RSG
the science of insight

Side-by-Side Peer Review Report

2.3.2021

Submitted to:
California High-Speed Rail Authority

Submitted by:
RSG

In Cooperation with:
LTK

55 Railroad Row
White River Junction, VT 05001
802.295.4999
www.rsginc.com

Table of Contents

List of Figures

List of Tables

List of Abbreviations

ACE	Altamont Corridor Express
CalSTA	California State Transportation Agency
CHSRA	California High-Speed Rail Authority
CVS	Central Valley Segment
DB	Deutsche Bahn Engineering & Consulting
ETO	Early Train Operator
HSR	High-Speed Rail
LOS	Level of Service
LOSSAN	Los Angeles – San Diego – San Luis Obispo Rail (Corridor)
MOU	Memorandum of Understanding
NorCal	Northern California
NTD	National Transit Database
O&M	Operations and Maintenance
RVM	Revenue Vehicle Mile
SBS	Side-by-Side
SCORE	Southern California Optimized Rail Expansion
SJ	San Joaquins
SoCal	Southern California
ZEV	Zero-Emission Vehicles

Executive Summary

In May 2019, the Board of the California High-Speed Rail Authority (CHSRA) tasked the Early Train Operator (ETO) with performing a side-by-side (SBS) study of a high-speed rail (HSR) service and its ridership, revenue, and operations on three stand-alone services.

Deutsche Bahn Engineering & Consulting ("DB") is working on the consulting phase of the ETO contract for this project and is a member of the ETO Team. This report, prepared by RSG, constitutes a peer review of the ETO Team's findings. Specifically, this report investigates whether the ETO Team properly conducted their ridership study and whether the results produced were reasonable.

RSG found no fatal flaws with the modeling work done by the ETO Team. The work applied the model appropriately. The work is based on a "high-level" ridership forecast to answer the questions asked as part of the SBS comparison study and is caveated accordingly. Moreover, the ridership estimates are within expected and published elasticity ranges for travel time and frequency with the exception of the Southern California (SoCal) corridor being higher than expected.

Additionally, RSG conducted a benchmarking review to compare the SBS ridership forecasts with other project examples from the United States and Europe. RSG had some difficulty locating examples that were analogous to the Central Valley Segment (CVS) situation but still found some comparisons. These comparisons demonstrated that HSR projects are highly complex and take a long time. Additionally, they are frequently completed in pieces, often with different speed trains running on the same track in a hybrid electrified system.

The CVS corridor, which includes the HSR service from Bakersfield to Merced and improvements in supporting Altamont Corridor Express (ACE) and San Joaquins rail and bus services, obtains the highest forecast gain in ridership and does so at the lowest increase in cost, relative to a "No Build" scenario. It also provides the largest gains in passenger miles traveled and lowest cost per passenger mile. However, over 75% of the gain in ridership in the CVS corridor is from trips that are *not* riding on the HSR system itself between Merced and Bakersfield.

Instead, these trips occur on trains or buses that are part of the significant new network of rail and bus service that serve the major areas of the northern Central Valley, including Oakland/Bay Area, San Jose, Sacramento, Stockton, and Merced. This new network will only be implemented with the introduction of the HSR service to improve connectivity by the regional rail operators.

The revenues from CVS HSR ridership (Bakersfield to Merced) will comprise roughly half the increase in revenues between the "Build" and "No Build" scenarios, even though the HSR segment will carry only about 25% of the increase in trips; however, these are longer trips, some using multiple services, and therefore pay higher fares on average per trip due to the longer distances.

The CVS corridor will go from the present relatively low level of service to an hourly network of HSR, ACE, and San Joaquins trains and supplemental buses. The Thruway Buses in the south serving Bakersfield also have increased frequency and will be extended to more destinations. ACE will go from weekday-only service to seven days per week. These service increases, along with the opening of the first truly HSR corridor in the nation, represent a major paradigm shift for the region's transportation alternatives. These changes represent an opportunity but also a risk.

Travel speeds in the HSR corridor between Bakersfield and Merced will increase significantly, reducing travel times for several major station pairs. These pairs include Bakersfield-Fresno and Bakersfield-Merced, which are completely in the corridor. This also affects trips to points north and west, including intercity markets such as Bakersfield-Sacramento, Fresno-Sacramento, Bakersfield-Oakland, and Fresno-Oakland.

