palmdale to LA Basin destinations, from Merced to San Jose, and from Emeryville to San Francisco.

Objective

- Test an IOS alternative from Merced to Palmdale with a frequency of two peak TPH. Amtrak service is provided between Merced and Oakland, and between Merced and Sacramento. Dedicated coach services to San Fernando, Burbank Airport, LA Union Station, Van Nuys, West LA, and Santa Anita depart from Palmdale in 10-023. Dedicated coach services from Emeryville to San Francisco and from Merced to San Jose. **Run is compared to run 10-007 (Merced to Bakersfield Scenario).**

Run Details

- HSR Stations: Merced, Fresno, Visalia, Bakersfield, and Palmdale.
- Hourly Peak HSR Trains: Two.
- Fares: 83 percent airfare on HSR; $20 for bus transfer.

Annual Ridership Results (millions)

	10-007 [a]	10-023 [a]	Change
System-wide	6.8	13.1	+93%

[a] Excludes ridership from Amtrak-only passengers.

Annual Revenue Results (millions)

	10-007 [b]	10-023 [b]	Change
System-wide	$549	$1,209	+120%

[b] Excludes revenue from Amtrak passengers.

Summary Notes

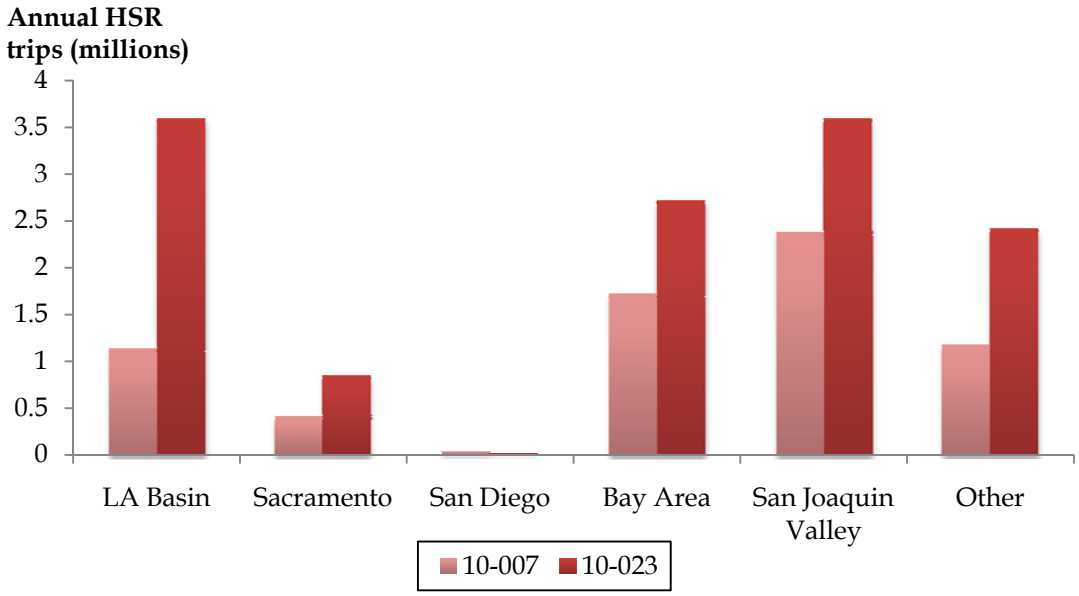
- **Compared to Run 10-007 –** HSR service is extended to Palmdale and peak-period frequency is increased from one to two TPH. Coach service to Burbank Airport and Los Angeles Union Station decreases from three to two buses per hour in the peak period and from two to one bus per hour in off-peak periods. Coach frequency at the San Fernando station increases from one BPH to three BPH during off-peak periods.

- **Service Extension and Frequency Increases Drive Ridership Gains –** The increase in interregional HSR travel is due in large part to the extension of HSR service south to Palmdale and the doubling of peak hour service frequency. The HSR service extension allows for an increase in annual interregional travel to/from destinations in the LA Basin, the Bay Area, Sacramento, and San Joaquin Valley. The most significant increase occurs between the LA Basin and the San Joaquin Valley (277 percent).

- **Increase in coach service frequencies to San Fernando contributes to LA Basin ridership gains –** New off-peak accessibility from the Palmdale terminus to San Fernando increases HSR ridership to and from the San Fernando market.

- **Ridership increases significantly across origin regions –** Figure 3 shows the annual interregional HSR trips by origin region for run 10-023 and the 10-007 base run. Figures exclude Amtrak-only passengers. Ridership increases in every region, but LA Basin trip origins increase at the greatest rate (over 217 percent) due to the extension of HSR service south into the LA Basin.

Figure 3. Annual Interregional HSR Ridership by Origin Region



Overall Findings Summary

- **Extending HSR service south to Palmdale increases ridership –** Extending HSR service to provide an access point in the populous LA Basin region contributes to a significant increase in HSR trips to and from the LA Basin. When paired with a doubling of peak hour HSR service frequencies (as in run 10-023), extending HSR service to Palmdale contributes to a 93 percent increase in interregional trips in run 10-023.

- **The split of Amtrak and HSR stations in Fresno reduces interregional ridership –** Split HSR and Amtrak stations in Fresno contribute to a decrease in interregional HSR travel due to additional transfer and travel time associated with northern Amtrak-HSR connections. Increasing HSR service frequencies appears to help offset the adverse effects of increased transfer times at Fresno.

Table 1. Annual Region-to-Region Ridership and Revenue

All Revenue Information in 2010 Dollars

Market	Total Market Trips (millions)	10-007 Merced to Bakersfield Scenario		10-011 Fresno to Palmdale Scenario		10-020 Fresno to Palmdale (Split Fresno Station) Scenario		10-023 Merced to Palmdale Scenario	
		HSR Ridership (millions)	HSR Revenues (millions)	HSR Ridership (millions)	HSR Revenues (millions)	HSR Ridership (millions)	HSR Revenues (millions)	HSR Ridership (millions)	HSR Revenues (millions)
LA Basin – Sacramento	8	0.4	$36	1.0	$99	0.9	$91	1.3	$137
LA Basin – San Diego	142	0.0	$0	0.0	$0	0.0	$0	0.0	$0
LA Basin – Bay Area	22	1.2	$104	2.2	$233	2.1	$214	3.2	$340
Sacramento – Bay Area	72	0.0	$0	0.0	$0	0.0	$0	0.0	$0
San Diego – Sacramento	2	0.0	$0	0.0	$0	0.0	$0	0.0	$0
San Diego – Bay Area	8	0.0	$4	0.0	$1	0.0	$1	0.0	$2
Bay Area – San Joaquin Valley	71	2.2	$187	1.2	$110	1.1	$101	2.2	$188
San Joaquin Valley – LA Basin	70	0.7	$48	1.6	$135	1.5	$126	2.7	$221
Sacramento – San Joaquin Valley	22	0.4	$32	0.2	$17	0.2	$15	0.4	$33
San Diego – San Joaquin Valley	0	0.0	$1	0.0	$1	0.0	$1	0.0	$1
within Bay Area Peninsula	7,709	0.0	$0	0.0	$0	0.0	$0	0.0	$0
within North LA Basin	8,685	0.0	$0	0.0	$0	0.0	$0	0.0	$0
within South LA Basin	10,790	0.0	$0	0.0	$0	0.0	$0	0.0	$0
North LA – South LA	2,943	0.0	$0	0.0	$0	0.0	$0	0.0	$0
within San Diego Region	8,277	0.0	$0	0.0	$0	0.0	$0	0.0	$0
within San Joaquin Valley	6,338	0.7	$38	0.3	$18	0.3	$17	1.0	$53
Other	7,346	1.2	$99	1.7	$162	1.5	$151	2.4	$235
Total	**52,508**	**6.8**	**$549**	**8.3**	**$776**	**7.7**	**$717**	**13.1**	**$1,209**

Notes: 1. See *HSR Ridership and Revenue 2030 Model Runs (10-006, 10-007, 10-009, and 10-022)* for details about run 10-007.

2. Figures exclude Amtrak-only passengers.

Appendix – Operating Plans

10-011 Fresno to Palmdale Scenario

IOS with one TPH between Fresno and Palmdale, with Amtrak connections to Sacramento, Oakland, and San Jose; and coach connections to San Fernando, Burbank Airport, Los Angeles (Union Station), Van Nuys, West Los Angeles, Santa Anita, and from Emeryville to San Francisco.

6 Peak Hours

Pattern#	1A
Frequency of service (mins)	60
San Francisco (bus)	0
Oakland	
Emeryville	30
# of buses	6

Transfer Time @ Emeryville 10

Pattern#	1	2	3
Frequency of service (mins)	60	60	60
Oakland	0		
Emeryville	10		
Richmond	19		
Martinez	49		
Antioch	69		
Stockton	107		
San Jose (bus)		0	
Sacramento			0
Lodi			28
Stockton			45
Modesto			79
Denair/Turlock			92
Merced	135		121
Madera	163		149
Fresno	199	195	185
# of buses/CVR	6	6	6

Transfer Time @ Fresno 15 15 15

Pattern#	1
Frequency of service (mins)	60
Fresno	0
Visalia	15
Bakersfield	45
Palmdale	79
# of trains	6

Transfer Time @ Bakersfield 15 15 15

Pattern#	1	2	3
Frequency of service (mins)	60	60	60
Palmdale	0	0	0
San Fernando (bus)			85
Burbank Airport (bus)	95		
Los Angeles Union Station (bus)	120		
Van Nuys (bus)		85	
West Los Angeles (bus)		105	
Santa Anita (bus)			125
# of buses	6	6	6

Includes dwell and 3.5% recovery time
Where timetable shows separate arrival and departure times, midpoint of dwell shown

10 Off Peak Hours

Pattern#	1A
Frequency of service (mins)	60
San Francisco (bus)	0
Oakland	
Emeryville	30
# of buses	10

Transfer Time @ Emeryville 10

Pattern#	1	2	3
Frequency of service (mins)	60	60	60
Oakland	0		
Emeryville	10		
Richmond	19		
Martinez	49		
Antioch	69		
Stockton	107		
San Jose (bus)		0	
Sacramento			0
Lodi			28
Stockton			45
Modesto			79
Denair/Turlock			92
Merced	135		121
Madera	163		149
Fresno	199	180	185
# of buses/CVR	10	10	10

Transfer Time @ Fresno 15 15 15

Pattern#	1
Frequency of service (mins)	60
Fresno	0
Visalia	15
Bakersfield	45
Palmdale	79
# of trains	10

Transfer Time @ Bakersfield 15 15

Pattern#	1	2
Frequency of service (mins)	60	60
Palmdale	0	0
San Fernando (bus)	65	65
Burbank Airport (bus)	82	
Los Angeles Union Station (bus)	107	
Van Nuys (bus)		82
West Los Angeles (bus)		102
Santa Anita (bus)		
# of buses	10	10

Includes dwell and 3.5% recovery time
Where timetable shows separate arrival and departure times, midpoint of dwell shown

10-020 Fresno to Palmdale (Split Fresno Station) Scenario

IOS with one TPH between Fresno and Palmdale, with Amtrak connections to Sacramento, Oakland, and San Jose; and coach connections to San Fernando, Burbank Airport, Los Angeles (Union Station), Van Nuys, West Los Angeles, Santa Anita, and from Emeryville to San Francisco.

8 Peak Hours

Pattern#	1A
Frequency of service (mins)	60
San Francisco (bus)	0
Oakland	
Emeryville	30
# of buses	6

Transfer Time @ Emeryville 10

Pattern#	1	2	3
Frequency of service (mins)	60	60	60
Oakland	0		
Emeryville	10		
Richmond	19		
Martinez	49		
Antioch	69		
Stockton	107		
San Jose (bus)		0	
Sacramento			0
Lodi			28
Stockton			45
Modesto			79
Denair/Turlock			92
Merced	135		121
Madera	163		149
Fresno	199	155	185
# of buses/CVR	6	6	6

Transfer Time @ Fresno 30

Pattern#	1
Frequency of service (mins)	60
Fresno	0
Visalia	15
Bakersfield	45
Palmdale	79
# of trains	6

Transfer Time @ Bakersfield 15

Pattern#	1	2	3
Frequency of service (mins)	60	60	60
Palmdale	0	0	0
San Fernando (bus)			85
Burbank Airport (bus)	95		
Los Angeles Union Station (bus)	120		
Van Nuys (bus)		85	
West Los Angeles (bus)		105	
Santa Anita (bus)			125
# of buses	6	6	6

Includes dwell and 3.5% recovery time
Where timetable shows separate arrival and departure times, midpoint of dwell shown

10 Off Peak Hours

Pattern#	1A
Frequency of service (mins)	60
San Francisco (bus)	0
Oakland	
Emeryville	30
# of buses	10

Transfer Time @ Emeryville 10

Pattern#	1	2	3
Frequency of service (mins)	60	60	60
Oakland	0		
Emeryville	10		
Richmond	19		
Martinez	49		
Antioch	69		
Stockton	107		
San Jose (bus)		0	
Sacramento			0
Lodi			28
Stockton			45
Modesto			79
Denair/Turlock			92
Merced	135		121
Madera	163		149
Fresno	199	180	185
# of buses/CVR	10	10	10

Transfer Time @ Fresno 30

Pattern#	1
Frequency of service (mins)	60
Fresno	0
Visalia	15
Bakersfield	45
Palmdale	79
# of trains	10

Transfer Time @ Bakersfield 15

Pattern#	1	2	3
Frequency of service (mins)	60	60	60
Palmdale	0	0	0
San Fernando (bus)	65	65	85
Burbank Airport (bus)	82		
Los Angeles Union Station (bus)	107		
Van Nuys (bus)		82	
West Los Angeles (bus)		102	
Santa Anita (bus)			125
# of buses	10	10	10

Includes dwell and 3.5% recovery time
Where timetable shows separate arrival and departure times, midpoint of dwell shown

CAMBRIDGE SYSTEMATICS

10-023 Merced to Palmdale Scenario

IOS with two TPH in peak period and one TPH in off-peak period from Merced to Palmdale, with Amtrak connections to the Bay Area and Sacramento, and coach connections to the LA Basin and from Emeryville to San Francisco.

6 Peak Hours

Pattern#	1A
Frequency of service (mins)	60
San Francisco (bus)	0
Oakland	
Emeryville	30
# of buses	6

Transfer Time @ Emeryville 10

Pattern#	1	2	3
Frequency of service (mins)	60	60	60
Oakland	0		
Emeryville	10		
Richmond	19		
Martinez	49		
Antioch	69		
Stockton	107		
San Jose (bus)		0	
Sacramento			0
Lodi			28
Stockton			45
Modesto			79
Denair/Turlock			92
Merced	135	150	121
# of buses/CVR	6	6	6

Transfer Time @ Merced 10 15 10

Pattern#	1
Frequency of service (mins)	30
Merced	0
Fresno	23
Visalia	38
Bakersfield	68
Palmdale	102
# of trains	12

Transfer Time @ Palmdale 15

Pattern#	1	2	3
Frequency of service (mins)	30	60	60
Palmdale	0	0	0
San Fernando (bus)			85
Burbank Airport (bus)	95		
Los Angeles Union Station (bus)	120		
Van Nuys (bus)		85	
West Los Angeles (bus)		105	
Santa Anita (bus)			125
# of buses	12	6	6

Includes dwell and 3.5% recovery time
Where timetable shows separate arrival and departure times, midpoint of dwell shown

10 Off Peak Hours

Pattern#	1A
Frequency of service (mins)	60
San Francisco (bus)	0
Oakland	
Emeryville	30
# of buses	10

Transfer Time @ Emeryville 10

Pattern#	1	2	3
Frequency of service (mins)	60	60	60
Oakland	0		
Emeryville	10		
Richmond	19		
Martinez	49		
Antioch	69		
Stockton	107		
San Jose (bus)		0	
Sacramento			0
Lodi			28
Stockton			45
Modesto			79
Denair/Turlock			92
Merced	135	135	121
# of buses/CVR	10	10	10

Transfer Time @ Merced 10 15 10

Pattern#	1
Frequency of service (mins)	60
Merced	0
Fresno	23
Visalia	38
Bakersfield	68
Palmdale	102
# of trains	10

Transfer Time @ Palmdale 15

Pattern#	1	2	3
Frequency of service (mins)	60	60	60
Palmdale	0	0	0
San Fernando (bus)	65	65	85
Burbank Airport (bus)	82		
Los Angeles Union Station (bus)	107		
Van Nuys (bus)		82	
West Los Angeles (bus)		102	
Santa Anita (bus)			125
# of buses	10	10	10

Includes dwell and 3.5% recovery time
Where timetable shows separate arrival and departure times, midpoint of dwell shown

Memorandum

TO: Nick Brand

FROM: Jeff Buxbaum, Roberto Alvarado, Michael Snavely, David Kurth

DATE: July 11, 2011

RE: HSR Ridership and Revenue 2030 Model Runs (10-012, 10-021, and 10-024)

This memorandum describes three high-speed rail (HSR) ridership and revenue model run initial operating segment (IOS) alternatives located in the Central Valley and extending to the San Fernando Valley. Each scenario includes a combination of dedicated feeder coach service from the San Fernando terminus to Los Angeles (LA) Basin destinations and Amtrak connection service from the northern terminus to the Bay Area and Sacramento. Run 10-012 evaluates an IOS segment between Fresno and San Fernando; 10-021 evaluates the same segment with split Amtrak and HSR stations in Fresno; 10-024 tests the impact of extending the northern terminus to Merced. Below are summary descriptions of each run:

- **10-012 – Fresno to San Fernando Scenario –** 83 percent of average airfare; one peak train per hour (TPH); Amtrak connections from Fresno to Oakland/Emeryville and Sacramento; feeder coach connection from Fresno to San Jose, from Emeryville to San Francisco, and from San Fernando to LA Basin destinations.

- **10-021 – Fresno to San Fernando (Split Fresno Station) Scenario –** 83 percent of average airfare; two peak TPH; Amtrak connections from Fresno to Oakland/Emeryville and Sacramento; feeder coach connection from San Fernando to LA Basin destinations, from Fresno to San Jose, and from Emeryville to San Francisco. Same operating plan as 10-012 except 15 minutes added to transfer time from HSR to Amtrak feeder service to simulate separate HSR and Amtrak station locations.

- **10-024 – Merced to San Fernando Scenario –** 83 percent of average airfare; three peak TPH; Amtrak connections from Merced to Oakland/Emeryville and Sacramento; feeder coach connection from San Fernando to LA Basin destinations, from Merced to San Jose, and from Emeryville to San Francisco.

The next section summarizes the major findings of each run. Refer to Table 1 for comparison of the three IOS runs. Hourly operating plan details for each run are provided in the Appendix.

Individual Model Run Findings

10-012 – Fresno to San Fernando Scenario

IOS with one peak TPH between Fresno and San Fernando; Amtrak connections from Fresno to Oakland/Emeryville and Sacramento treated as extensions of HSR service; feeder coach connection from San Fernando to LA Basin, from Fresno to San Jose, and from Emeryville to San Francisco.