Both speed and service will be improved, which should increase ridership, but there is the risk that potential riders will remain car-centric and not change their behavior. Forecasting what will happen due to a radical change is much less certain than forecasting incremental changes. The CVS "Build" scenario is a radical change.

Risk exists in the fact demand for the services may not materialize in the CVS as expected. However, this risk has more margin for error to still achieve the financial benefits as compared to the Northern California and Southern California corridors, which have higher costs and lower forecasted ridership and revenue.

Finally, there is some risk that the transportation services expected in the CVS "Build" scenario will not fully materialize. Again, this risk seems relatively low compared to the Northern California/SoCal corridors since there is much less need for additional regional funding in the "Build" scenario of the CVS relative to the other corridors. CHSRA is currently working with the relevant partners to sign a memorandum of understanding (MOU) to mitigate this potential risk.

1.0 Introduction

In May 2019, the Board of the California High-Speed Rail Authority (CHSRA) tasked the Early Train Operator (ETO) with performing a side-by-side (SBS) study of a high-speed rail (HSR) service and its ridership, revenue, and operations on three stand-alone services. Deutsche Bahn Engineering & Consulting ("DB") is working on the consulting phase of the Early Train Operator (ETO) contract and is a member of the ETO Team.

One service is in the Central Valley (called the California Valley Segment, or CVS), with HSR service between Merced and Bakersfield connecting to improved rail and bus services to Sacramento, Stockton, Oakland, and San Jose. Additionally, the CVS also has improved Thruway Bus services from the points south of Merced to Bakersfield and other HSR stations. The second service, called the Northern California (NorCal) corridor, is in the Bay Area and is the Caltrain system, between San Francisco's 4th Street/King Street Station and Gilroy. The third service is the Southern California (SoCal) corridor and comprises the Metrolink/Los Angeles – San Diego – San Luis Obispo Rail Corridor (LOSSAN Corridor) from Burbank to Anaheim in the Los Angeles region.

For the SBS study, the ETO Team, comprising DB staff and subconsultants, performed analyses to estimate ridership and farebox revenues as well as benefit and cost calculations.[1] The ETO Team, in consultation with stakeholders, decided during the CVS analysis in 2018/2019 to use the California State Rail Plan Model as the only readily available tool that was suitable to estimate ridership for short, stand-alone HSR corridors based on the SBS level of service (LOS) and other inputs described in the SBS report.

The ETO Team delivered the *California High-Speed Rail Early Train Operator Side-by-Side Study Quantitative Report*[2] in February 2020. The report reaffirmed the original recommendation from the CHSRA to invest in the CVS. The report also included findings from another study that reviewed the SBS conclusions, which was conducted by KPMG. KPMG's report is an expanded business case study that was prepared with input and feedback from the California State Transportation Agency (CalSTA), San Joaquin, and Altamont Corridor Express (ACE).[3]

After reviewing the SBS report and the KPMG report, the Legislature requested that additional analysis be undertaken to confirm the reasonableness of the ridership forecasts in these documents. This report, prepared by RSG, constitutes a peer review of the ETO's findings in response to the Legislature's request. Specifically, this report investigates whether the ETO Team appropriately forecast ridership for the SBS study and whether the results produced were reasonable. Its scope as a peer review report is "high-level" for use in planning and comparing the corridors.

[1] This report refers to the ETO Team in general for each portion of the different analyses even though parts of the study were performed by different team members or subconsultants.
[2] The ETO Team. "California High-Speed Rail Early Train Operator: Side-by-Side Quantitative Report," February 8, 2020. Prepared for California High-Speed Rail Authority.
[3] KPMG. "California High-Speed Rail Merced to Bakersfield Business Case Study," February 2020. Prepared for California High-Speed Rail Authority.

CHSRA and the Legislature are using the ETO's forecasts to understand where to best allocate the already appropriated $4.8 billion in high-speed rail (HSR) funding. This raises important questions about which of the three services is best to allocate the money to.

For instance, should the funding be spent in the CVS where existing HSR infrastructure has been started and where HSR money has already been spent? The HSR segment runs from Bakersfield to Merced and, in the "Build" scenario, connects with additional Thruway Bus in Bakersfield and various new rail and bus services to Sacramento, Oakland, and San Jose from Merced.

Alternatively, would it be more beneficial to allocate the resources in the NorCal corridor (the corridor operated by Caltrain from Gilroy to San Francisco) or in the SoCal corridor (the Metrolink/LOSSAN corridor from Burbank to Anaheim in the Los Angeles region)?

RSG's primary task was evaluating the models' inputs and outputs using the documentation and data provided. This was done to analyze which of the three investment corridors—NorCal, SoCal, and the CVS—had the highest ridership potential and other associated benefits.

Additionally, RSG conducted a benchmarking review to compare the SBS ridership forecasts with other project examples around the United States and Europe. These findings are included in Chapter 5.0 and Appendix B (under separate cover). RSG had some difficulty locating examples that were analogous to the SBS situation but still found some comparisons.

LTK, a subconsultant to RSG for this peer review, also conducted a review of the ETO Team's methodology to develop the SoCal corridor operations and maintenance (O&M) costs for the SBS study and the assumptions used to develop those costs. This review was undertaken only for the SoCal service to provide more clarity on those costs. This was done because there was less clear cost information from the SoCal service providers on costs than was provided by the regional rail operators for the CVS or the NorCal services.

All the caveats and disclaimers made by the ETO Team as part of their work also apply to the authors of this report whose peer review relied on their data and assumptions. Please see Chapter 9.0 for more information.

2.0 Data and Reports Evaluated

RSG reviewed the existing reports and information pertaining to the California HSR project and the SBS study. During this process, RSG also conducted significant independent analyses of the data contained in the various reports. This was done to understand the reasonableness of the assumptions in the reports and the resulting ridership based on the assumed growth and LOS that would occur in the "Build" versus the "No Build" scenarios.

RSG's charge was to ensure the ridership aligns with independently published ranges for other projects and that it was properly generated and then correctly applied. Many of the documents listed here provided useful context about ridership and LOS characteristics. However, RSG's peer review required a more detailed understanding of where the ridership was presumed to be going exactly and how that ridership was generated. Specifically, the reports alone were not detailed enough to understand exactly *how* new trips were being generated by the HSR in some locations. For example, between a given station pair, what was the improved frequency and travel time?

In other cases, RSG was unable to identify from the reports where riders were traveling to and from to ensure riders were actually using the HSR network (as opposed to adjacent services) in the CVS. Many passenger movements were shown using large, aggregated geographic zones that do not allow the ability to understand what station pair is being used or what transit system is being used. Finally, RSG's peer review sought to verify which ridership should be considered part of the HSR system benefits versus which riders would have been there anyway.

As a result of these preliminary documentation analysis limitations, RSG requested and received additional reports and data from the ETO Team to better understand the ridership generated from the three corridors—the CVS, the NorCal, and the SoCal. These reports and datasets are listed below.

2.1 Initial Documents for Review and Reference

- California High-Speed Rail Merced to Bakersfield Business Case Study.[4]
- Central Valley Segment System Management & Operations Interim Financial Plan.[5]
- Side-By-Side Comparison: Southern California High-Speed Rail Financial Study, Peninsula Corridor Financial Study, Central Valley Segment Financial Study Draft Qualitative Report.[6]

[4] Ibid.
[5] The ETO Team. "California High-Speed Rail Early Train Operator: Central Valley Segment System Management & Operations Interim Financial Plan," January 31, 2020. Prepared for California High-Speed Rail Authority.
[6] The ETO Team. "Side-By-Side Comparison: Southern California High-Speed Rail Financial Study, Peninsula Corridor Financial Study, Central Valley Segment Financial Study Draft Qualitative Report," October 31, 2019. Prepared for California High-Speed Rail Authority.

- Side-by-Side Study Quantitative Report.[7]
- Daily Train and Bus Pairs Schedule Schematics by Scenario.[8]
- Central Valley and Peninsula Corridors Operations Financial Plan Study.[9]
- Draft 2020 Business Plan: Statements from Assembly Hearing Related to High-Speed Rail Ridership (8/21/20).
- Central Valley Segment System Management & Operations Interim Financial Plan Assumptions Register.[10]
- Northern California Corridor Assumptions Register.[11]
- Southern California Corridor Assumptions Register.[12]
- Board Meeting Presentation: Side-by-Side Study Quantitative Analysis - Summary of Findings and Conclusions.[13]
- California High-Speed Rail Briefing: February 18, 2020, Board Meeting Agenda Item #2.[14]
- Presentation: Side-by-Side Study Peer Review – Information for Kick-Off Meeting.[15]
- Presentation: Side by Side Analysis Quantitative Analysis - Summary of Methodology - Metrolink Meeting.[16]
- Choosing a Long Range Vision Caltrain Business Plan.[17]
- Getting Southern California High Speed Rail-Ready with an Investment in Metrolink's Burbank to Anaheim Corridor.[18]