Objective

Test IOS scenarios connecting Fresno and San Fernando. Compare results to run to **10-007 – Merced to Bakersfield.**[1] Amtrak service from Fresno to Oakland/Emeryville and Sacramento. Bus service from San Fernando to Burbank Airport, LA Union Station, Van Nuys, West LA, and Santa Anita; from Emeryville to San Francisco; and from Fresno to San Jose.

Run Details

- HSR Stations: Fresno, Visalia, Bakersfield, Palmdale, and San Fernando.
- Hourly Peak HSR Trains: One.
- Fares: 83 percent airfare on HSR; $10 for bus transfer to LA Basin; $25 for bus transfer to San Jose; Original fare on Amtrak.

Annual Ridership Results (millions)

	10-007 [a]	10-012 [a]	Change
System-wide	6.8	10.4	+53
Interregional	6.8	9.4	+38
Intraregional		1.0	

[a] Excludes ridership from Amtrak-only passengers.

[1] **10-007 – Merced to Bakersfield Scenario** – IOS, 83 percent of average airfare; one peak TPH; Amtrak connection from Merced to Oakland and Sacramento; feeder coach connection from Bakersfield to LA Basin, from Merced to San Jose, and from Emeryville to San Francisco. For details, see *HSR Ridership and Revenue 2030 Model Runs (10-006, 10-007, 10-009, and 10-022)*.

Annual Revenue Results (millions)

	10-007 [b]	10-012 [b]	Change
System-wide	$549	$817	+49%
Interregional	$549	$801	+46%
Intraregional	$0	$17	

[b] Excludes revenue from Amtrak-only passengers.

Summary Notes

- **Compared to Run 10-007 –** HSR service is extended south to San Fernando, but the northern terminus is moved south from Merced to Fresno. Amtrak feeder service is extended south to Fresno. Feeder coach connections to Burbank Airport, LA Union Station, Van Nuys, West LA, and Santa Anita depart from San Fernando rather than Bakersfield. Bus service to Burbank airport and LA Union station has been reduced from three peak buses per hour (BPH) to one peak BPH. The frequency of bus connections to San Francisco and San Jose are identical for both scenarios.

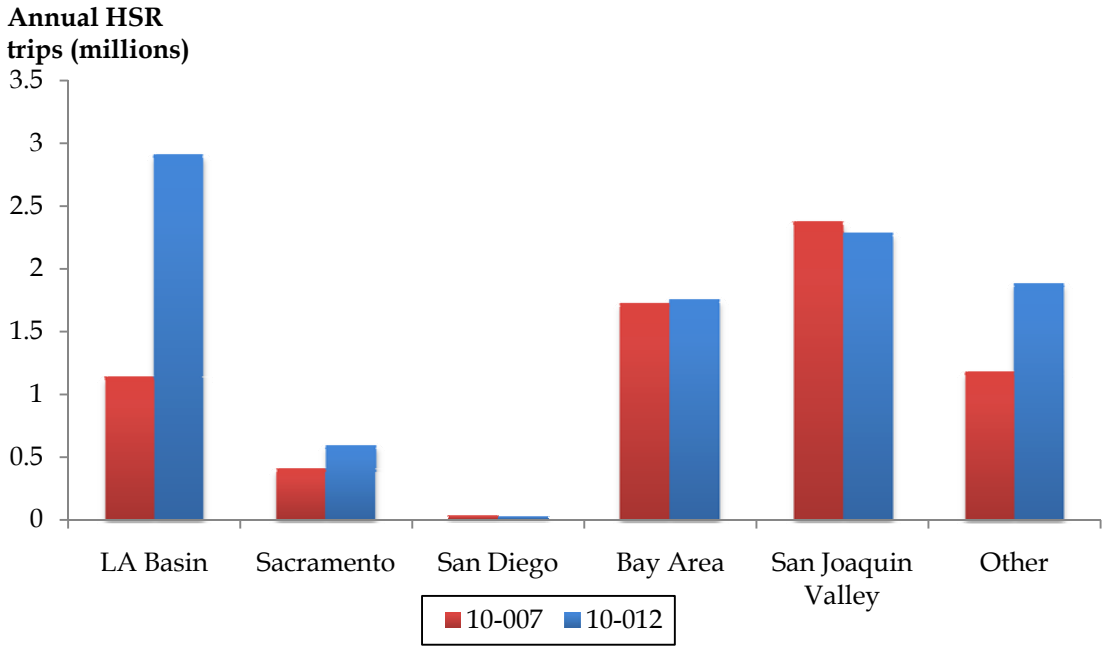
- **Service extensions south to San Fernando and improvements in Amtrak service boost ridership –** The increase in interregional HSR travel is due in large part to an increase in HSR service between LA Basin and the northern regions of the Central Valley due to the addition of the Palmdale and San Fernando stations. Another contributing factor is the inclusion of Amtrak stations in the San Joaquin Valley, specifically at Merced and Madera. Although runs 10-007 and 10-012 both feature one HSR train per hour, Amtrak frequencies increase to two TPH at the Merced and Madera stops, allowing passengers from both the Oakland and Sacramento termini improved access the HSR system.

- **Market-to-Market Ridership Increases –** The greatest increase in interregional ridership occurs in the LA Basin-San Joaquin Valley market (263 percent), followed by LA Basin-Sacramento (141 percent), and LA Basin-Bay Area (95 percent). These increases more than offset a decrease in ridership from the San Joaquin Valley to Sacramento and Bay Area destinations due to an average 60-minute increase in travel time to the San Joaquin Valley from those markets. Ridership also decreases by about 70 percent between the San Diego region and the Bay area due to a reduction in coach feeder services in the LA Basin.

  The extension to San Fernando also supports an additional 700,000 intraregional HSR trips between Palmdale and San Fernando annually.

- **Annual sources of HSR ridership by origin region –** Figure 1 shows HSR trips by origin region for the two runs. Figures exclude Amtrak-only passengers. Annual trips increase in all the regions with the exception of San Joaquin Valley.

Figure 1. Annual Interregional HSR Ridership by Origin Region



- **Low frequency in feeder coach connections –** Note that ridership on the HSR feeder coach service from San Fernando is very low due in large part to competitive existing Metrolink and regional bus services with lower fares.

10-021 – Fresno to San Fernando (Split Fresno Station) Scenario

IOS with two peak TPH between Fresno and San Fernando (split Fresno station), Amtrak connections from Fresno to Oakland and Sacramento treated as extensions of HSR service; feeder coach connection from San Fernando to LA Basin destinations, from Fresno to San Jose, and from Emeryville to San Francisco.

Objective

- Test various IOS scenarios connecting Fresno and San Fernando. Same operating plan as 10-012 except: 1) 15 minutes added to transfer time from HSR to Amtrak feeder service to simulate separate HSR and Amtrak station locations; and 2) coach service added from San Fernando to Santa Anita during off-peak hours.

Run Details

- HSR Stations: Fresno, Visalia, Bakersfield, Palmdale, and San Fernando.
- Hourly Peak HSR Trains: Two.
- Fares: 83 percent airfare on HSR; $10 for bus transfer to LA Basin; $25 for bus transfer to San Jose; original fare on Amtrak.

Annual Ridership Results (millions)

	10-012 [a]	10-021 [a]	Change
System-wide	10.4	10.9	+5%
Interregional	9.4	9.9	+5%
Intraregional Bay Area	1.0	1.0	0%

[a] Excludes ridership from Amtrak-only passengers.

Annual Revenue Results (millions)

	10-012 [b]	10-021 [b]	Change
System-wide	$817	$930	+14%
Interregional	$801	$912	+14%
Intraregional Bay Area	$17	$18	

[b] Excludes revenue from Amtrak-only passengers.

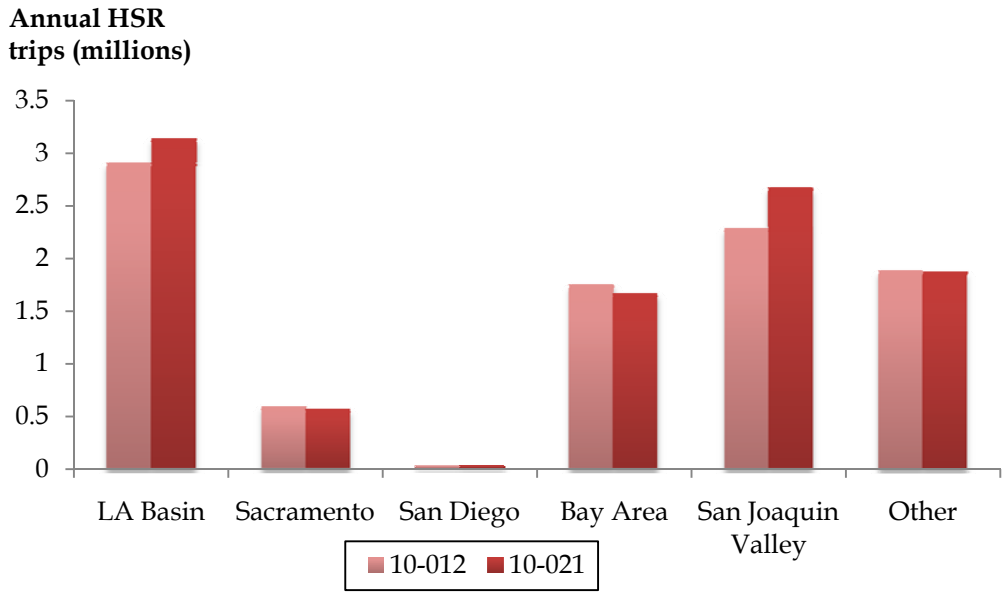
Summary Notes

- **Compared to Run 10-012 –** HSR frequency increases from one peak TPH to two TPH. Fresno Amtrak and Fresno HSR stations are treated as separate stations with feeder coach connection, resulting in a travel time increase of 15 minutes for trips traveling through Fresno. Peak period buses from San Fernando to LA Union Station increase from one to two BPH in the peak period. A feeder coach connection from San Fernando to Santa Anita is added in the off-peak period.

- **Improved frequency drives interregional ridership increase –** The increase in interregional HSR travel results from an increase in HSR frequency of one to two trains per hour between LA Basin and San Joaquin Valley markets, including travel within the San Joaquin Valley. Annual trips between LA Basin and San Joaquin Valley increase 24 percent, while within the San Joaquin Valley trips rise by 36 percent. The increase in travel between these regions more than offsets a decrease in travel in the Bay Area-LA Basin (five percent) and Bay Area-San Joaquin Valley (five percent) markets, due to the additional transfer time at Fresno.

- **Annual sources of HSR ridership –** Figure 2 shows the HSR ridership by origin region for the two runs. Figures exclude Amtrak-only passengers. Trips originating in the LA Basin region increase by about eight percent and from the San Joaquin Valley trips rise 17 percent. Trips originating in the Bay Area and Sacramento decrease by five percent due to additional travel time through Fresno.

Figure 2. Annual Interregional HSR Ridership by Origin Region



10-024 – Merced to San Fernando Scenario

IOS with three peak period TPH and two off-peak TPH from Merced to San Fernando; Amtrak connections from Merced to Oakland and Sacramento treated as extensions of HSR service; feeder coach connections from San Fernando to LA Basin destinations, from Merced to San Jose, and from Emeryville to San Francisco.

Objective

- Test IOS alternative from Merced to San Fernando featuring three TPH. Run is compared to **10-023 – Merced to Palmdale.**[2] Amtrak service between Merced and Oakland and between Merced and Sacramento. Bus service from San Fernando to Burbank Airport, LA Union Station, Van Nuys, West LA, and Santa Anita; from Emeryville to San Francisco; and from Merced to San Jose.

Run Details

- HSR Stations: Merced, Fresno, Visalia, Bakersfield, Palmdale, and San Fernando.
- Hourly Peak HSR Trains: Three.
- Fares: 83 percent airfare on HSR; $10 for bus transfer to LA Basin; $25 for bus transfer to San Jose; Original fare on Amtrak.

Annual Ridership Results (millions)

	10-023 [a]	10-024 [a]	Change
System-wide	13.1	16.4	+25%
Interregional	13.1	15.4	+18%
Intraregional	0	1.0	

[a] Excludes ridership from Amtrak-only passengers.

[2] **10-023 – Merced to Palmdale Scenario** – 83 percent of average airfare; two peak TPH; Amtrak connections from Merced to the Bay Area and Sacramento; feeder coach connection from Palmdale to LA Basin destinations, from Merced to San Jose, and from Emeryville to San Francisco. For details, see *HSR Ridership and Revenue 2030 Model Runs (10-011, 10-020, and 10-023).*

Annual Revenue Results (millions)

	10-023 [b]	10-024 [b]	Change
System-wide	$1,209	$1,439	+19%
Interregional	$1,209	$1,421	+18%
Intraregional Bay Area	$0	$18	

[b] Excludes revenue from Amtrak-only passengers.

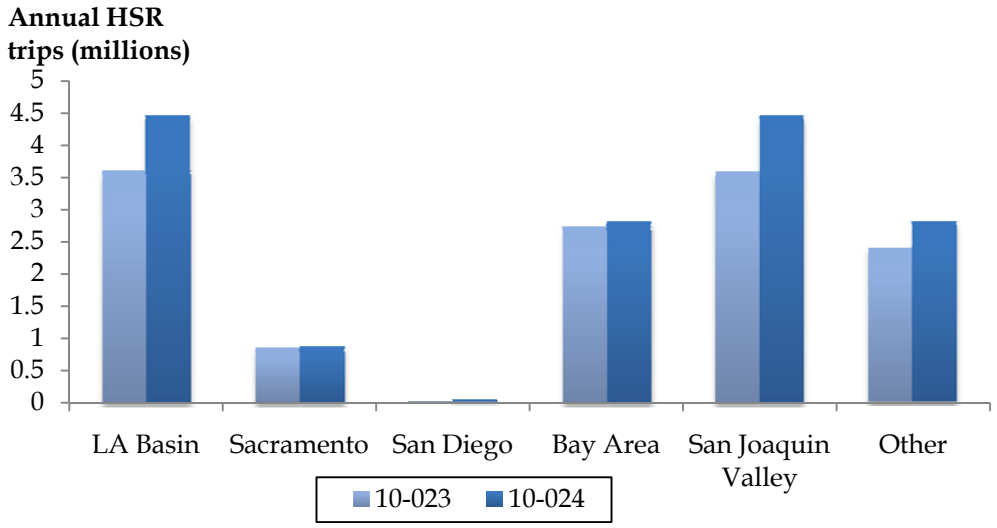
Summary Notes

- **Compared to Run 10-023 –** HSR service is extended to San Fernando Valley and peak period frequency is increased from two TPH to three TPH. Feeder coach services to LA Basin destinations are offered from San Fernando and coach fare is reduced from $20 to $10. Coach service to Burbank Airport and LA Union Station is increased from two to three BPH in the peak period and from one to two BPH in the off-peak period.

- **Service extension and frequency increase drive gains –** The increase in interregional HSR travel is due in large part to the extension of HSR service into San Fernando Valley. The extension generates an increase in travel in the LA Basin-Bay Area (four percent), and LA Basin-San Joaquin Valley (57 percent) markets. HSR travel within the San Joaquin Valley increases by eight percent due to improved peak period HSR service frequency. The extension to San Fernando also contributes to a 35 percent increase in HSR trips between the Bay Area and San Diego.

- **Annual sources of HSR ridership by origin –** Figure 3 shows the HSR ridership by origin region for the two runs. Ridership slightly increases in every region, but San Joaquin Valley trip origins increase at the greatest rate (over 19 percent).

Figure 3. Annual Interregional HSR Ridership by Origin Region



Overall Findings Summary

- **Service extensions south into the San Fernando Valley boost ridership –** These runs demonstrate that, holding other factors constant, extending HSR service south from Bakersfield or Palmdale into the San Fernando Valley has a significant postitive effect on interregional HSR ridership, particularly in long-distance trips between the LA Basin and points north.

- **Increasing HSR service frequency offsets the adverse effect of split Amtrak and HSR stations in Fresno –** While the split Amtrak and HSR stations in Fresno has an adverse effect on ridership levels, run 10-021 demonstrates increasing peak HSR frequency from one to two trains per hour can more than offset these impacts.

- **Extending the northern HSR terminus to Merced contributes to greater interregional ridership –** Setting the northern transfer point to Amtrak at Merced not only provides HSR access farther north in the San Joaquin Valley, it also eliminates the additional negative impact of split Fresno Amtrak and HSR stations on passengers transferring between Amtrak feeder service and HSR in the northern end of the system.

Table 1. Annual Region-to-Region Ridership and Revenue
All Revenue Information in 2010 Dollars

Market	Total Market Trips (millions)	10-012 – Fresno to San Fernando Scenario		10-021 – Fresno to San Fernando (Split Fresno Station) Scenario		10-024 – Merced to San Fernando Scenario	
		HSR Ridership (millions)	HSR Revenue (millions)	HSR Ridership (millions)	HSR Revenue (millions)	HSR Ridership (millions)	HSR Revenue (millions)
LA Basin – Sacramento	8	1.0	$95	0.9	$101	1.3	$148
LA Basin – San Diego	142	0.0	$0	0.0	$1	0.0	$1
LA Basin – Bay Area	22	2.3	$223	2.1	$236	3.3	$371
Sacramento – Bay Area	72	0.0	$0	0.0	$0	0.0	$0
San Diego – Sacramento	2	0.0	$0	0.0	$0	0.0	$0
San Diego – Bay Area	8	0.0	$1	0.0	$1	0.0	$3
Bay Area – San Joaquin Valley	71	1.2	$99	1.2	$105	2.2	$193
San Joaquin Valley – LA Basin	70	2.5	$175	3.2	$236	4.2	$322
Sacramento – San Joaquin Valley	22	0.2	$15	0.2	$16	0.4	$35
San Diego – San Joaquin Valley	0	0.0	$1	0.0	$1	0.0	$1
within Bay Area Peninsula	7,709	0.0	$0	0.0	$0	0.0	$0
within North LA Basin	8,691	1.0	$17	1.0	$18	1.0	$18
within South LA Basin	10,795	0.0	$0	0.0	$0	0.0	$0
North LA – South LA	2,952	0.0	$0	0.0	$0	0.0	$0
within San Diego region	8,277	0.0	$0	0.0	$0	0.0	$0
within San Joaquin Valley	6,338	0.3	$16	0.4	$24	1.1	$57
Other	7,346	1.9	$175	1.9	$193	2.8	$291
Total	**52,527**	**10.4**	**$817**	**10.9**	**$930**	**16.4**	**$1,439**
within entire LA Basin	22,438	1.0	$17	1.0	$18	1.0	$18
Total between regions	**910**	**9.4**	**$801**	**9.9**	**$912**	**15.4**	**$1,421**

Note: Figures exclude Amtrak-only passengers.

Appendix – Operating Plans

10-012 – Fresno to San Fernando Scenario

Initial Operating Segment (IOS) with one TPH between Fresno and San Fernando, with bus/train connections to the Bay Area, Sacramento, and the LA Basin.

IOS 1TPH between Fresno and Palmdale, with bus or train connections to the Bay Area, Sacramento, and LA Basin

6 Peak Hours

Pattern#	1A
Frequency of service (mins)	60
San Francisco (bus)	0
Oakland	
Emeryville	30
# of buses	6

Transfer Time @ Emeryville 10

Pattern#	1	2	3
Frequency of service (mins)	60	60	60
Oakland	0		
Emeryville	10		
Richmond	19		
Martinez	49		
Antioch	69		
Stockton	107		
San Jose (bus)		0	
Sacramento			0
Lodi			28
Stockton			45
Modesto			79
Denair/Turlock			92
Merced	135		121
Madera	163		149
Fresno	199	195	185
# of buses/CVR	6	6	6

Transfer Time @ Fresno 15 15 15

Pattern#	1
Frequency of service (mins)	60
Fresno	0
Visalia	15
Bakersfield	45
Palmdale	79
San Fernando	102
# of trains	6

Transfer Time @ San Fernando 15 15 15

Pattern#	1	2	3
Frequency of service (mins)	60	60	60
San Fernando (bus)	0	0	0
Burbank Airport (bus)	17		
Los Angeles Union Station (bus)	42		
Van Nuys (bus)		17	
West Los Angeles (bus)		37	
Santa Anita (bus)			40
# of buses	6	6	6

Includes dwell and 3.5% recovery time
Where timetable shows separate arrival and departure times, midpoint of dwell shown

10 Off Peak Hours

Pattern#	1A
Frequency of service (mins)	60
San Francisco (bus)	0
Oakland	
Emeryville	30
# of buses	10

Transfer Time @ Emeryville 10

Pattern#	1	2	3
Frequency of service (mins)	60	60	60
Oakland	0		
Emeryville	10		
Richmond	19		
Martinez	49		
Antioch	69		
Stockton	107		
San Jose (bus)		0	
Sacramento			0
Lodi			28
Stockton			45
Modesto			79
Denair/Turlock			92
Merced	135		121
Madera	163		149
Fresno	199	180	185
# of buses/CVR	10	10	10

Transfer Time @ Fresno 15 15 15

Pattern#	1
Frequency of service (mins)	60
Fresno	0
Visalia	15
Bakersfield	45
Palmdale	79
San Fernando	102
# of trains	10

Transfer Time @ San Fernando 15 15

Pattern#	1	2
Frequency of service (mins)	60	60
San Fernando (bus)	0	0
Burbank Airport (bus)	17	
Los Angeles Union Station (bus)	42	
Van Nuys (bus)		17
West Los Angeles (bus)		37
Santa Anita (bus)		
# of buses	10	10

Includes dwell and 3.5% recovery time
Where timetable shows separate arrival and departure times, midpoint of dwell shown

10-021 – Fresno to San Fernando (Split Fresno Station) Scenario

IOS with two TPH between Fresno and San Fernando, with bus/train connections to the Bay Area, Sacramento, and the LA Basin. Split Amtrak/HSR stations in Fresno.

IOS 2TPH between Fresno and San Fernando, with bus or train connections to the Bay Area, Sacramento, and LA Basin

6 Peak Hours

Pattern#	1A
Frequency of service (mins)	60
San Francisco (bus)	0
Oakland	
Emeryville	30
# of buses	6

Transfer Time @ Emeryville 10

Pattern#	1	2	3
Frequency of service (mins)	60	60	60
Oakland	0		
Emeryville	10		
Richmond	19		
Martinez	49		
Antioch	69		
Stockton	107		
San Jose (bus)		0	
Sacramento			0
Lodi			28
Stockton			45
Modesto			79
Denair/Turlock			92
Merced	135		121
Madera	163		149
Fresno	199	195	185
# of buses/CVR	6	6	6

Transfer Time @ Fresno 30

Pattern#	1
Frequency of service (mins)	30
Fresno	0
Visalia	15
Bakersfield	45
Palmdale	79
San Fernando	102
# of trains	6

Transfer Time @ San Fernando 15

Pattern#	1	2	3
Frequency of service (mins)	30	60	60
San Fernando (bus)	0	0	0
Burbank Airport (bus)	17		
Los Angeles Union Station (bus)	42		
Van Nuys (bus)		17	
West Los Angeles (bus)		37	
Santa Anita (bus)			40
# of buses	6	6	6

Includes dwell and 3.5% recovery time
Where timetable shows separate arrival and departure times, midpoint of dwell shown

10 Off Peak Hours

Pattern#	1A
Frequency of service (mins)	60
San Francisco (bus)	0
Oakland	
Emeryville	30
# of buses	10

Transfer Time @ Emeryville 10

Pattern#	1	2	3
Frequency of service (mins)	60	60	60
Oakland	0		
Emeryville	10		
Richmond	19		
Martinez	49		
Antioch	69		
Stockton	107		
San Jose (bus)		0	
Sacramento			0
Lodi			28
Stockton			45
Modesto			79
Denair/Turlock			92
Merced	135		121
Madera	163		149
Fresno	199	180	185
# of buses/CVR	10	10	10

Transfer Time @ Fresno 30

Pattern#	1
Frequency of service (mins)	30
Fresno	0
Visalia	15
Bakersfield	45
Palmdale	79
San Fernando	102
# of trains	10

Transfer Time @ San Fernando 15

Pattern#	1	2	3
Frequency of service (mins)	60	60	60
San Fernando (bus)	0	0	0
Burbank Airport (bus)	17		
Los Angeles Union Station (bus)	42		
Van Nuys (bus)		17	
West Los Angeles (bus)		37	
Santa Anita (bus)			40
# of buses	10	10	10

Includes dwell and 3.5% recovery time
Where timetable shows separate arrival and departure times, midpoint of dwell shown

10-024 – Merced to San Fernando Scenario

IOS with three TPH in peak period and two TPH in off-peak period from Merced to San Fernando, with train connections to the Bay Area and Sacramento, and bus connections to LA Basin destinations.

IOS 3TPH between Merced and San Fernando, with bus or train connections to the Bay Area, Sacramento, and LA Basin

6 Peak Hours

Pattern#	1A
Frequency of service (mins)	60
San Francisco (bus)	0
Oakland	
Emeryville	30
# of buses	6

Transfer Time @ Emeryville 10

Pattern#	1	2	3
Frequency of service (mins)	60	60	60
Oakland	0		
Emeryville	10		
Richmond	19		
Martinez	49		
Antioch	69		
Stockton	107		
San Jose (bus)		0	
Sacramento			0
Lodi			28
Stockton			45
Modesto			79
Denair/Turlock			92
Merced	135	150	121
# of buses/CVR	6	6	6

Transfer Time @ Merced 10 15 10

Pattern#	1	1
Frequency of service (mins)	30	60
Merced	0	0
Fresno	23	23
Visalia	38	-
Bakersfield	68	63
Palmdale	102	97
San Fernando	125	120
# of trains	12	6

Transfer Time @ San Fernando 15

Pattern#	1	2	3
Frequency of service (mins)	20	30	30
San Fernando (bus)	0	0	0
Burbank Airport (bus)	17		
Los Angeles Union Station (bus)	42		
Van Nuys (bus)		17	
West Los Angeles (bus)		37	
Santa Anita (bus)			40
# of buses	18	12	12

Includes dwell and 3.5% recovery time
Where timetable shows separate arrival and departure times, midpoint of dwell shown

10 Off Peak Hours

Pattern#	1A
Frequency of service (mins)	60
San Francisco (bus)	0
Oakland	
Emeryville	30
# of buses	10

Transfer Time @ Emeryville 10

Pattern#	1	2	3
Frequency of service (mins)	60	60	60
Oakland	0		
Emeryville	10		
Richmond	19		
Martinez	49		
Antioch	69		
Stockton	107		
San Jose (bus)		0	
Sacramento			0
Lodi			28
Stockton			45
Modesto			79
Denair/Turlock			92
Merced	135	135	121
# of buses/CVR	10	10	10

Transfer Time @ Merced 10 15 10

Pattern#	1
Frequency of service (mins)	30
Merced	0
Fresno	23
Visalia	38
Bakersfield	68
Palmdale	102
San Fernando	125
# of trains	10

Transfer Time @ San Fernando 15

Pattern#	1	2	3
Frequency of service (mins)	30	60	60
San Fernando (bus)	0	0	0
Burbank Airport (bus)	17		
Los Angeles Union Station (bus)	42		
Van Nuys (bus)		17	
West Los Angeles (bus)		37	
Santa Anita (bus)			40
# of buses	10	10	10

Includes dwell and 3.5% recovery time
Where timetable shows separate arrival and departure times, midpoint of dwell shown

Memorandum

TO: Nick Brand

FROM: Rachel Copperman, Michael Snavely and Jeff Buxbaum

DATE: August 1, 2011

RE: HSR Ridership and Revenue 2030 Model Run (10-010)

This memorandum describes one high-speed rail (HSR) ridership and revenue model run initial operating segment (IOS) alternative with termini in San Jose and Los Angeles (LA). The scenario includes Caltrain connection service from the northern terminus to Bay Area destinations. Below is a summary description of this run:

- **10-010 – San Jose to Los Angeles Union Station Scenario –** 83 percent of average airfare; four peak train per hour (TPH); Caltrain connection from San Jose to San Francisco.

The next section summarizes the run's major findings. Refer to Table 1 for annual region-to-region ridership and revenue. Hourly operating plan details are provided in the Appendix.

Model Run Findings

10-010 – San Jose to Los Angeles Union Station Scenario

IOS with four peak TPH between San Jose and LA Union Station; Caltrain connections from San Jose to San Francisco treated as extensions of HSR service.

Objective

Test an IOS scenario connecting San Jose to LA Union Station with Caltrain feeder service to San Francisco. Compare results to run to 10-009: San Jose to Bakersfield.[1]

- HSR Stations: San Jose, Gilroy, Fresno, Visalia, Bakersfield, Palmdale, San Fernando, and LA Union Station.
- Hourly Peak HSR Trains: Four.
- Fares: 83 percent airfare on HSR; Original fare on Caltrain.

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[1] **10-009 San Jose to Bakersfield Scenario –** 83 percent of average airfare; 3 peak TPH; Caltrain service from San Jose to San Francisco; dedicated coach connection from Bakersfied to LA Basin. For details, see *HSR Ridership and Revenue 2030 Model Runs (10-006, 10-007, 10-009, and 10-022).*

Annual Ridership Results (millions)

	10-009 [a]	10-010 [a]	Change
System-wide	10.1	21.4	111%
Interregional	10.0	18.9	89%
Intraregional	0.1	2.5	24%

[a] Excludes ridership from Caltrain-only passengers.

Annual Revenue Results (millions)

	10-009 [b]	10-010 [b]	Change
System-wide	$705	$1,686	140%
Interregional	$702	$1,633	133%
Intraregional	$3	$53	1,667%

[b] Excludes revenue from Caltrain-only passengers.

Summary Notes

- **Compared to Run 10-009 –** HSR service is extended south from Bakersfield to LA Union Station, replacing the feeder coach connections to the SCAG region. The northern terminus remains at San Jose. Caltrain service connecting San Jose to San Francisco remains the same. HSR service frequency increases from 3 TPH to 4 TPH in the peak period, and from 2 TPH to 3 TPH in the offpeak period.

- **Service extensions south to LA Union Station and improvements in HSR service boost ridership –** The increase in interregional HSR travel is due in large part to an increase in HSR service between the LA Basin and the northern regions of the Central Valley and Bay Area due to the addition of the Palmdale, San Fernando, and LA destinations. Travel times between LA Union Station and points north decrease by approximately 78 minutes on average. The increase of 1 TPH in peak and offpeak hours also contributes to ridership growth.

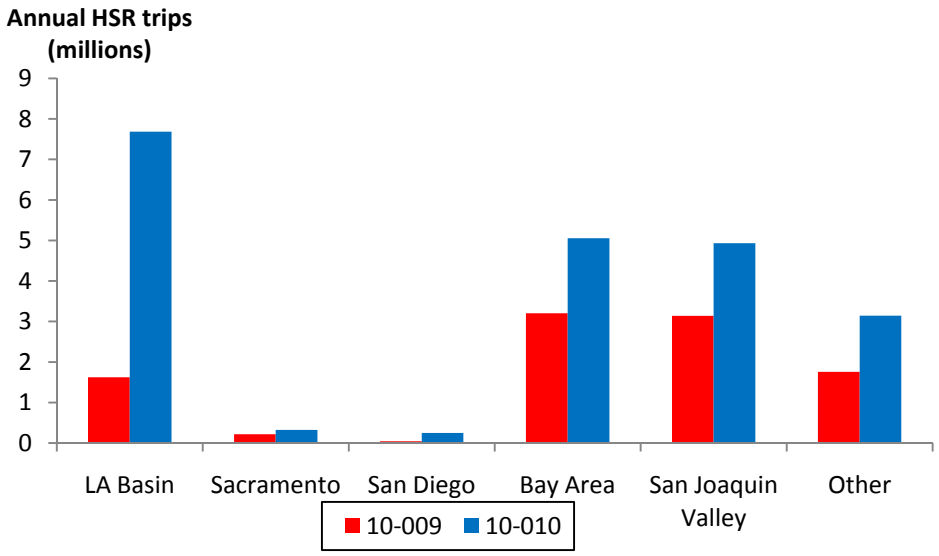
- **Market-to-Market Ridership Increases –** The greatest increase in interregional ridership occurs in the LA Basin-San Joaquin Valley market (432 percent), followed by San Diego-Bay Area (387 percent), San Diego-San Joaquin Valley (250 percent), and LA Basin-Bay Area (148 percent). These increases more than offset a decrease in ridership from the San Joaquin Valley to Sacramento, San Joaquin Valley to Bay Area, and within San Joaquin Valley due to a decrease in service frequency to Gilroy and Visalia.

The extension to LA Union Station also supports an additional 2.4 million intraregional HSR trips between Palmdale and LA Union Station annually.

- **Revenue increases -** Revenue increases at a greater rate than ridership due to higher fare values from the LA Basin to points north. Bus fare between LA Union Station and Bakersfield is $25 in run 10-009 compared to the $62 HSR fare between LA Union Station and Bakersfield.

- **Annual sources of HSR ridership by origin region –** Figure 1 shows HSR trips by origin region for the two runs. Figures exclude Caltrain-only passengers. Annual trips increase in all the regions with the exception of San Joaquin Valley.

Figure 1. Annual Interregional HSR Ridership by Origin Region



Overall Results

- **Extending HSR to LA Union Station increases ridership substantially**. Extending the southern terminus from Bakersfield to LA Union Station has a very significant positive impact on ridership, particularly in long-distance travel markets. The addition of another high speed train in peak and offpeak hours also contributes to a greater than 100 percent increase in ridership versus a San Jose to Bakersfield IOS.

- **Revenues increase at an even greater rate**. Since HSR fares between Bakersfield and LA Basin destinations are significantly greater than dedicated coach fares, growth in system-wide revenues outpaces ridership growth.

Table 1. Annual Region-to-Region Ridership and Revenue
All Revenue Information in 2010 Dollars

Market	Total Market Trips (millions)	10-009 San Jose to Bakersfield Scenario		10-010 San Jose to LA Union Station Scenario	
		HSR Ridership (millions)	HSR Revenues (millions)	HSR Ridership (millions)	HSR Revenues (millions)
LA Basin – Sacramento	8	0.2	$14	0.4	$43
LA Basin – San Diego	142	0.0	$0	0.1	$1
LA Basin – Bay Area	22	2.2	$182	5.4	$588
Sacramento – Bay Area	72	0.0	$0	0.0	$0
San Diego – Sacramento	2	0.0	$0	0.0	$0
San Diego – Bay Area	8	0.1	$7	0.4	$44
Bay Area – San Joaquin Valley	71	4.1	$307	4.0	$308
San Joaquin Valley – LA Basin	70	0.9	$61	4.7	$354
Sacramento – San Joaquin Valley	22	0.3	$21	0.3	$22
San Diego – San Joaquin Valley	0	0.0	$0	0.0	$2
within Bay Area Peninsula	7,708	0.1	$3	0.1	$3
within North LA Basin	8,691	0.0	$0	1.9	$39
within South LA Basin	10,795	0.0	$0	0.0	$0
North LA – South LA	2,952	0.0	$0	0.5	$11
within San Diego region	8,277	0.0	$0	0.0	$0
within San Joaquin Valley	6,338	0.5	$30	0.5	$30
Other	7,346	1.8	$79	3.1	$240
Total	**52,527**	**10.1**	**$705**	**21.4**	**$1,686**
within entire LA Basin	22,438	0	$0	2.4	$50
within entire Bay Area	7,708	0.1	$3	0.1	$3
Total between regions	14,036	10.0	$702	18.9	$1,633

Note: Figures exclude Caltrain-only passengers.

Appendix – Operating Plan

10-010 – San Jose to Los Angeles Union Station Scenario

Initial Operating Segment (IOS) with four TPH between San Jose and Los Angeles Union Station, with Caltrain connections to the Bay Area.

6 Peak Hours

Pattern#	10	20
Frequency of service (mins)	60	60
San Francisco	0	0
South San Francisco		
Millbrae	16	16
San Mateo	-	24
Hillsdale	24	-
Redwood City	-	33
Palo Alto	35	39
Mountain View	42	-
Sunnyvale	-	48
San Jose	57	59
# of trains	6	6

Transfer Time @ San Jose 10

	10	20	30	40
Frequency	60	60	60	60
Run times from start in minutes				
San Jose	0	0	0	0
Gilroy	15	15	18	18
Fresno	59	59	62	62
Visalia	69	69	72	78
Bakersfield	100	100	103	109
Palmdale	131	137	134	146
San Fernando	151	157	160	172
Los Angeles	166	172	175	187
# of Trains	6	6	6	6

10 Off Peak Hours

Pattern#	10	20
Frequency of service (mins)	60	60
San Francisco	0	0
South San Francisco		
Millbrae	16	16
San Mateo	-	24
Hillsdale	24	-
Redwood City	-	33
Palo Alto	35	39
Mountain View	42	-
Sunnyvale	-	48
San Jose	57	59
# of trains	10	10

Transfer Time @ San Jose 10

	10	20	30
Frequency	60	60	60
Run times from start in minutes			
San Jose	0	0	0
Gilroy	15	18	18
Fresno	59	62	62
Visalia	69	72	78
Bakersfield	100	103	109
Palmdale	137	134	146
San Fernando	157	160	172
Los Angeles	172	175	187
# of Trains	10	10	10

Memorandum

TO: Nick Brand

FROM: Rachel Copperman, Michael Snavely and Jeff Buxbaum

DATE: August 1, 2011

RE: HSR Ridership and Revenue 2030 Model Runs (10-008, 10-013, 10-014a, 10-014b, 10-015, 10-016)

This memorandum describes eight high-speed rail (HSR) ridership and revenue model Phase 1 operating segment alternatives between the Bay Area and Los Angeles (LA) Basin. Each alternative uses the same HSR operating system, but fares, other modal level-of-service characteristics, and socioeconomic forecasts are varied by run. Each run builds off of the previous run. Run 10-008 introduces a new Phase 1 operating plan and fare structure[1]; 10-013 reflects socioeconomic forecasts that account for the recent recession for three different forecast years (2020, 2030 and 2050); 10-014a updates the air operating plan and fares and revises HSR fares; 10-014b also updates conventional rail[2] operating plans and fares, and auto operating costs; and runs 10-015 and 10-016 examine the sensitivity of HSR ridership to air and HSR fares. Below is a summary description of the operating plan and fare systems of each run:

- **10-008 – Updated Operating Plan & HSR Fares Scenario –** 83 percent of average airfare; two peak (one offpeak) trains per hour (TPH) between San Francisco and Los Angeles, three peak (three offpeak) TPH between San Francisco and Anaheim, one peak (one offpeak) TPH between San Francisco and Merced, and one peak (one offpeak) TPH between Merced and Los Angeles; auto operating cost of 24 cents per mile.