[7] The ETO Team. "California High-Speed Rail Early Train Operator: Side-by-Side Study Quantitative Report," February 8, 2020. Prepared for California High-Speed Rail Authority.
[8] The ETO Team. "Daily Train and Bus Pairs Schedule Schematics by Scenario," n.d. Prepared for California High-Speed Rail Authority.
[9] The ETO Team. "Central Valley and Peninsula Corridors Operations Financial Plan Study," May 1, 2019. Prepared for California High-Speed Rail Authority.
[10] The ETO Team. "Central Valley Segment System Management & Operations Interim Financial Plan Assumptions Register," January 1, 2020. Prepared for California High-Speed Rail Authority.
[11] The ETO Team. "California High-Speed Rail Early Train Operator: Northern California Corridor Assumptions Register (Used as input for the ETO Side-By-Side Study)," December 16, 2019. Prepared for California High-Speed Rail Authority.
[12] The ETO Team. "California High-Speed Rail Early Train Operator: Southern California Corridor Assumptions Register (Used as input for the ETO Side-By-Side Study)," December 11, 2019. Prepared for California High-Speed Rail Authority.
[13] The ETO Team. "Board Meeting Presentation: Side-by-Side Study Quantitative Analysis - Summary of Findings and Conclusions," February 20, 2020. Prepared for California High-Speed Rail Authority.
[14] California High-Speed Rail Authority. "California High-Speed Rail Briefing: February 18, 2020, Board Meeting Agenda Item #2," Prepared by Frank Vacca, Chief of Rail Operations, for Chairman Mendonca and Board Members.
[15] The ETO Team. "Side-by-Side Study Peer Review – Information for Kick-Off Meeting," August 17, 2020. Prepared for California High-Speed Rail Authority.
[16] The ETO Team. "Side by Side Analysis Quantitative Analysis - Summary of Methodology, February 5, 2020. Prepared for Metrolink Meeting.
[17] JPB. "Choosing a Long Range Vision," August 1, 2019. Prepared for Caltrain.
[18] Metrolink. "Getting Southern California High Speed Rail-Ready with an Investment in Metrolink's Burbank to Anaheim Corridor," September 26, 2019.

- Valley Rail Sacramento Extension Project Final Environmental Impact Report.[19]

2.2 Additional Reports/Data Requested, Received, and Reviewed

- Central Valley HSR Ridership and Revenue Estimates – Scenario 2028.12.31.[20]
- Draft Peninsula Corridor HSR Ridership and Revenue Estimates –Scenarios and Summaries.[21]
- Draft Southern California Corridor (SoCal) HSR Ridership and Revenue Estimates.[22]
- Raw ridership matrix files (.mat files for each corridor from the California State Rail Plan Model):
  - SoCal: Model inputs and outputs by zone.
  - NorCal: Model inputs and outputs by zone.
  - CVS: Model inputs and outputs by zone and station zones.
  - Shapefiles of HSR zones.
- Model output processing steps.

2.3 Unavailable Data

- Station-to-station model output files for the CVS and for SoCal (NorCal was available in the *Peninsula Corridor HSR Ridership and Revenue Estimates –Scenarios and Summaries* report). RSG did receive detailed zone matrices for the CVS, but RSG did not receive detailed station-to-station ridership, some of the transfer data at Merced, and data for Thruway Bus.
- Postprocessing of the data was explained, but the actual specific changes to all outputs (e.g., how station-to-station pairs for the entire system were modified) were not provided. The incremental application and adjustments of model outputs for HSR station pairs were provided.
- Detailed data on how many trips using Thruway Buses are not connecting to HSR stations (Senate Bill 742) and, if not connecting, where these trips are occurring, was not provided. Only summaries of these trips were provided.

Based on the information received, RSG felt confident that the review could be performed to evaluate the ridership in the SBS study to validate the use of comparing the three corridors.

[19] AECOM. "Final Environmental Impact Report: Volume 1," September 2020. State Clearinghouse #2019090306. Prepared for San Joaquin Regional Rail Commission and San Joaquin Joint Powers Authority.
[20] ETO Team. "Central Valley HSR Ridership and Revenue Estimates – Scenario 2028.12.31," November 25, 2019. Prepared for DB Engineering & Consulting.
[21] ETO Team. "Draft Peninsula Corridor HSR Ridership and Revenue Estimates –Scenarios and Summaries," January 25, 2019. Prepared for California Department of Transportation, California State Transportation Agency, and DB Engineering & Consulting.
[22] ETO Team. "Draft Southern California Corridor (SoCal) HSR Ridership and Revenue Estimates," January 17, 2020. Prepared for DB Engineering & Consulting.