- **10-013 (2030) – Updated Socioeconomic Forecasts Scenario –** 83 percent of average airfare; Operating plan as described in 10-008; Revised socioeconomic forecasts that account for the recent recession; auto operating cost of 24 cents per mile.

- **10-013 (2020) – Updated Socioeconomic Forecasts Scenario -** 83 percent of average airfare; Operating plan as described in 10-008; Socioeconomic forecasts that account for the recent recession; Auto travel times reflect 2020 conditions; auto operating cost of 24 cents per mile.

- **10-013 (2050) – Updated Socioeconomic Forecasts Scenario -** 83 percent of average airfare; Operating plan as described in 10-008; Socioeconomic forecasts that account for the recent recession; Auto travel times reflect 2050 conditions; auto operating cost of 24 cents per mile.

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[1] Compared to the May 2009 Operating Plan as revised with higher parking cost assumptions.
[2] Conventional rail modes include Amtrak, Altamont Commuter Express, Caltrain, and Metrolink

- **10-014a – Updated Air & HSR Fares Scenario -** 83 percent of average airfare, but capped at $72; operating plan as described in 10-008; revised socioeconomic forecasts used in 10-013; updated air operating plan and airfares based on current forecasts; auto operating cost of 24 cents per mile.

- **10-014b – Updated Conventional Rail Operation Plans & Auto Costs Scenario –** 83 percent of average airfare, but capped at $72; operating plan as described in 10-008; revised socioeconomic forecasts used in 10-013; air operating plan and fares as updated in 10-014a; updated air and conventional rail operating plans and fares based on current forecasts; auto operating cost of 25 cents per mile.

- **10-015 – 9 Percent Decrease in Airfares Scenario –** Operating plan and HSR fare structure as described in 10-008; revised socioeconomic forecasts used in 10-013; air operating plan as updated in 10-014a; conventional rail operating plans and fares as updated in 10-014b; decrease in airfare of nine percent compared to 10-014a airfare structure; auto operating cost of 25 cents per mile.

- **10-016 – 4.5 Percent Decrease in HSR Fare Cap Scenario –** Operating plan as described in 10-008; revised socioeconomic forecasts used in 10-013; air operating plan as updated in 10-014a; conventional rail operating plans and fares as updated in 10-014b; decrease in airfare of nine percent compared to 10-014a airfare structure; decrease in HSR fares by 4.5 percent for select station to station pairs; auto operating cost of 25 cents per mile.

The next section summarizes the major findings of each run. Refer to Table 1 and Table 2 for a comparison of the eight Phase 1 runs. Hourly operating plan details are provided in the Appendix.

Individual Model Run Findings

10-008 – Updated Operating Plan & HSR Fares Scenario

Phase 1 two peak (one offpeak) trains per hour (TPH) between San Francisco and LA, three peak (three offpeak) TPH between San Francisco and Anaheim, one peak (one offpeak) TPH between San Francisco and Merced, and one peak (one offpeak) TPH between Merced and LA. HSR Fare structure is 83 percent of average airfare. Auto operating cost is 24 cents per mile.

Objective

Test a new Phase 1 operating plan connecting San Francisco and Anaheim and new HSR fare structure at 83 percent of average airfare. Compare results to May 2009 Operating Plan Scenario.[3]

Annual Ridership Results (millions)

	May 2009 Operating Plan	10-008	Change
System-wide	54.5	31.6	-42%
Interregional	40.4	24.3	-40%
Intraregional	14.1	7.3	-49%

Annual Revenue Results (millions)

	May 2009 Operating Plan	10-008	Change
System-wide	$2,392	$2,234	-7%
Interregional	$2,232	$2,062	-8%
Intraregional	$160	$172	+1%

[3] **May 2009 Operating Plan Scenario** – Phase 1, 50 percent of average airfare; 6.5 peak (and 6 offpeak) HST per hour from SF Transbay to LA Basin; 1.5 peak (and 1 offpeak) HST per hour from SF Transbay to Merced; 1.5 peak (and 1 offpeak) HST per hour from Merced to Anaheim; includes higher parking cost assumption.

Summary Notes

- **Compared to May 2009 Operating Plan –** SF 4th & King and Visalia are added, San Fernando Valley replaces Sylmar and Burbank. Fares are increased from 50 percent to 83 percent of airfares. LA Basin fares are set to average of interregional and intraregional fares. Travel times are slowed on many lines to account for slower recovery time, slower speed curves, and longer dwell time at stations. Service frequency decreases between most station pairs.

- **Decrease in service frequency and increase in HSR fares reduce ridership –** The decrease in interregional HSR travel is due in large part to a decrease in HSR service frequencies between most station pairs, and HSR fare increases.

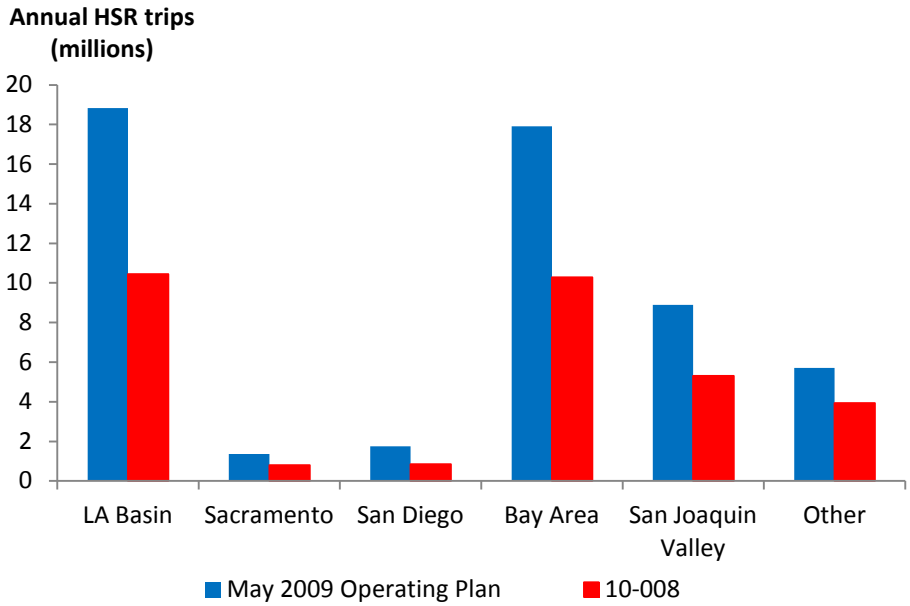
- **Market-to-Market ridership decreases –** The greatest decrease in interregional ridership occurs in the San Diego to Sacramento market (80 percent), followed by San Diego-San Joaquin (42 percent), and San Diego-Bay Area (54 percent). No market has an increase in ridership.

  Slower travel times, increased fares, and lower service frequencies also contribute to a 47 percent decrease in ridership within the Bay Area. These issues and the replacement of Sylmar and Burbank with San Fernando Valley station decreases ridership within the LA Basin by 52 percent.

- **Revenue declines by a smaller rate –** The smaller percentage decrease in revenue compared to ridership is due to an increase in HSR fares from 50 percent of airfares to 83 percent of airfares. Revenue for intra-regional LA Basin trips increases by 23 percent, due to higher fare schedules.

- **Annual sources of HSR ridership by origin region –** Figure 1 shows HSR trips by origin region for the two runs.

Figure 1. Annual Interregional HSR Ridership by Origin Region



10-013 (2030) – Updated Socioeconomic Forecasts Scenario

Identical to Run 10-008, but with revised socioeconomic input data that accounts for the recent recession.

Objective

Test a Phase I scenario with updated socioeconomic input data based on forecasts developed in 2011 that account for the recent recession, and examine the resulting change in HSR ridership and revenue.

Annual Ridership Results (millions)

	10-008	10-013 (2030)	Change
System-wide	31.6	31.9	+1%
Interregional	24.3	24.7	+1%
Intraregional	7.3	7.2	0%

Annual Revenue Results (millions)

	10-008	10-013 (2030)	Change
System-wide	$2,234	$2,253	+1%
Interregional	$2,062	$2,085	+1%
Intraregional	$172	$169	0%

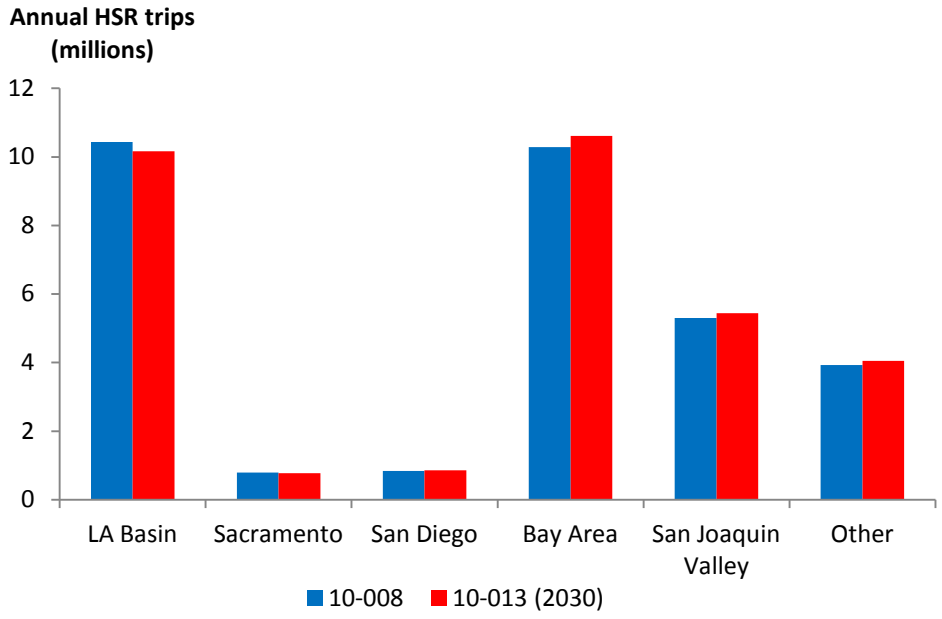
Summary Notes

- **Compared to Run 10-008 –** Underlying socioeconomic data was revised to account for the recent recession. Overall, revised 2030 households are 99 percent of prior 2030 forecasts; revised employment forecasts are 94 percent of prior levels.

- **New Geographic Distribution of Population and Employment Increases Ridership –** The growth in interregional HSR travel results from an increase in population within the Bay Area and coastal California, offsetting a decrease in population and employment in other parts of California. The greatest increase in interregional ridership occurs between the Bay Area and San Joaquin Valley (six percent).

- **Annual sources of HSR ridership –** Figure 2 shows HSR ridership by origin region for the two runs.

Figure 2. Annual Interregional HSR Ridership by Origin Region



10-013 (2020) – Updated Socioeconomic Forecasts Scenario

Identical to Run 10-013 (2030) (as described above), but with year 2020 socioeconomic input data and auto travel times that reflect 2020 forecasted congestion.

Objective

Test the impact of socioeconomic data using year 2020 socioeconomic input data and auto travel times.

Annual Ridership Results (millions)

	10-013 (2030)	10-013 (2020)	Change
System-wide	31.9	28.6	-10%
Interregional	24.7	21.3	-14%
Intraregional	7.2	7.3	0%

Annual Revenue Results (millions)

	10-013 (2030)	10-013 (2020)	Change
System-wide	$2,253	$1,970	-13%
Interregional	$2,085	$1,799	-14%
Intraregional	$169	$171	0%

Summary Notes

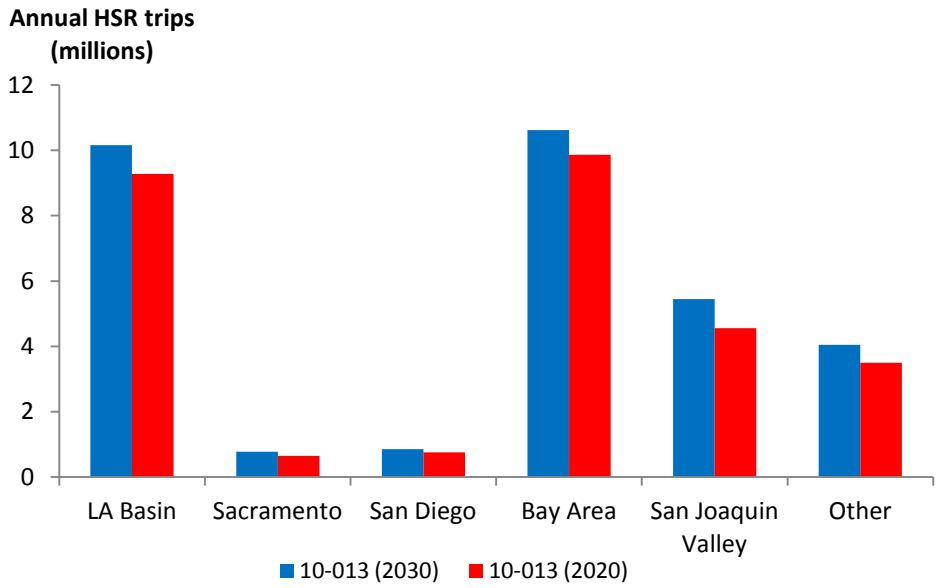
- **Compared to Run 10-013 (2030) –** The year 2020 household forecast is 91 percent of Run 10-13 (2030) forecasts, and the 2020 employment forecast is 90 percent of the 10-013 (2030) forecast. Auto congestion and travel times, are lower than year 2030, with the exception of intraregional Bay Area auto trips.

- **Lower population results in a decrease in total trips –** Total inter-regional trips are nine percent less in 2020 compared to 2030, which correlates with the population differences. Total trips within the Bay Area fall by eight percent, and total trips within the LA Basin fall by nine percent, also due to a smaller populations.

- **Lower auto congestion results in a greater decrease in HSR trips -** Interregional HSR ridership is 14 percent lower in 2020 compared to 2030 due to the greater attractiveness of auto modes given lower congestion levels. In contrast, Bay Area intraregional ridership rises by two percent due to greater auto congestion along the Peninsula in 2020.

- **Annual sources of HSR ridership by origin –** Figure 3 shows the HSR ridership by origin region for the two runs.

Figure 3. Annual Interregional HSR Ridership by Origin Region



10-013 (2050) – Updated Socioeconomic Forecasts Scenario

Identical to Run 10-013 (2030) (as described above), but with year 2050 socioeconomic input data and auto travel times that reflect 2050 forecasted congestion.

Objective

Test the impact of socioeconomic data using year 2050 socioeconomic input data and auto travel times.

Annual Ridership Results (millions)

	10-013 (2030)	10-013 (2050)	Change
System-wide	31.9	35.6	+12%
Interregional	24.7	28.5	+15%
Intraregional	7.2	7.1	0%

Annual Revenue Results (millions)

	10-013 (2030)	10-013 (2050)	Change
System-wide	$2,253	$2,574	+14%
Interregional	$2,085	$2,409	+16%
Intraregional	$169	$165	0%

Summary Notes

- **Compared to Run 10-013 (2030) –** The year 2050 household forecast is 112 percent of 2030 forecasts, and year 2050 employment is 123 percent of 2030 levels. Auto congestion and resulting auto travel times are higher than year 2030, with the exception of intraregional Bay Area trips.

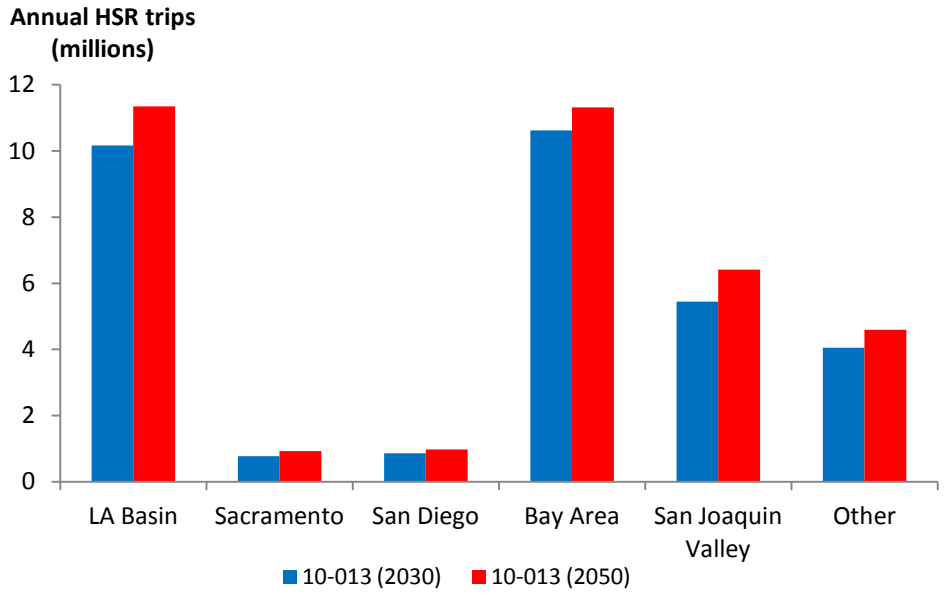
- **Increase in population results in an increase in total trips –** Total inter-regional trips is 13 percent higher in 2050 due to growth in the size of the travel market. Total trips within the Bay Area grow by 14 percent, while trips within the LA Basin grow by 12 percent.

- **Higher auto congestion results in a greater increase in HSR trips -** Interregional HSR ridership is 15 percent greater in 2050 due to longer auto travel times on more heavily congested roadways.

- **Changes in geographic distribution of population decreases ridership –** Within the Bay Area and LA Basin, HSR ridership decreases between 2030 and 2050 because population tends to shift away from locations near HSR stations in those regions.

- **Annual sources of HSR ridership by origin –** Figure 4 shows the HSR ridership by origin region for the two runs.

Figure 4. Annual Interregional HSR Ridership by Origin Region



10-014a – Updated Air & HSR Fares Scenario

Identical to Run 10-013 (2030), but with HSR fare capped at $72, and updated air operating plan and airfares based on current forecasts.

Objective

Test the impacts of a capped HSR fare structure and air operating plan and fare changes on HSR ridership and revenue. Compare results to run to Run 10-013 (2030).

Annual Ridership Results (millions)

	10-013 (2030)	10-014a	Change
System-wide	31.9	35.2	+10%
Interregional	24.7	27.8	+13%
Intraregional	7.3	7.3	0%

Annual Revenue Results (millions)

	10-013 (2030)	10-014a	Change
System-wide	$2,253	$2,198	-2%
Interregional	$2,085	$2,027	-3%
Intraregional	$173	$173	0%

Summary Notes

- **Compared to Run 10-013 (2030) –** Compared to Run 10-013, airfares and air headways were updated to reflect current forecasted conditions, resulting in a decrease in air service frequency between major airports. HSR fares were capped at $72, which had the impact of decreasing HSR fares for some station to station pairs).

- **Decrease in air service frequency and lower HSR fares increase ridership –** The increase in interregional HSR travel is due to the decrease in service frequency between major airports and lower HSR fares for several HSR station pairs. The largest increase in HSR ridership is seen for longer distance trips, which are most impacted by the HSR fare cap.

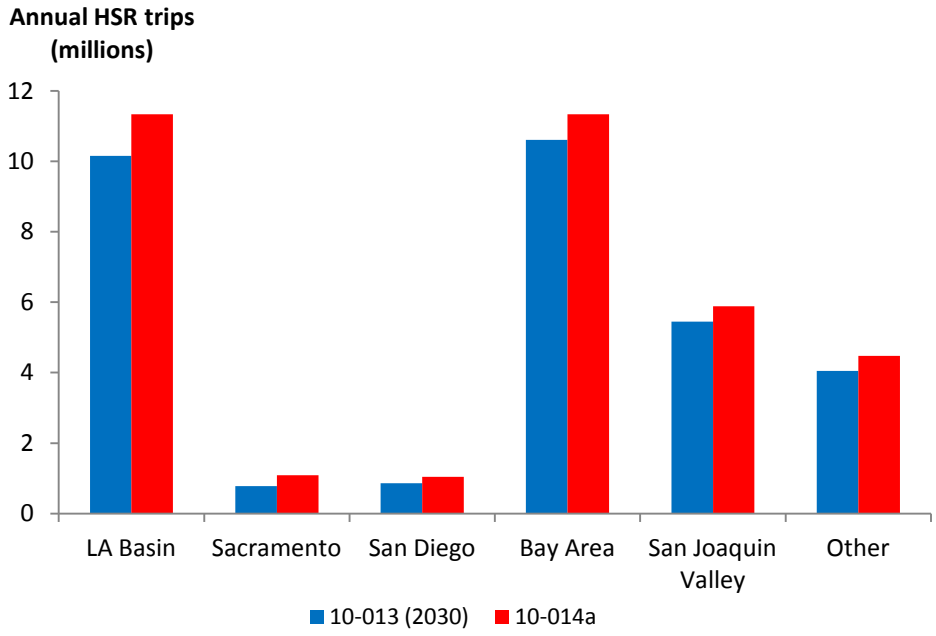
- **Market-to-Market ridership increases –** The greatest decrease in interregional ridership occurs in the San Diego to Sacramento market (200 percent), followed by LA Basin-Sacramento (48 percent), San Diego-San Joaquin Valley (25 percent) and San Diego-Bay Area (23 percent). No market has a decrease in ridership.

Intraregional travel within the Bay Area and the LA Basin were unaffected since intraregional air travel does not exist and HSR fares were lower than the $72 fare cap.

- **Revenues decrease slightly –** The slight decrease in revenue is due to the HSR fare cap, which yields a lower return on long-distance trips.

- **Annual sources of HSR ridership by origin –** Figure 5 shows HSR ridership by origin region for the two runs.

Figure 5. Annual Interregional HSR Ridership by Origin Region



10-014b – Updated Conventional Rail Operation Plans & Auto Costs Scenario

Identical to Run 10-014a, but with updated conventional rail operating plans and fares based on current forecasts. Auto operating costs increase from 24 cents per mile to 25 cents per mile based on revised fuel cost forecasts.

Objective

Test the impact of new conventional rail operating plans and fares and auto operating costs on HSR ridership in revenue. Compare results to run to Run 10-014a.

Annual Ridership Results (millions)

	10-014a	10-014b	Change
System-wide	35.2	37.1	+5%
Interregional	27.8	28.6	+3%
Intraregional	7.3	8.5	16%

Annual Revenue Results (millions)

	10-014a	10-014b	Change
System-wide	$2,198	$2,307	+5%
Interregional	$2,027	$2,108	+4%
Intraregional	$173	$199	+15%

Summary Notes

- **Compared to Run 10-014a –** Conventional rail fares and operating plans were updated to reflect current conditions and forecasts. Affected services included the Altamont Commuter Express (ACE), Caltrain, Metrolink, and Amtrak. Auto operating costs increased from 24 cents per mile to 25 cents per mile.

- **Conventional rail service changes and increased auto costs drive higher HSR ridership –** The increase in interregional HSR travel is due to lower conventional rail levels of service between long distance markets, as well as the higher cost of auto travel.

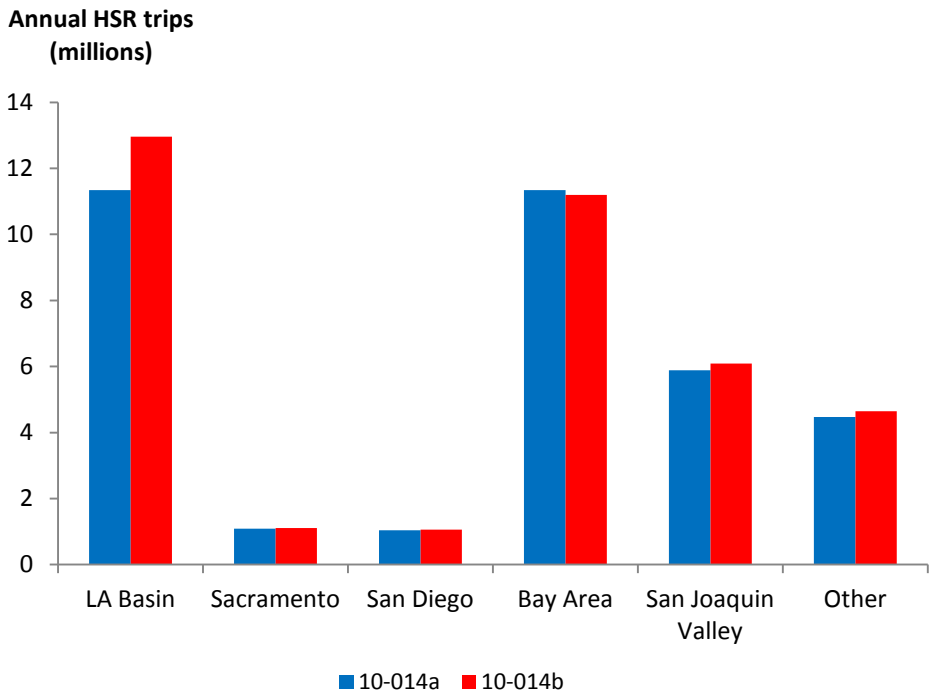
- **Market-to-Market ridership increases –** The greatest increase in interregional ridership occurs in the San Diego to San Joaquin Valley market (20 percent).

  Intraregional Bay Area ridership decreased by nine percent, due to Caltrain's improvements in level of service (including service frequency, stop locations, and fare patterns), which

increased Caltrain's attractiveness as a competitor. Intraregional LA Basin ridership increases by 39 percent, due in part to the increased HSR accessibility provided by higher conventional rail service frequencies.

- **Annual sources of HSR ridership by origin –** Figure 6 shows the HSR ridership by origin region for the two runs.

Figure 6. Annual Interregional HSR Ridership by Origin Region



10-015 – 9 Percent Decrease in Airfares Scenario

Identical to Run 10-014b, but airfares were reduced by nine percent between all airport pairs.

Objective

Test the sensitivity of HSR ridership if airfares are reduced by a factor of nine percent. Compare results to Run 10-014b.

Annual Ridership Results (millions)

	10-014b	10-015	Change
System-wide	37.1	36.2	-2%
Interregional	28.6	27.8	-3%
Intraregional	8.5	8.5	0%

Annual Revenue Results (millions)

	10-014b	10-015	Change
System-wide	$2,307	$2,239	-3%
Interregional	$2,108	$2,040	-3%
Intraregional Bay Area	$199	$199	0%

Summary Notes

- **Compared to Run 10-014b –** Airfares were reduced between all airport pairs by nine percent.

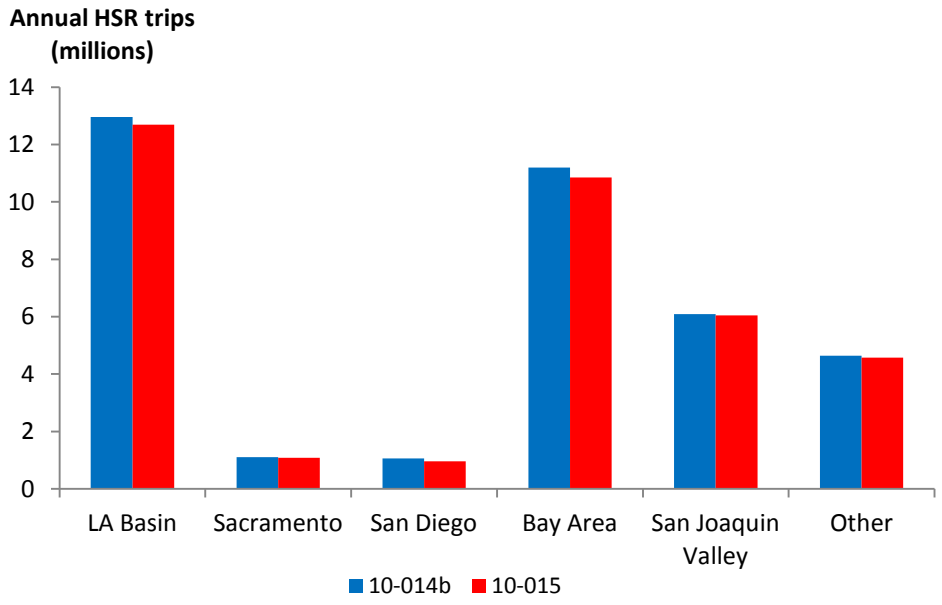
- **Reduction in airfare increases air ridership at the expense of HSR ridership –** Interregional air ridership increases by seven percent, due to the nine percent reduction in airfares. HSR shows the largest percentage decrease in ridership (three percent) compared to auto and conventional rail modes.

- **Market-to-Market ridership decreases –** The greatest decrease in interregional ridership occurs in the San Diego to Sacramento market (33 percent), followed by San Diego-San Joaquin Valley (17 percent), and San Diego-Bay Area (9 percent). No market shows an increase in ridership.

  Intraregional travel in the Bay Area and LA Basin markets were not affected since intraregional air travel does not exist in the model.

- **Annual sources of HSR ridership by origin –** Figure 7 shows HSR ridership by origin region for the two runs.

Figure 7. Annual Interregional HSR Ridership by Origin Region



10-016– 4.5 Percent Decrease in HSR Fare Cap Scenario

Identical to Run 10-015, but HSR fares are capped at $69 rather than $72.

Objective

Test the sensitivity of HSR ridership to a 4.5 percent reduction in the HSR fare cap. Compare results to Run 10-015.

Annual Ridership Results (millions)

	10-015	10-016	Change
System-wide	36.2	36.9	+2%
Interregional	27.8	28.5	+3%
Intraregional	8.5	8.5	0%

Annual Revenue Results (millions)

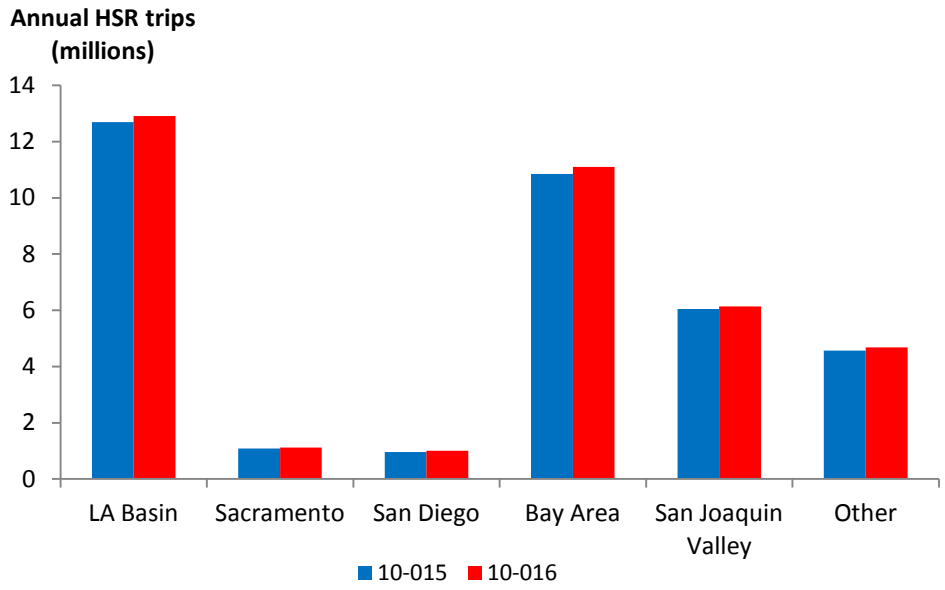
	10-015	10-016	Change
System-wide	$2,239	$2,230	~0%
Interregional	$2,040	$2,030	~0%
Intraregional Bay Area	$199	$199	0%

Summary Notes

- **Compared to Run 10-015 –** HSR fares were capped at $69, compared to $72 in Run 10-015.
- **Decrease in HSR fare cap increases interregional ridership –** The increase in interregional HSR travel is due to lower HSR fares for longer distance HSR station pairs. The largest increase in HSR ridership is observed in longer distance trips, which are affected by the cap in HSR fares.
- **Market-to-Market ridership increases –** The greatest increase in interregional ridership occurs in the San Diego to Sacramento market (nine percent), followed by San Diego-Bay Area (five percent), LA Basin – Bay Area (four percent), and LA Basin-Sacramento (three percent). No market has a decrease in ridership. Intraregional Bay Area and LA Basin markets were not affected since intraregional fares did not exceed the new fare cap.
- **Revenues remain relatively constant –** No net change in revenue results, since increases in HSR ridership are offset by decreased fare collection.

- **Annual sources of HSR ridership by origin –** Figure 8 shows the HSR ridership by origin region for the two runs.

Figure 8. Annual Interregional HSR Ridership by Origin Region



Overall Summary

- **Higher HSR fare assumptions and reduced service frequency result in significant ridership declines** – a restructured operating plan with lower service frequencies and higher fare assumptions results in ridership declines, though revenues decline at a lower rate due to higher fare capture.

- **Updated socioeconomic forecasts result in little net change in ridership and revenue due to population shifts** – though lower population and household growth is observed in forecasts updated to account for the economic downturn, a redistribution of population to the Bay Area from regions less accessible to HSR results in little net change in year 2030. Tests of year 2020 and 2050 socio-economc data and auto travel times suggest that HSR ridership and revenue responds positively to increases in roadway congestion.

- **HSR fare caps boost interregional ridership** – capping fares results in greater interregional ridership but negligible or negative revenue impacts due to lower fare capture. Intraregional trips are unaffected.

- **Higher auto operating costs result in a modest increase in ridership and revenue** – a one cent increase in auto operating costs yielded a five percent boost in HSR ridership and revenue.

- **HSR ridership is somewhat sensitive to responses in airfare price** – a nine percent reduction in airfares resulted in a two percent drop in both ridership and revenue.

Table 1. Year 2030 Annual Region-to-Region Ridership and Revenue
All Revenue Information in 2010 Dollars

Market	10-008 - Updated Operating Plan & HSR Fares		10-013 (2030) – Updated Socioeconomic Forecasts		10-013 (2020) – Updated Socioeconomic Forecasts		10-013 (2050) – Updated Socioeconomic Forecasts	
	HSR Ridership (millions)	HSR Revenue (millions)	HSR Ridership (millions)	HSR Ridership (millions)	HSR Ridership (millions)	HSR Revenue (millions)	HSR Ridership (millions)	HSR Revenue (millions)
LA Basin – Sacramento	1.2	$126	1.2	$121	1.0	$105	1.4	$142
LA Basin – San Diego	0.2	$5	0.1	$5	0.1	$4	0.2	$6
LA Basin – Bay Area	7.4	$761	7.4	$759	6.6	$671	8.4	$863
Sacramento – Bay Area	0.0	$0	0.0	$0	0.0	$0	0.0	$1
San Diego – Sacramento	0.0	$1	0.0	$1	0.0	$1	0.0	$2
San Diego – Bay Area	1.5	$155	1.5	$160	1.4	$144	1.7	$180
Bay Area – San Joaquin Valley	4.8	$359	5.1	$381	4.4	$330	5.6	$425
San Joaquin Valley – LA Basin	4.5	$322	4.4	$317	3.7	$261	5.4	$393
Sacramento – San Joaquin Valley	0.4	$29	0.4	$30	0.3	$22	0.5	$38
San Diego – San Joaquin Valley	0.0	$3	0.0	$3	0.0	$2	0.1	$3
within Bay Area Peninsula	3.5	$62	3.6	$65	3.7	$67	3.4	$61
within North LA Basin	1.6	$48	1.6	$47	1.6	$48	1.5	$43
within South LA Basin	0.3	$8	0.3	$7	0.3	$7	0.3	$9
North LA – South LA	1.9	$55	1.7	$49	1.7	$49	1.8	$52
within San Diego region	0.0	$0	0.0	$0	0.0	$0	0.0	$0
within San Joaquin Valley	0.5	$28	0.5	$29	0.4	$21	0.6	$38
Other	3.9	$273	4.1	$278	3.5	$238	4.6	$319
Total	**31.6**	**$2,234**	**31.9**	**$2,253**	**28.6**	**$1,970**	**35.6**	**$2,574**
within entire LA Basin	3.8	$110	3.6	$103	3.6	$104	3.7	$104
within entire MTC	3.5	$62	3.6	$65	3.7	$67	3.4	$61
Total between regions	24.3	$2,062	24.7	$2,085	21.3	$1,799	28.5	$2,409

Table 2. Year 2030 Annual Region-to-Region Ridership and Revenue
All Revenue Information in 2010 Dollars

Market	10-014a – Updated Air & HSR Fares		10-014b – Updated Conventional Rail Op Plans & Auto Costs		10-015 – 9 Percent Decrease in Airfares Scenario		10-016 – 4.5 Percent Decrease in HSR Fare Cap Scenario	
	HSR Ridership (millions)	HSR Revenue (millions)	HSR Ridership (millions)	HSR Ridership (millions)	HSR Ridership (millions)	HSR Revenue (millions)	HSR Ridership (millions)	HSR Revenue (millions)
LA Basin – Sacramento	1.7	$139	1.8	$143	1.7	$139	1.8	$138
LA Basin – San Diego	0.1	$5	0.1	$4	0.1	$4	0.1	$4
LA Basin – Bay Area	8.3	$670	8.5	$685	8.0	$647	8.3	$644
Sacramento – Bay Area	0.0	$0	0.0	$0	0.0	$0	0.0	$0
San Diego – Sacramento	0.0	$2	0.0	$2	0.0	$2	0.0	$2
San Diego – Bay Area	1.9	$151	1.9	$153	1.7	$139	1.8	$140
Bay Area – San Joaquin Valley	5.3	$382	5.5	$396	5.4	$393	5.5	$392
San Joaquin Valley – LA Basin	5.0	$351	5.2	$362	5.2	$359	5.2	$356
Sacramento – San Joaquin Valley	0.4	$32	0.4	$32	0.4	$32	0.4	$32
San Diego – San Joaquin Valley	0.1	$4	0.1	$4	0.1	$4	0.1	$4
within Bay Area Peninsula	3.6	$65	3.3	$59	3.3	$59	3.3	$59
within North LA Basin	1.6	$48	1.6	$44	1.6	$44	1.6	$44
within South LA Basin	0.3	$7	1.2	$28	1.2	$28	1.2	$28
North LA – South LA	1.8	$53	2.5	$67	2.5	$67	2.5	$67
within San Diego region	0.0	$0	0.0	$0	0.0	$0	0.0	$0
within San Joaquin Valley	0.5	$30	0.5	$32	0.5	$32	0.5	$31
Other	4.5	$284	4.6	$295	4.6	$289	4.7	$287
Total	**35.2**	**$2,224**	**37.1**	**$2,307**	**36.2**	**$2,239**	**37.0**	**$2,230**
within entire LA Basin	3.7	$108	5.2	$140	5.2	$140	5.2	$140
within entire MTC	3.6	$65	3.3	$59	3.3	$59	3.3	$59
Total between regions	27.8	$2,050	28.6	$2,108	27.8	$2,040	28.5	$2,030

Appendix – Operating Plan

All Runs

Phase 1 operating plan with 4 HST per hour from SF Transbay to LA Basin, 1 HST per hour from SF 4th & King to Anaheim (peak only), 1 HST per hour from SF Transbay to Merced, and 1 HST per hour from Merced to LA Union Station.