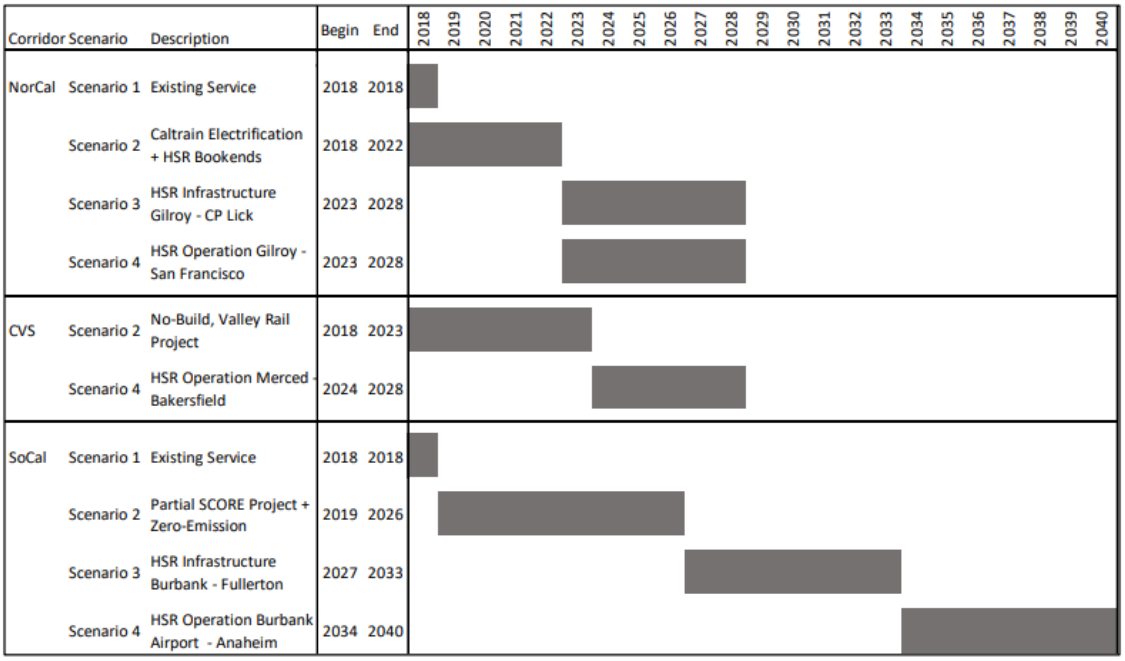
3.0 Review of Inputs and Assumptions

The following sections discuss the inputs and assumptions that were used to apply the model in the SBS study.

3.1 Build Year

The SBS used a 2029 build year. This is the year that the CVS will be ready to assume operations. Figure 3-1 shows the schedule for completing each of the scenario builds. The SBS is intended to quantify the benefits derived from each corridor of the allocated $4.8 billion. The CVS and, likely, the NorCal corridors will be ready to start the build services by 2029. However, it is unclear whether the SoCal corridor will actually be able to operate the "Build" scenario in 2029 as described in the SBS study, since the development of the HSR infrastructure even under optimistic assumptions will require a longer project development phase. Even so, the estimates assume the SoCal corridor will be ready in 2029. This is a conservative assumption, meaning the SoCal corridor is being given more benefits (starting earlier) than what may occur. Given these facts, RSG believes the assumption of the 2029 build year aligns with the SBS study's aims.

Figure 3-1: Estimated Implementation Schedule of Regional and HSR Investment



Source: Side-by-Side Study Quantitative Report[23]

[23] The ETO Team. "California High-Speed Rail Early Train Operator: Side-by-Side Quantitative Report," February 8, 2020. Prepared for California High-Speed Rail Authority, p. 102, Figure 7-1.

3.2 Total Travel Demand Interpolation to 2029 Assumptions

To obtain total travel demand matrices (annual interregional trips by all modes in the state of California) in the study year of 2029 for the SBS, the ETO Team took the existing base year (2010) and 2040 matrices from the California State Rail Plan Model and interpolated them to the study year of 2029. RSG requested that the ETO Team verify that these interpolations were developed using "No Build" scenarios, which the ETO Team confirmed. This means the total travel demand does not vary due to any potential new rail infrastructure. This clarification confirms the trip matrices in the SBS are based on the travel *before* any build benefits are considered and are not including any growth due to a new transportation options that would make it more attractive to live in a given area.