Phase 1 Test train patterns at 6 peak hours, one-way

	10	20	30	40*	50	60	70
Frequency	60	60	60	60	60	60	60
Run times from start in minutes							
San Francisco	0	0	0	0	0	0	
Millbrae	10	11	18	9	18	18	
Redwood City	15	17	33	21	24	24	
San Jose	25	35	51	39	42	35	
Gilroy	36	50	69	54	63	53	
Merced			108				0
Fresno	72	94		92	107	91	25
Visalia	81	104		102	117	110	35
Bakersfield	105	135		133	142	141	66
Palmdale	134	166		170	179	172	103
San Fernando	153	186		196	199	198	129
Los Angeles	160	201		211	214	213	144
Norwalk		216			229	228	
Anaheim		229			242	241	
# of Trains	6	6	6	6	6	6	6

* San Francisco stop at 4th and King Station

Phase 1 Test train patterns for 10 off-peak hours, one-way

	y	y	y	y	y	y
	15	25	35	55	65	75
Frequency	60	60	60	60	60	60
Run times from start in minutes						
San Francisco	0	0	0	0	0	
Millbrae	11	11	21	18	11	
Redwood City	17	17	33	30	17	
San Jose	28	35	51	48	35	
Gilroy	43	50	69	66	50	
Merced			108			0
Fresno	87	94		104	94	25
Visalia	97	104		114	113	35
Bakersfield	128	135		139	144	66
Palmdale	159	166		170	181	103
San Fernando	179	186		190	207	129
Los Angeles	194	201		205	222	144
Norwalk		216		220	237	
Anaheim		229		233	250	
# of Trains	6	6	6	6	6	6

xxx No Stop
xxx Stop
xxx 3 min. for overtakes

Memorandum

TO: Nick Brand

FROM: Michael Snavely, Jeff Buxbaum, and Roberto Alvarado

DATE: September 8, 2011

RE: HSR Ridership and Revenue 2030 Model Runs (11-026c; 11-030b; 11-031d)

This memorandum describes three high-speed rail (HSR) ridership and revenue model run alternatives with northern termini at San Jose and sothern termini at San Fernando or Bakersfield. Run 11-026c evaluates a segment between San Jose and San Fernando; run 11-030b evaluates the same extent but with one fewer peak train per hour; and run 11-031d tests the impact of relocating the southern terminus to Bakersfield from San Fernando. Below is a summary description of the operating plan and fare systems of each run:

- **11-026c – San Jose to San Fernando (5TPH) Scenario –** 83 percent of May 2011 average airfare; four peak trains per hour (TPH) between San Jose and San Fernando; one peak TPH between Merced and San Fernando; Caltrain connection from San Jose to San Francisco (SF) 4th & King; dedicated coach connections from Merced to Sacramento and from San Fernando to Los Angeles (LA) Basin destinations; auto operating cost of 25 cents per mile.

- **11-030b – San Jose to San Fernando (4 TPH) Scenario –** 83 percent of May 2011 average airfare; three peak TPH between San Jose and San Fernando; one peak TPH between Merced and San Fernando; Caltrain connection from San Jose to SF 4th & King; dedicated coach connections from Merced to Sacramento and SF Transbay, and from San Fernando to LA Basin destinations; auto operating cost of 25 cents per mile.

- **11-031d – San Jose to Bakersfield Scenario -** 83 percent of May 2001 average airfare; three peak TPH between San Jose and Bakersfield; one peak TPH between Merced and Bakersfield; Caltrain connection from San Jose to SF 4th & King; dedicated coach connections from Merced to Sacramento and SF Transbay, and from Bakersfield to LA Basin destinations; auto operating cost of 25 cents per mile.

The next section summarizes the major findings of each run. Refer to Table 1 for run result summaries. Hourly operating plan details are provided in the Appendix.

Individual Model Run Findings

11-026c – San Jose to San Fernando (5 TPH) Scenario

Scenario featuring four peak TPH between San Jose and San Fernando; one peak TPH from Merced to San Fernando; Caltrain connection between San Jose and SF 4th and King; dedicated coach service from Merced to Sacramento and from San Fernando to LA Basin destinations.

Objective

Compare results to run 10-014b.[1] Test the effect of relocating the northern terminus to San Jose (from San Francisco) and the southern terminus to San Fernando (from Anaheim).

Run Details:

- **HSR stations:** San Jose, Gilroy, Merced, Fresno, Visalia, Bakersfield, Palmdale, San Fernando.
- **Hourly peak HSR trains:** four between San Jose and San Fernando; one between Merced and San Fernando.
- **Fares:** 83 percent of May 2011 average airfare

Annual Ridership Results (millions)

	10-014b	11-026c	Change
System-wide	37.1	20.5	-45%
Interregional	28.6	20.0	-30%
Intraregional	8.5	0.4	-95%

[1] **10-014b – Updated Conventional Rail Operation Plans & Auto Costs Scenario –** 83 percent of average airfare, but capped at $72; operating plan as described in 10-008; revised socioeconomic forecasts used in 10-013; air operating plan and fares as updated in 10-014a; updated air and conventional rail operating plans and fares based on current forecasts; auto operating cost of 25 cents per mile. For details see *HSR Ridership and Revenue 2030 Model Runs (10-008, 10-013, 10-014a, 10-014b, 10-015, 10-016)*.

Annual Revenue Results (millions)

	10-014b	11-026c	Change
System-wide	$2,307	$1,505	-35%
Interregional	$2,108	$1,492	-29%
Intraregional	$199	$12	-94%

Summary Notes

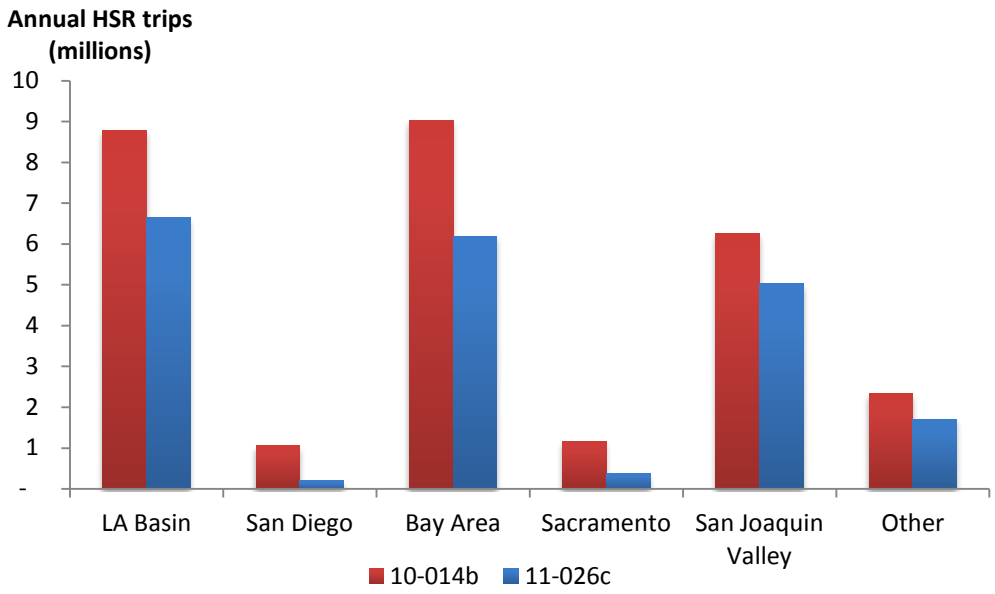
- **Compared to run 10-014b –**HSR operating segment was shortened from San Francisco to San Jose in the north and from Anaheim to San Fernando in the South. San Joaquin Amtrak service was eliminated and treated only as an access/egress mode on HSR. Caltrain lines are treated only as an access/egress mode on HSR. Dedicated coach services from Merced to Sacramento and from San Fernando to LA Basin destinations were added.

- **Elimination of HSR stations in Bay Area and LA Basin negatively affects interregional and intraregional travels –** The limited operating segment omits six HSR stations relative to run 10-014b (San Francisco, Millbrae, Redwood City, Los Angeles Union Station, Norwalk, and Anaheim), which reduces interregional ridership by 30 percent compared to the complete phase I system. HSR travel between the Bay Area and points south declines steeply since this travel now requires HSR passengers to transfer using Caltrain, resulting in longer travel times. Trips originating from San Diego and LA Basin to destinations north are also less attractive as they requires HSR passengers to transfer to dedicated coach services. LA Basin intraregional HSR ridership decreases by 92 percent, while Bay Area intraregional ridership decreases by 99 percent.

- **Market-to-market ridership decreases –** Interregional ridership decreases in all markets compared to a complete phase I system, with the greatest decreases occurring in the San Diego – Sacramento (93 percent), San Diego – Bay Area (83 percent), and San Diego – LA Basin (75 percent) markets.

- **Ridership decreases across all regions –** Figure 1 shows HSR trips by origin region for the two runs.

Figure 1. Annual Interregional HSR Ridership by Origin Region



11-030b – San Jose to San Fernando (4 TPH) Scenario

Scenario featuring three peak TPH between San Jose and San Fernando; one peak TPH between Merced and San Fernando; Caltrain connection between San Jose and SF 4th & King; dedicated coach connections from Merced to Sacramento and SF Transbay, and from San Fernando to LA Basin destinations.

Objective

Compare results to run 11-026c. Test the effect in ridership and revenue of reducing peak San Jose – San Fernando trains from four to three per hour but increasing the frequency of stops at Central Valley stations by 1 TPH, reducing peak LA Basin coach headways from 15 to 12 minutes, and adding a dedicated coach connection between Merced and the SF Transbay Terminal.

Run Details:

- **HSR stations:** San Jose, Gilroy, Merced, Fresno, Visalia, Bakersfield, Palmdale, San Fernando.
- **Hourly peak HSR trains:** three between San Jose and San Fernando; one between Merced and San Fernando.
- **Fares:** 83 percent of May 2011 average airfare

Annual Ridership Results (millions)

	11-026c	11-030b	Change
System-wide	20.5	20.6	+0.5%
Interregional	20.0	20.2	+1.0%
Intraregional	0.4	0.4	0%

Annual Revenue Results (millions)

	11-026c	11-030b	Change
System-wide	$1,505	$1,508	+0.2%
Interregional	$1,492	$1,496	+0.2%
Intraregional	$12	$13	+8%

Summary Notes

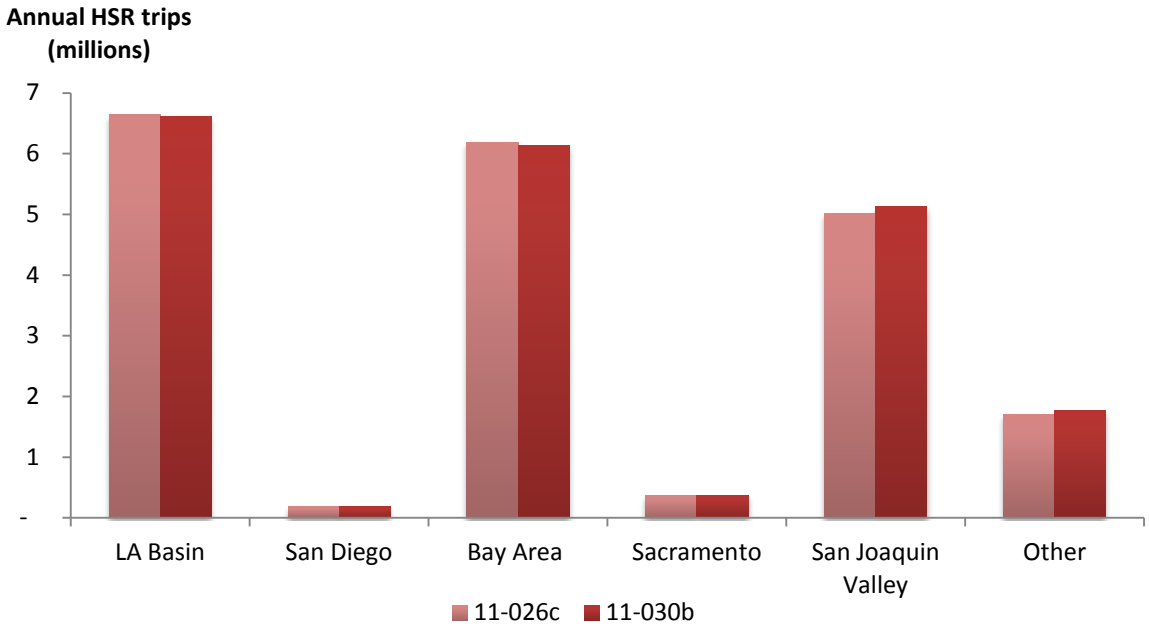
- **Compared to run 11-026c –**HSR operating plan was revised. HSR service frequency from San Jose to San Fernando was reduced from four peak TPH to three peak TPH. Dedicated coach connection between Merced and San Francisco was added. Peak headways on coach services were reduced from 15 to 12 minutes from San Fernando, and additional coach service to Los Angeles Union Station (LAUS) was added.

- **Service changes result in slightly higher ridership –** Although run 11-030b features one fewer peak train per hour between San Jose and San Fernando compared to run 11-026c, frequencies at Gilroy, Fresno, Visalia, Bakersfield, and Palmdale increase by one TPH during peak periods due to operating plan changes (see Appendix A for details). Higher service levels at these stations, when combined with a new dedicated feeder coach connection between Merced and San Francisco and reduced average travel times on coach services in the LA Basin region, more than compensate for the loss in ridership due to lower service frequencies between San Jose and San Fernando. These factors contribute to a one percent overall increase in interregional ridership.

  Intraregional HSR trips in the LA Basin remained constant while intraregional trips in the Bay Area increase 22 percent due to additional service options between San Jose and Gilroy.

- **Annual sources of HSR ridership –** Figure 2 shows HSR ridership by origin region for the two runs.

Figure 2. Annual Interregional HSR Ridership by Origin Region



11-031d – San Jose to Bakersfield Scenario

Scenario featuring three peak TPH between San Jose and Bakersfield; one peak TPH between Merced and Bakersfield; Caltrain connection between San Jose and SF 4th & King; dedicated coach connections from Merced to Sacramento and SF Transbay, and from Bakersfield to LA Basin destinations.

Objective

Test the impact of relocating the southern HSR terminus to Bakersfield from San Fernando. Compare results to run 11-030b.

Run Details:

- **HSR stations:** San Jose, Gilroy, Merced, Fresno, Visalia, Bakersfield.
- **Hourly peak HSR trains:** three between San Jose and Bakersfield; one between Merced and Bakersfield.
- **Fares:** 83 percent of May 2011 average airfare

Annual Ridership Results (millions)

	11-030b	11-031d	Change
System-wide	20.6	11.5	-44%
Interregional	20.2	11.4	-44%
Intraregional	0.4	0.03	-93%

Annual Revenue Results (millions)

	11-030b	11-031d	Change
System-wide	$1,508	$768	-49%
Interregional	$1,496	$768	-49%
Intraregional	$13	$0.5	-96%

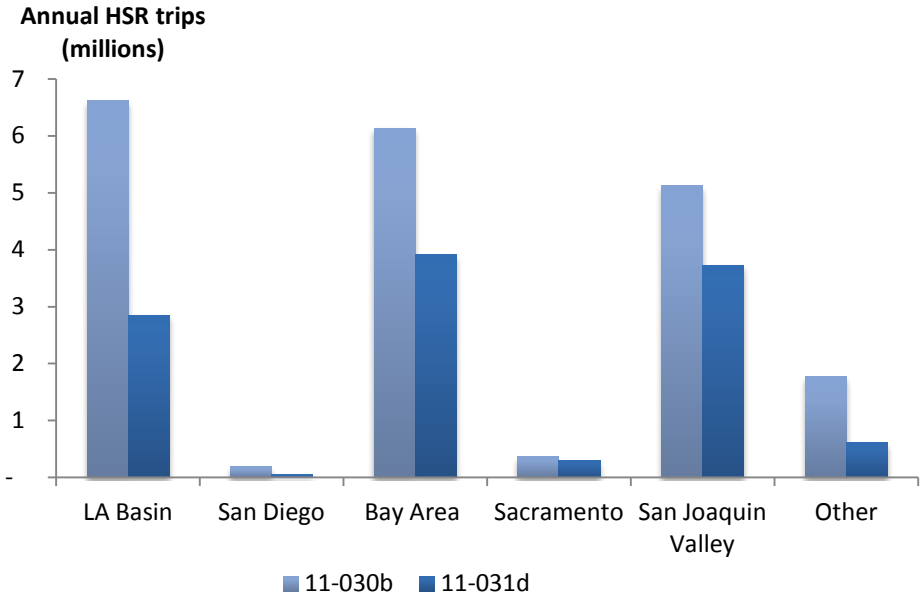
Summary Notes

- **Compared to Run 11-030b–** HSR operating plan service frequencies remained the same, but trains terminated at Bakersfield rather than San Fernando**.**

- **Relocation of HSR station to Bakersfield reduces ridership –** The elimination of HSR stations at Palmdale and San Fernando decreases interregional trips by 44 percent. This service reduction causes average travel times to LA Basin destinations to increase by more than 250 percent, making HSR a significantly less attractive option to affected passengers.