This confirmation is important because the growth rates for total trips in the *2018 California State Rail Plan* seem to assume increased accessibility (i.e., new rail build out) in their forecasts, which average about 1.7% growth per year.[24] However, as shown in the Trip Growth Assumptions section of this report, the ETO Team has only assumed an average growth in total trips of 0.6% per year, which is the objective way to grow the trips.

3.3 "No Build" Versus the "Build" Scenarios

One of the most critical assumptions to verify in the SBS study is when benefits of the HSR system should start to be counted. RSG reviewed the logic as described in the *Side-by-Side Study Peer Review – Information for Kick-Off Meeting August 17, 2020 presentation* as well as in the other SBS documentation. Based on this review, RSG concluded the ETO Team has properly accounted for when and where the benefits of the HSR should be allocated for all three corridors.

To arrive at this conclusion, RSG applied the following logic, which was the same logic employed by the ETO Team. For each corridor there are *up to* four scenarios:

- **Scenario 1 (Base Case)**: Current (today's) operation as a reference point to pivot off.
- **Scenario 2 ("No Build")**: Committed future regional projects using approved *non-HSR funds* and HSR bookend investments as the "No Build." In other words, these investments would happen even if the HSR were not built.
- **Scenario 3 ("Build" Scenario)**: HSR infrastructure funds spent but without any HSR train sets running. This scenario includes any additional regional funds paired with early eligible HSR infrastructure investment and additional regional service improvements.
- **Scenario 4 ("Build" Scenario)**: Complete HSR investment to provide full HSR stand-alone service in addition to the improved regional service in Scenario 3.

The logic applied here is that the "No Build" scenario (Scenario 2) assumes non-HSR investment will have happened *before* the HSR investment is provided. Once these investments

[24] AECOM. "2018 California State Rail Plan," September 2018. Prepared for California Department of Transportation, p. 19.

are considered, then the HSR investments are added as the "Build" scenarios. The incremental benefit from "No Build" to "Build" then is considered the HSR benefit.

This concept is easier to understand when using actual examples, so the following section applies these scenarios to each corridor in the study.

Northern California

- **Scenario 2 ("No Build")**: Assumes the following infrastructure will be in place prior to the HSR, and HSR benefits only are counted *after* these regional improvements are made: Electrification San Francisco to San Jose and the addition of Caltrain Electric Trains.
- **Scenario 3 ("Build" Scenario 1 for NorCal)**: Assumes electrification and HSR infrastructure to Gilroy from San Jose, grade separations, Diridon Station, and additional Caltrain electric trains. Because HSR money is being used to fund part of these improvements, benefits from this HSR investment are counted in this scenario.
- **Scenario 4 ("Build" Scenario 2 for NorCal)**: Assumes additional HSR maintenance facilities, HSR trains sets, station improvements, and track improvements (curve straightening). These additional (incremental) benefits are counted for the HSR investment in this scenario as well.

Southern California

- **Scenario 2 ("No Build")**: Assumes initial Southern California Optimized Rail Expansion (SCORE) program investment, Link Union Station (Metro) Phase A, Conversion to Zero-Emission Vehicles (ZEVs) and ZEV maintenance facilities, and Regional Trains.
- **Scenario 3 ("Build" Scenario 1 for SoCal)**: Burbank to Los Angeles Union Station (LAUS) 4 Tracks, LAUS to Fullerton 4 Tracks, Link US Phase B, Rail Systems, and Regional Trains.
- **Scenario 4 ("Build" Scenario 2 for SoCal)**: Burbank Airport Station, Anaheim Station, Electrification, Mod Stations, LMF, and HSR Trains.

Central Valley Segment

- **Scenario 2 ("No Build")**: Valley Rail Project with Expansion of Service to Natomas and ACE rail service to Ceres with connecting buses to Merced. Assumes Madera to Poplar HSR building continues, but no HSR operations. Assumes weekday-only service of ACE services and San Joaquins services operating seven days per week (as of today).
- **Scenario 4 ("Build," Scenario 1, there is no Scenario 3 in the CVS)**: HSR completed and operational from Merced to Bakersfield with HSR train sets operating and connectivity projects complete. The rail/bus network north of Merced is built out so timed connections are available for each high-speed train. Full ACE rail service to Merced. ACE service running all seven days. Increase in San Joaquins frequency from Merced to

Sacramento. Buses to fill any gaps in the train schedule so there are 18 trains or buses per day in each direction to Merced from San Jose, Oakland area, and Sacramento.

3.4 Trip Growth Assumptions

The total market trips reflect trips made across all modes between each production and attraction zone. These are used as the basis for the mode split model that predicts what percentage of the trips for each production-attraction zone pair are made by rail. Table 3-1 shows the approximate annual change in total trip productions and attractions between the base year (2017 or 2018) and the forecast year (2028 or 2029, depending on the corridor), averaged across zones within various counties. Although minor differences existed between corridors due to the different base and forecast years, the rates were similar across corridors. The rate for the most relevant corridor for each county is shown in Table 3-1.

Table 3-1: Annual Change in Total Trips for All Modes, by Production/Attraction and Region

COUNTY/REGION	PRODUCTIONS	ATTRACTIONS
Kern County	1.5%	1.6%
Kings/Tulare Counties	1.1%	1.0%
Fresno County	1.9%	1.9%
Madera County	0.8%	0.6%
Merced County	1.4%	1.1%
Stanislaus County	2.5%	2.5%
San Joaquin County	2.0%	2.0%
Sacramento County	2.1%	2.2%
Alameda/Contra Costa/Solano Counties	0.8%	0.7%
Santa Clara County	1.0%	1.0%
San Mateo County	0.7%	0.6%
San Francisco County	1.0%	1.1%
Marin/Sonoma/Napa Counties	0.5%	0.5%
Other Northern California Counties	0.9%	0.8%
Santa Cruz/Monterey/San Benito Counties	0.8%	0.8%
Santa Barbara/San Luis Obispo Counties	0.6%	0.6%
Ventura County	0.5%	0.5%
North LA (San Fernando & Antelope Valleys)	-0.3%	-0.2%
Rest of Los Angeles County	-0.7%	-0.7%
Orange County	0.3%	0.1%
San Diego County	0.8%	0.8%
Riverside/Imperial/San Bernardino Counties	1.1%	1.0%
Total	**0.6%**	**0.6%**

The total market trip growth used in the modeling was based on the trip rates used in the *2018 California State Rail Plan* “No Build” scenario for 2040. The trips for the forecast year (2028 or 2029) were obtained using a straight-line interpolation between the state rail plan base year and forecast year (2040).

Using the trip rates from the *2018 California State Rail Plan* “No Build” scenario reflects a conservative assumption that no new growth in total intercity trips will be induced by improvements in accessibility from new rail projects. By contrast, the “Build” scenario in the *2018 California State Rail Plan*, which assumes the full HSR system and many other

improvements by 2040, assumes a 1.7% overall average annual growth in intercity trips—almost three times as high as the 0.6% average annual growth shown in Table 3-1.

To summarize, the growth rates used in the SBS study are conservative and consistent across the three corridors studies.

3.5 Corridor Population

The population of the counties in the SoCal corridor far outpaces the population in the other corridors (Table 3-2 through Table 3-4). However, the populations of the CVS and NorCal corridors are not as different as one might expect, although the CVS area is not nearly as dense as the NorCal area. The number of people benefiting from the HSR investment in the stand-alone corridor in SoCal is much lower than the total population since the investment is only possible between Burbank and Anaheim. This is not the case in NorCal and CVS corridors, where most people can benefit in those corridors from the HSR investment.

Table 3-2: CVS Corridor Population, by County

CORRIDOR/COUNTY	POPULATION
Fresno County	999,101
Kern County	900,202
Kings County	152,940
Madera County	157,327
Merced County	277,680
Sacramento County	1,552,058
San Joaquin County	762,148
Stanislaus County	550,660
Tulare County	466,195
Total	**5,818,311**

Source: 2018 American Community Survey 5-Year Estimates

Table 3-3: NorCal Corridor Population, by County

CORRIDOR/COUNTY	POPULATION
Alameda County	1,671,329
Contra Costa County	1,153,526
San Francisco County	881,549
San Mateo County	766,573
Santa Clara County	1,927,852
Total	**6,400,829**

Source: 2018 American Community Survey 5-Year Estimates

Table 3-4: SoCal Corridor Population, by County

CORRIDOR/COUNTY	POPULATION
Los Angeles County	10,039,107
Orange County	3,175,692
Riverside County	2,470,546
San Bernardino County	2,180,085
Ventura County	846,006
Total	**18,711,436**

Source: 2018 American Community Survey 5-Year Estimates

3.6 Conservative and Optimistic Forecasting Assumptions

The assumptions used during the modeling process can have a major impact on the findings in terms of how the corridors perform relative to each other. The following assumptions impact the CVS forecasts. Most of the assumptions were conservative and decrease the relative benefit of the CVS (meaning that the CVS may perform even better than forecasted), while others are optimistic and increase the relative benefits of the CVS (meaning it may not do as well).