- **Market-to-market ridership decreases –** The greatest decreases in interregional ridership occur in the LA Basin – San Diego market (100 percent), followed by Bay Area – San Diego (76 percent) and LA Basin – San Joaquin Valley (60 percent). Figure 3 shows the HSR ridership by origin region for the two runs.

Figure 3. Annual Interregional HSR Ridership by Origin Region



Overall Summary

- **The San Jose – San Fernando operating segment is not a replacement for complete Phase I service –** Caltrain and dedicated coach feeder services cannot replace the convenience of direct HSR access points in the Bay Area and LA Basin**.**

- **Extending the southern terminus to San Fernando from Bakersfield improves ridership significantly –** A decline in ridership of over 40 percent is predicted due to the inconvenience caused by loss of station access at San Fernando and Palmdale stations alone.

- **Replacing express with local operating plans appears to be an adequate substitute for reducing a peak TPH in the San Jose – San Fernando segment.**. Interregional HSR travel in run 11-030b benefits from: (1) an additional train per hour at Gilroy, Fresno, Visalia, Bakersfield, and Palmdale stations; (2) a reduction in average coach travel times to LA Basin destinations; and (3) the additional coach service from Merced to SF (Transbay). Together, these factors more than compensate for the loss of a peak express train per hour from San Jose to San Fernando.

Table 1. Year 2030 Annual Region-to-Region Ridership and Revenue
All revenue information in 2010 dollars

Market	10-014b – San Francisco to Anaheim (Updated Conventional Rail Operation Plans & Auto Costs) Scenario		11-026c -- San Jose to San Fernando (5 TPH) Scenario		11-030b -- San Jose to San Fernando (4 TPH) Scenario		11-031d -- San Jose to Bakersfield Scenario	
	HSR Ridership (millions)	HSR Revenue (millions)	HSR Ridership (millions)	HSR Revenue (millions)	HSR Ridership (millions)	HSR Revenue (millions)	HSR Ridership (millions)	HSR Revenue (millions)
LA Basin – Sacramento	1.8	$143	0.5	$40	0.5	$40	0.4	$25
LA Basin – San Diego	0.1	$4	0.0	$1	0.0	$1	0.0	$0
LA Basin – Bay Area	8.5	$685	6.8	$553	6.7	$541	3.2	$240
Sacramento – Bay Area	0.0	$0	0.0	$0	0.0	$0	0.0	$0
San Diego – Sacramento	0.0	$2	0.0	$0	0.0	$0	0.0	$0
San Diego – Bay Area	1.9	$153	0.3	$26	0.3	$24	0.1	$5
Bay Area – San Joaquin Valley	5.5	$396	4.1	$292	4.1	$295	4.1	$286
San Joaquin Valley – LA Basin	5.2	$362	4.0	$281	4.0	$284	1.6	$99
Sacramento – San Joaquin Valley	0.4	$32	0.2	$11	0.2	$11	0.2	$10
San Diego – San Joaquin Valley	0.1	$4	0.0	$2	0.0	$2	0.0	$1
within Bay Area Peninsula	3.3	$59	0.0	$0	0.0	$1	0.0	$1
within North LA Basin	1.5	$44	0.4	$12	0.4	$12	0.0	$0
within South LA Basin	1.2	$28	0.0	$0	0.0	$0	0.0	$0
North LA – South LA	2.5	$67	0.0	$0	0.0	$0	0.0	$0
within San Diego region	0.0	$0	0.0	$0	0.0	$0	0.0	$0
within San Joaquin Valley	0.5	$32	0.7	$40	0.8	$43	0.6	$33
Other	4.6	$295	3.3	$247	3.5	$259	1.2	$68
Total	**37.1**	**$2,307**	**20.5**	**$1,505**	**20.6**	**$1,508**	**11.5**	**$768**
within entire LA Basin	5.2	$140	0.4	$12	0.4	$12	0.0	$0
within entire MTC	3.3	$59	0.0	$0	0.0	$1	0.03	$0.5
Total between regions	28.6	$2,108	20.0	$1,492	20.2	$1,500	11.4	$768

Appendix – Operating Plans

11-026c – San Jose to San Fernando (5 TPH) Scenario

Scenario featuring four peak trains per hour (TPH) between San Jose and San Fernando; one peak TPH between Merced and San Fernando; Caltrain connection from San Jose to San Francisco (SF) 4th & King; feeder coach connections from Merced to Sacramento and from San Fernando to LA Basin destinations

Bay to Basin Train Patterns for 6 peak hours, one-way

	20	40	50	60	70
Frequency	60	60	60	60	60
Run times from start in minutes					
San Jose	0	0	0	0	
Gilroy	15	15	18	18	
Merced					0
Fresno	59	53	62	56	25
Visalia	69	63	72	66	41
Bakersfield	100	88	97	97	72
Palmdale	131	119	128	134	109
San Fernando (at Sylmar)	153	141	150	156	131
# of Trains	6	6	6	6	6

* San Francisco stop at 4th and King Station

Bay to Basin Train Patterns for 10 off-peak hours, one-way

	y	y	y
	15	65	75
Frequency	60	60	60
minutes			
San Jose	0	35	
Gilroy	15	53	
Merced			0
Fresno	59	97	25
Visalia	69	107	41
Bakersfield	100	138	72
Palmdale	131	175	109
San Fernando (at Sylmar)	147	197	131
# of Trains	6	6	6

xxx	No Stop
xxx	Stop

11-030b – San Jose to San Fernando (4 TPH) Scenario

Scenario featuring three peak TPH between San Jose and San Fernando; one peak TPH between Merced and San Fernando; Caltrain connection from San Jose to SF 4th & King; dedicated feeder coach connections from Merced to Sacramento and SF Transbay, and from San Fernando to LA Basin destinations.

6 Peak Hours

Pattern#	1	2	3	3
Frequency of service (mins)	60	60	60	60
San Francisco	0			
Oakland	40			
Dublin Pleasanton BART	80			
Sacramento		0		
Stockton		60		
Modesto		120		
Denair/Turlock		155		
Merced	200	200		
San Francisco (4th and King)			0	0
Millbrae			16	16
San Mateo			-	24
Hillsdale			26	-
Redwood City			-	33
Palo Alto			37	39
Mountain View			44	-
Sunnyvale			-	48
San Jose			59	59
# of buses	6	6	6	6

Transfer Time @ San Jose or Merced 15 15 15 15

Pattern#	1	2	2
Frequency of service (mins)	60	30	60
San Jose	0	0	
Gilroy	18	18	
Merced	-	-	0
Fresno	62	62	25
Visalia	78	-	41
Bakersfield	109	103	72
Palmdale	146	140	109
San Fernando	168	162	131
# of trains	6	12	6

Transfer Time @ San Fernando 15 15 15

Pattern#	1	2	3
Frequency of service (mins)	15	20	20
San Fernando (bus)	0	0	0
Burbank Airport (bus)	12		
Los Angeles Union Station (bus)	37		
Van Nuys (bus)		12	
West Los Angeles (bus)		32	
Santa Anita (bus)			40
# of buses	24	18	18

Includes dwell and 7.5% recovery time

10 Off Peak Hours

Pattern#	1	2	3
Frequency of service (mins)	60	60	30
San Francisco	0		
Oakland	40		
Dublin Pleasanton BART	80		
Sacramento		0	
Stockton		60	
Modesto		120	
Denair/Turlock		155	
Merced	200	200	
San Francisco (4th and King)			0
Millbrae			16
San Mateo			24
Hillsdale			28
Redwood City			35
Palo Alto			41
Mountain View			48
Sunnyvale			53
San Jose			64
# of buses	10	10	20

Transfer Time @ San Jose or Merced 15 15 15

Pattern#	1	2	2
Frequency of service (mins)	60	60	60
San Jose	0	0	
Gilroy	18	18	
Merced	-	-	0
Fresno	62	62	25
Visalia	78	-	41
Bakersfield	109	103	72
Palmdale	146	140	109
San Fernando	168	162	131
# of trains	10	10	10

Transfer Time @ San Fernando 15 15 15

Pattern#	1	2
Frequency of service (mins)	20	30
San Fernando (bus)	0	0
Burbank Airport (bus)	12	
Los Angeles Union Station (bus)	37	
Van Nuys (bus)		17
West Los Angeles (bus)		37
Santa Anita (bus)		
# of buses	30	20

Includes dwell and 7.5% recovery time

11-031d – San Jose to Bakersfield Scenario

Scenario featuring three peak TPH between San Jose and Bakersfield; one peak TPH between Merced and Bakersfield; Caltrain connection from San Jose to SF 4th & King; dedicated feeder coach connections from Merced to Sacramento and SF Transbay, and from Bakersfield to LA Basin destinations

8 Peak Hours

Pattern#	1	2	3	3
Frequency of service (mins)	60	60	60	60
San Francisco	0			
Oakland	40			
Dublin Pleasanton BART	80			
Sacramento		0		
Stockton		60		
Modesto		120		
Denair/Turlock		155		
Merced	200	200		
San Francisco (4th and King)			0	0
Millbrae			16	16
San Mateo			-	24
Hillsdale			26	-
Redwood City			-	33
Palo Alto			37	39
Mountain View			44	-
Sunnyvale			-	48
San Jose			68	69
# of buses	6	6	6	6

Transfer Time @ San Jose or Merced	15	15	15	15

Pattern#	1	2	2
Frequency of service (mins)	60	30	60
San Jose	0	0	
Gilroy	18	18	
Merced	-	-	0
Fresno	62	62	25
Visalia	78	-	41
Bakersfield	105	99	68
# of trains	6	12	6

Transfer Time @ Bakersfield	15	15	15

Pattern#	1	2	3	3
Frequency of service (mins)	15	20	20	15
Bakersfield (bus)	0	0	0	0
Palmdale (bus)				60
San Fernando (bus)		115	115	
Burbank Airport (bus)	127			
Los Angeles Union Station (bus)	152			
Van Nuys (bus)		132		
West Los Angeles (bus)		152		
Santa Anita (bus)			155	
# of buses	24	18	18	24

Includes dwell and 7.5% recovery time

10 Off Peak Hours

Pattern#	1	2	3
Frequency of service (mins)	60	60	30
San Francisco	0		
Oakland	40		
Dublin Pleasanton BART	80		
Sacramento		0	
Stockton		60	
Modesto		120	
Denair/Turlock		155	
Merced	200	200	
San Francisco (4th and King)			0
Millbrae			16
San Mateo			24
Hillsdale			28
Redwood City			35
Palo Alto			41
Mountain View			48
Sunnyvale			53
San Jose			64
# of buses	10	10	20

Transfer Time @ San Jose or Merced	15	15	15

Pattern#	1	2	2
Frequency of service (mins)	60	60	60
San Jose	0	0	
Gilroy	18	18	
Merced	-	-	0
Fresno	62	62	25
Visalia	78	-	41
Bakersfield	105	99	68
# of trains	10	10	10

Transfer Time @ Bakersfield	15	15	15

Pattern#	1	2	2
Frequency of service (mins)	20	30	20
Bakersfield (bus)	0	0	0
Palmdale (bus)			60
San Fernando (bus)		115	
Burbank Airport (bus)	127		
Los Angeles Union Station (bus)	152		
Van Nuys (bus)		132	
West Los Angeles (bus)		152	
Santa Anita (bus)			
# of buses	30	20	30

Includes dwell and 7.5% recovery time

Memorandum

TO: Nick Brand

FROM: Michael Snavely, Roberto Alvarado, and Jeff Buxbaum

DATE: September 8, 2011

RE: HSR Ridership and Revenue 2030 Model Runs (11-027d, 11-028d)

This memorandum describes two high-speed rail (HSR) ridership and revenue model run scenario alternatives with northern termini at Merced and southern termini in Los Angeles County. Each scenario provides dedicated coach service from Merced to Bay Area and Sacramento destinations, and from the southern terminus to Los Angeles (LA) Basin destinations. Run 11-027d evaluates an operating segment from Merced to Palmdale; run 10-028d tests the impact of extending the southern terminus to San Fernando. Below is a summary description of the operating plans and fare systems of each run:

- **11-027d – Merced to Palmdale Scenario –** 83 percent of May 2011 average airfare; three peak trains per hour (TPH) between Merced and Palmdale; dedicated coach connections from Merced to Sacramento and the Bay Area, and from Palmdale to LA Basin destinations; auto operating cost of 25 cents per mile.

- **11-028d –Merced to San Fernando Scenario -** 83 percent of May 2001 average airfare; three peak TPH between Merced and San Fernando; dedicated coach connections from Merced to Sacramento and the Bay Area, and from San Fernando to LA Basin destinations; auto operating cost of 25 cents per mile.

The next section summarizes the major findings of each run. Refer to Table 1 for run result summaries. Hourly operating plan details are provided in the Appendix.

Individual Model Run Findings

11-027d – Merced to Palmdale Scenario

Scenario featuring three peak trains per hour (TPH) between Merced and Palmdale; dedicated feeder coach connections from Merced to Sacramento, San Francisco, and San Jose; and from Palmdale to LA Basin destinations.

Objective

Test the ridership and revenue impacts of a Merced – Palmdale operating segment. Compare ridership and revenue results to run 11-026c, which featured a San Jose – San Fernando segment.[1]

Run Details:

- **HSR stations:** Merced, Fresno, Visalia, Bakersfield, Palmdale
- **Hourly peak HSR trains:** three
- **Fares:** 83 percent of May 2011 average airfare

Annual Ridership Results (millions)

	11-026c	11-027d	Change
System-wide	20.5	10.8	-47%
Interregional	20.0	10.8	-46%
Intraregional	0.4	0	-100%

Annual Revenue Results (millions)

	11-026c	11-027d	Change
System-wide	$1,505	$783	-48%
Interregional	$1,492	$783	-48%
Intraregional	$12	$0	-100%

[1] **11-026c –San Jose to San Fernando (5 TPH) Scenario –** 83 percent of May 2011 average airfare; four peak TPH between San Jose and San Fernando; one peak TPH between Merced and San Fernando; Caltrain connection from San Jose to San Francisco (SF) 4th & King; dedicated coach connections from Merced to Sacramento and from San Fernando to Los Angeles (LA) Basin destinations. For more information, see *HSR Ridership and Revenue 2030 Model Runs (11-026c, 11-030b, 11-031d)*.

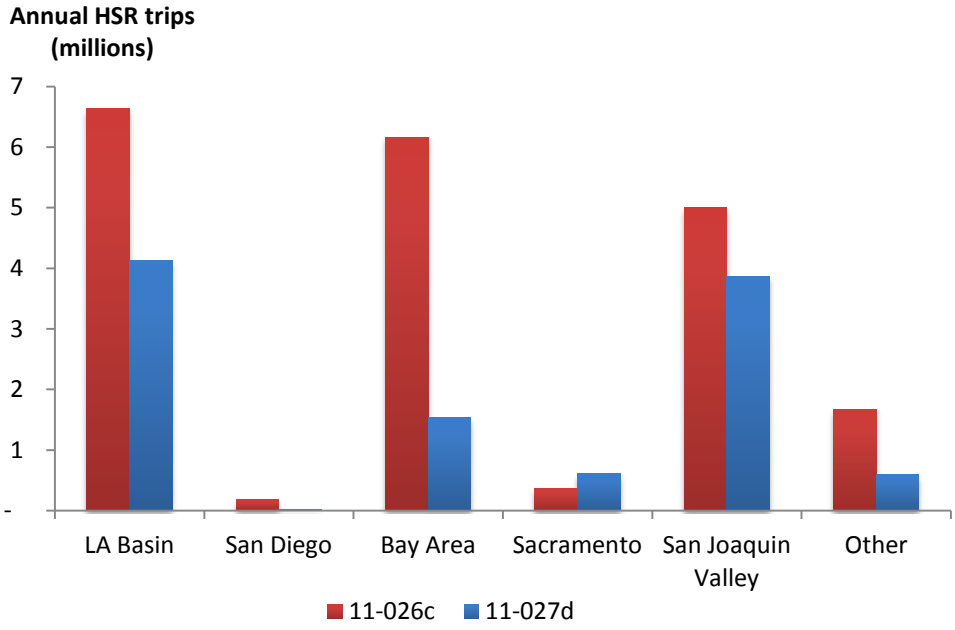
Summary Notes

- **Compared to run 11-026c –**HSR operating segment is shortened to Merced in the north and Palmdale in the south, eliminating San Jose, Gilroy, and San Fernando HSR station access points. In addition, HSR service frequency was reduced from five total peak TPH to three peak TPH.

- **Elimination of HSR stations and more limited service frequency reduce ridership –** The elimination of HSR access points at San Jose, Gilroy and San Fernando, and increases in average headways, reduce interregional ridership by 46 percent. Average travel times to/from the Bay Area increase by more than 100 percent, making longer HSR trips less attractive. Intraregional ridership in the Bay Area and LA Basin decreases by 100 percent due to these service reductions.

- **Ridership decreases across most regions –** Figure 1 shows HSR trips by origin region for the two runs. Trip origins from the Sacramento region increase 64 percent due to improvements in dedicated coach service frequency from Merced (run 11-026c features one 90 minute headways during peak hours while run 11-027d features 20 minute headways).

Figure 1. Annual Interregional HSR Ridership by Origin Region



11-028d – Merced to San Fernando Scenario

Scenario featuring three peak TPH between Merced and San Fernando; dedicated coach connections from Merced to Sacramento, San Francisco, and San Jose; and from San Fernando to LA Basin destinations.

Objective

Test the ridership and revenue impacts of extending the southern terminus from Palmdale to San Fernando. Compare results to run 11-027d.

Run Details:

- **HSR stations:** Merced, Fresno, Visalia, Bakersfield, Palmdale, San Fernando
- **Hourly peak HSR trains:** three
- **Fares:** 83 percent of May 2011 average airfare

Annual Ridership Results (millions)

	11-027d	11-028d	Change
System-wide	10.8	13.1	+21%
Interregional	10.8	12.7	+18%
Intraregional	0	0.4	

Annual Revenue Results (millions)

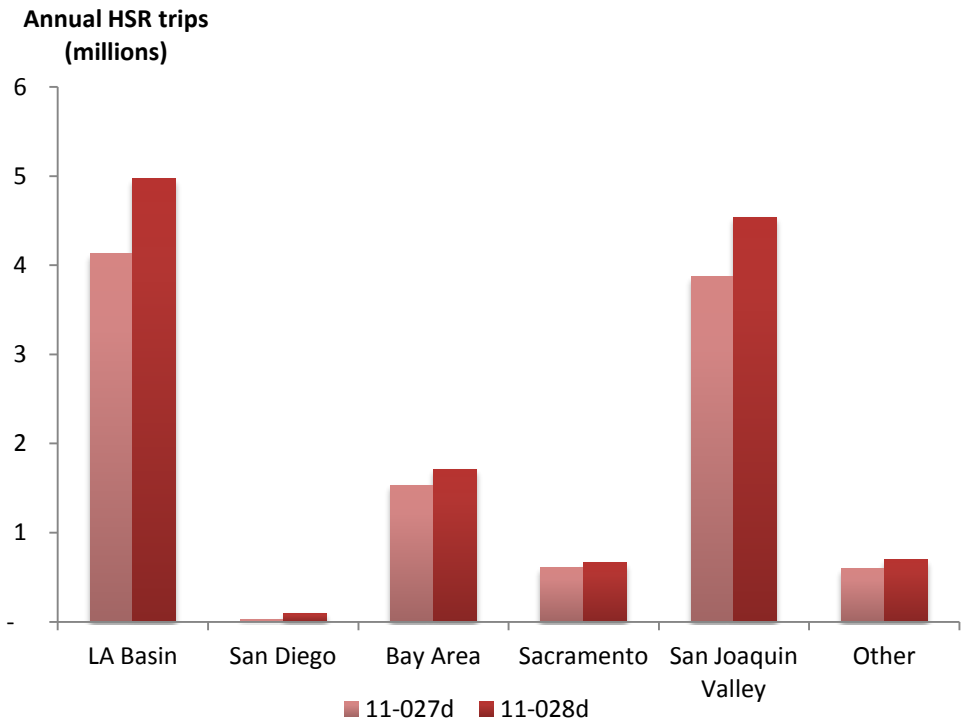
	11-027d	11-028d	Change
System-wide	$783	$929	+19%
Interregional	$783	$917	+17%
Intraregional	$0	$12	

Summary Notes

- **Compared to Run 11-027d –** The southern terminus is extended to San Fernando from Palmdale. HSR service frequency remains constant at three peak TPH.
- **HSR service extension boosts ridership –**Interregional ridership increases 18 percent due to the addition of the San Fernando station, which attracts additional HSR riders to and from the LA Basin and San Diego region.

- **Ridership increases across all regions –** Figure 2 shows HSR ridership by origin region for both runs. Ridership increases in every region.

Figure 2. Annual Interregional HSR Ridership by Origin Region



Overall Summary

- **Dedicated coach service is no substitute for HSR stations in the Bay Area –** Although San Jose and Gilroy HSR stations in the Bay Area are replaced with dedicated coach service from Merced to San Francisco and San Jose, average travel times increase by more than 100 percent, causing significant ridership and revenue reductions.

- **Extending service into the San Fernando Valley boosts ridership –** Run 11-028d demonstrates that, holding other factors constant, extending HSR service south from Palmdale to San Fernando has a significant positive effect on interregional HSR ridership, particularly in long-distance trips between Southern California and points north.

Table 1. Year 2030 Annual Region-to-Region Ridership and Revenue
All Revenue Information in 2010 Dollars

Market	11-026c San Jose to San Fernando (5 TPH) Scenario		11-027d Merced to Palmdale Scenario		11-028d Merced to San Fernando Scenario	
	HSR Ridership (millions)	HSR Revenue (millions)	HSR Ridership (millions)	HSR Revenue (millions)	HSR Ridership (millions)	HSR Revenue (millions)
LA Basin – Sacramento	0.5	$40	0.8	$61	0.9	$69
LA Basin – San Diego	0.0	$1	0.0	$0	0.0	$1
LA Basin – Bay Area	6.8	$553	2.2	$168	2.4	$188
Sacramento – Bay Area	0.0	$0	0.0	$0	0.0	$0
San Diego – Sacramento	0.0	$0	0.0	$0	0.0	$0
San Diego – Bay Area	0.3	$26	0.0	$2	0.1	$9
Bay Area – San Joaquin Valley	4.1	$292	0.8	$51	0.8	$51
San Joaquin Valley – LA Basin	4.0	$281	4.3	$326	5.6	$405
Sacramento – San Joaquin Valley	0.2	$11	0.4	$24	0.4	$24
San Diego – San Joaquin Valley	0.0	$2	0.0	$1	0.0	$2
within Bay Area Peninsula	0.0	$0	0.0	$0	0.0	$0
within North LA Basin	0.4	$12	0.0	$0	0.4	$12
within South LA Basin	0.0	$0	0.0	$0	0.0	$0
North LA – South LA	0.0	$0	0.0	$0	0.0	$0
within San Diego region	0.0	$0	0.0	$0	0.0	$0
within San Joaquin Valley	0.7	$40	1.1	$59	1.1	$59
Other	3.3	$251	1.2	$91	1.4	$107
Total	**20.5**	**$1,510**	**10.8**	**$783**	**13.1**	**$929**
within entire LA Basin	0.4	$12	0.0	$0	0.4	$12
within entire MTC	0.0	$0	0.0	$0	0.0	$0
Total between regions	20.0	$1,497	10.8	$783	12.7	$917

Appendix – Operating Plans

11-027d – Merced to Palmdale Scenario

Scenario featuring three peak TPH between Merced and Palmdale; dedicated coach connections from Merced to Sacramento and the Bay Area, and from Palmdale to LA Basin destinations.

8 Peak Hours

Pattern#	1	2	3
Frequency of service (mins)	20	20	20
San Francisco	0		
Oakland	40		
Dublin Pleasanton BART	80		
Sacramento		0	
Stockton		60	
Modesto		120	
Denair/Turlock		155	
San Jose			0
Gilroy			40
Merced	200	200	150
# of buses	18	18	18

Transfer Time @ Merced 15 15

Pattern#	1	2
Frequency of service (mins)	60	30
Merced	0	0
Fresno	25	25
Visalia	41	-
Bakersfield	72	66
Palmdale	105	99
# of trains	6	12

Transfer Time @ Palmdale 15 15 15

Pattern#	1	2	3
Frequency of service (mins)	20	30	30
Palmdale	0	0	0
San Fernando (bus)			60
Burbank Airport (bus)	72		
Los Angeles Union Station (bus)	97		
Van Nuys (bus)		72	
West Los Angeles (bus)		92	
Santa Anita (bus)			100
# of buses	18	12	12

Includes dwell and 7.5% recovery time

10 Off Peak Hours

Pattern#	1	2	3
Frequency of service (mins)	30	30	30
San Francisco	0		
Oakland	40		
Dublin Pleasanton BART	80		
Sacramento		0	
Stockton		60	
Modesto		120	
Denair/Turlock		155	
San Jose			0
Gilroy			40
Merced	200	200	150
# of buses	20	20	20

Transfer Time @ Merced 15 15

Pattern#	1	2
Frequency of service (mins)	60	60
Merced	0	0
Fresno	25	25
Visalia	41	-
Bakersfield	72	66
Palmdale	105	99
# of trains	10	10

Transfer Time @ Palmdale 15 15

Pattern#	1	2
Frequency of service (mins)	30	60
Palmdale	0	0
San Fernando (bus)		60
Burbank Airport (bus)	72	
Los Angeles Union Station (bus)	97	
Van Nuys (bus)		77
West Los Angeles (bus)		97
Santa Anita (bus)		
# of buses	20	10

Includes dwell and 7.5% recovery time

11-028d –Merced to San Fernando Scenario

Scenario featuring three peak TPH between Merced to San Fernando; dedicated coach connections from Merced to Sacramento and the Bay Area, and from San Fernando to LA Basin destinations.

8 Peak Hours

Pattern#	1	2	3
Frequency of service (mins)	20	20	20
San Francisco	0		
Oakland	40		
Dublin Pleasanton BART	80		
Sacramento		0	
Stockton		60	
Modesto		120	
Denair/Turlock		155	
San Jose			0
Gilroy			40
Merced	200	200	150
# of buses	18	18	18

Transfer Time @ Merced 15 15

Pattern#	1	2
Frequency of service (mins)	60	30
Merced	0	0
Fresno	25	25
Visalia	41	-
Bakersfield	72	66
Palmdale	109	103
San Fernando	131	125
# of trains	6	12

Transfer Time @ San Fernando 15 15 15

Pattern#	1	2	3
Frequency of service (mins)	20	30	30
San Fernando (bus)	0	0	0
Burbank Airport (bus)	12		
Los Angeles Union Station (bus)	37		
Van Nuys (bus)		12	
West Los Angeles (bus)		32	
Santa Anita (bus)			40
# of buses	18	12	12

Includes dwell and 7.5% recovery time

10 Off Peak Hours

Pattern#	1	2	3
Frequency of service (mins)	30	30	30
San Francisco	0		
Oakland	40		
Dublin Pleasanton BART	80		
Sacramento		0	
Stockton		60	
Modesto		120	
Denair/Turlock		155	
San Jose			0
Gilroy			40
Merced	200	200	150
# of buses	20	20	20

Transfer Time @ Merced 15 15

Pattern#	1	2
Frequency of service (mins)	60	60
Merced	0	0
Fresno	25	25
Visalia	41	-
Bakersfield	72	66
Palmdale	109	103
San Fernando	131	125
# of trains	10	10

Transfer Time @ San Fernando 15 15

Pattern#	1	2
Frequency of service (mins)	30	60
San Fernando (bus)	0	0
Burbank Airport (bus)	12	
Los Angeles Union Station (bus)	37	
Van Nuys (bus)		17
West Los Angeles (bus)		37
Santa Anita (bus)		
# of buses	20	10

Includes dwell and 7.5% recovery time

Memorandum

TO: Nick Brand

FROM: Jeff Buxbaum, Michael Snavely, David Kurth

DATE: September 7, 2011

RE: HSR Ridership and Revenue 2030 Model Run 11-017c

This memorandum describes the high-speed rail (HSR) ridership and revenue impacts of one Phase 1 operating system alternative featuring revised socioeconomic forecasts.. Run 11-017c is identical to run 10-014b[1] but underlying trip rate data is updated using a new socioeconomic (SE) data based on 2011 Moody's Economy.com forecasts. A summary of the run follows:

- **11-017c –Economy.com SE Data Scenario –** 83 percent of average airfare, but capped at a maximum of $72; operating plan is identical to 10-014b; socioeconomic forecast based on 2011 Moody's Economy.com SE data forecasts; auto operating cost of 25 cents per mile.

The next section summarizes the major findings of the model run. Refer to Table 1 for run result summary. Hourly operating plan detail is provided in the Appendix.

Model Run Finding

11-017c – Economy.com SE Data Scenario

Phase 1 operating system between San Francisco and Anaheim; four peak trains per hour (TPH) between San Francisco (SF) Transbay and Anaheim or LA Union Station (LAUS); one peak TPH between SF 4th & King and LAUS; one peak TPH between SF Transbay and Merced; and one peak TPH from Merced to LAUS.

Objective

Test the ridership and revenue impacts of revised socioeconomic data forecasts using 2011 Economy.com data. Compare results to run 10-014b.

Run Details

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[1] **10-014b – Updated Conventional Rail Operation Plans & Auto Costs Scenario –** 83 percent of average airfare, but capped at $72; operating plan as described in 10-008; revised socioeconomic forecasts used in 10-013; air operating plan and fares as updated in 10-014a; updated air and conventional rail operating plans and fares based on current forecasts; auto operating cost of 25 cents per mile. For details see *HSR Ridership and Revenue 2030 Model Runs (10-008, 10-013, 10-014a, 10-014b, 10-015, 10-016).*

- **HSR stations**: SF Transbay, SF 4th & King, Millbrae, Redwood City, San Jose, Gilroy, Merced, Fresno, Visalia, Bakersfield, Palmdale, San Fernando Valley, LA Union Station, Norwalk, Anaheim.

- **Hourly HSR trains**: seven total: five from SF to LAUS/Anaheim; one from SF to Merced; one from Merced to LAUS.

- **Fares**: 83 percent airfare on HSR, but capped at $72

Annual Ridership Results (millions)

	10-014b	11-017c	Change
System-wide	37.1	27.7	-25%
Interregional	28.6	21.3	-26%
Intraregional	8.5	6.4	-25%

Annual Revenue Results (millions)

	10-014b	11-017c	Change
System-wide	$2,307	$1,689	-27%
Interregional	$2,108	$1,532	-27%
Intraregional	$199	$156	-22%

Summary Notes

- **Compared to run 10-014b –** HSR stations and service frequency did not change between scenarios. Socioeconomic data was revised using 2011 Moody's Economy.com forecasts. Run 11-017c uses this data to update trip frequencies from the long-distance travel survey conducted by Cambridge Systematics to estimate interregional travel characteristics.[2]

- **Changes in socioeconomic data and trip rates reduce interregional ridership –** Interregional HSR ridership decrease by 26 percent due to revised SE forecasts and associated trip rates. The revised SE data resulted in slightly lower statewide household growth and significantly lower statewide employment growth compared to prior SE forecasts. Intraregional LA Basin and Bay Area ridership decrease by six percent and 54 percent, respectively.

[2] For details, see *California High Speed Rail Ridership and Revenue Forecasting Long Distance Interregional Travel Survey Results – Draft for August 10-11 Peer Review Panel Meeting.*

Interregional HSR ridership for business/commute purposes was significantly lower in run 11-017c than in 10-014b. This decrease is mostly due to limited employment growth, resulting in a large decrease in trip rates for both short (less than 100 miles) and long (over 100 miles) distance commute trips. Interregional HSR ridership in run 11-017c for recreation/other purposes was higher in the LA Basin, San Diego, and San Joaquin Valley regions due to higher trip rate survey estimates for these purposes. For long distance commute trips, trip rates were lower for recreation purposes but higher for other purposes.

- **Ridership decreases across most regions –** Figure 1 shows the HSR ridership by origin region for the two runs. Ridership from each region decreases except from San Diego. San Diego trip origins increase 37 percent due to (1) an increase in the number of households in this region and (2) an increase in short distance trip rates for recreation/other trips originating from this region.

Figure 1. Annual Interregional HSR Ridership by Origin Region

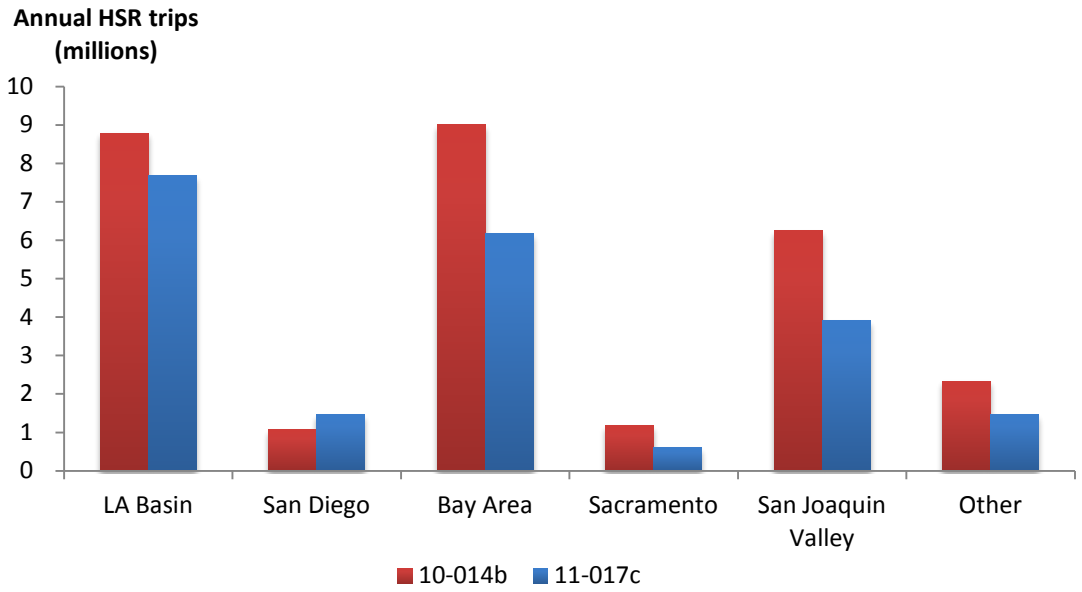

Table 1. Annual Region-to-Region Ridership and Revenue
All Revenue Information in 2010 Dollars

Market	10-014b – Updated Conventional Rail Op Plans & Auto Costs Scenario		11-017c – Economy.com SE Data Scenario	
	HSR Ridership (millions)	HSR Revenue (millions)	HSR Ridership (millions)	HSR Ridership (millions)
LA Basin – Sacramento	1.8	$143	1.1	$89
LA Basin – San Diego	0.1	$4	1.2	$39
LA Basin – Bay Area	8.5	$685	6.7	$540
Sacramento – Bay Area	0.0	$0	0.0	$0
San Diego – Sacramento	0.0	$2	0.0	$2
San Diego – Bay Area	1.9	$153	1.7	$139
Bay Area – San Joaquin Valley	5.5	$396	2.8	$197
San Joaquin Valley – LA Basin	5.2	$362	4.7	$319
Sacramento – San Joaquin Valley	0.4	$32	0.0	$4
San Diego – San Joaquin Valley	0.1	$4	0.0	$1
within Bay Area Peninsula	3.3	$59	1.5	$27
within North LA Basin	1.6	$44	1.5	$42
within South LA Basin	1.2	$28	1.0	$25
North LA – South LA	2.5	$67	2.4	$63
within San Diego region	0.0	$0	0.0	$0
within San Joaquin Valley	0.5	$32	0.1	$5
Other	4.6	$295	2.9	$198
Total	**37.1**	**$2,307**	**27.7**	**$1,689**
within entire LA Basin	5.2	$140	4.9	$130
within entire MTC	3.3	$59	1.5	$27
Total between regions	28.6	$2,108	21.3	$1,532

Appendix – Operating Plan

11-017c Economy.com SE Data Scenario

Phase 1 operating system between San Francisco and Anaheim; four peak trains per hour (TPH) between San Francisco (SF) Transbay and Anaheim or LA Union Station (LAUS); one peak TPH between SF 4th & King and LAUS; one peak TPH between SF Transbay and Merced; and one peak TPH from Merced to LAUS.

Phase 1 Test train patterns at 6 peak hours, one-way

	10	20	30	40*	50	60	70
Frequency	60	60	60	60	60	60	60
Run times from start in minutes							
San Francisco	0	0	0	0	0	0	
Millbrae	10	11	18	9	18	18	
Redwood City	15	17	**33**	21	24	24	
San Jose	25	35	51	39	42	35	
Gilroy	36	50	69	54	**63**	53	
Merced			108				0
Fresno	72	94		92	107	91	25
Visalia	81	104		102	117	**110**	35
Bakersfield	105	135		133	142	141	66
Palmdale	134	166		170	179	172	103
San Fernando	153	186		196	199	198	129
Los Angeles	160	201		211	214	213	144
Norwalk		216			229	228	
Anaheim		229			242	241	
# of Trains	6	6	6	6	6	6	6

* San Francisco stop at 4th and King Station

Phase 1 Test train patterns for 10 off-peak hours, one-way

	y	y	y	y	y	y
	15	25	35	55	65	75
Frequency	60	60	60	60	60	60
Run times from start in minutes						
San Francisco	0	0	0	0	0	
Millbrae	11	11	**21**	18	11	
Redwood City	17	17	33	30	17	
San Jose	28	35	51	48	35	
Gilroy	43	50	69	66	50	
Merced			108			0
Fresno	87	94		104	94	25
Visalia	97	104		114	**113**	35
Bakersfield	128	135		139	144	66
Palmdale	159	166		170	181	103
San Fernando	179	186		190	207	129
Los Angeles	194	201		205	222	144
Norwalk		216		220	237	
Anaheim		229		233	250	
# of Trains	6	6	6	6	6	6

xxx	No Stop	xxx	3 min. for overtakes
xxx	Stop		