The conservative assumptions include the following:

- The HSR mode is treated the same as the San Joaquins mode and not given additional benefit due to the better amenities of HSR train sets, track, etc.
- There was no reliability benefit included in the model (HSR on dedicated tracks will likely be more reliable than existing services)
- Optimal (revenue maximizing) fares were not used, but instead fares are set the same as the current San Joaquins fares; this is a conservative assumption relative to revenues.
- The 2029 total market assumes no induced demand due to partial HSR completion in the CVS, as noted in the Total Travel Demand Interpolation to 2029 Assumptions section of the report. (i.e., used “No Build” market projections).

- The 2029 build year assumes all corridors' infrastructure will be built by 2029, when in fact it is unlikely that will be the case for SoCal (because there is no current source of funding). Regardless, the ridership and benefits to SoCal are still assumed to start in 2029.
- San Francisco was not included in the CVS as a possible primary destination. In reality, San Francisco could be reached by Bay Area Rapid Transit from several stations. It is a popular attraction for intercity trips, and traveling by car to San Francisco is inconvenient because of high parking costs and congestion. Also, a car is not necessary for travel once in San Francisco.
- O&M costs are likely higher in the SoCal corridor than what is indicated in the SBS report (details included in Chapter 7.0).

The optimistic assumptions toward the CVS include the following:

- Bus service on the ACE and San Joaquins services is considered the same as San Joaquins rail service in the model (typically rail would be given a benefit over bus).
- Transfers are expected to be coordinated with short wait times when transferring to and from the HSR segment to other services in Merced or Bakersfield. If on-time performance is an issue once service begins, then this would decrease ridership. Also, if not all services are built, then the transfer convenience and timing would lag behind the forecast.

4.0 Evaluation of Results

4.1 Ridership Analysis

RSG conducted two analyses to understand whether the ridership estimates were reasonable in the SBS study. First, RSG reviewed the *Central Valley HSR Ridership and Revenue Estimates – Scenario 2028.12.31* report[25] to understand how the model was postprocessed/calibrated. While the postprocessing is not well documented, the State Rail Plan Model tends to overpredict short trips and underpredict long trips (as seen in the section below), and the ETO Team adjusted the model in an attempt to rectify this. This is not uncommon, as this model is trying to predict both long and short trips, which many modeling structures have difficulty with, as most are optimized for either longer trips (intercity models) or shorter trips (regional models). The short trip/long trip analysis is described in the Short Trips/Long Trips Discussion section below.

The second (and primary) analysis RSG employed to understand the reasonableness of ridership was elasticity analysis. Elasticities allow one to generalize behavior from other models or revealed behavior data to understand how ridership changes based on LOS changes. The primary changes of LOS in all three corridors are train frequency (number of trains per hour or per day per direction) and travel time.

RSG used an elasticity range (set at a high and low elasticity) seen in both actual project work that RSG conducted on Northeast Corridor commuter rail and in the literature.[26,27] For this study, RSG used a frequency range of 0.1 to 0.5. This means that a 10% increase in frequency leads to a ridership increase of between 1% and 5%. For travel time, RSG used a range of -0.3 to -0.8 (these are negative since when travel time goes down, ridership goes up) This means a reduction in travel time of 10% leads to an increase in ridership of 3% to 8%.

RSG used this technique on all three corridors to estimate the ridership impacts of changes in frequency and travel time, the results of which are shown in the Frequency and Travel Time Elasticity Tests section below.

[25] ETO Team. “Central Valley HSR Ridership and Revenue Estimates – Scenario 2028.12.31,” November 25, 2019. Prepared for DB Engineering & Consulting.
[26] Litman, Todd. “Transit Price Elasticities and Cross-Elasticities,” April 2, 2020. Victoria Transport Policy Institute.
[27] National Academies of Sciences, Engineering, and Medicine. “Traveler Response to Transportation System Changes Handbook, Third Edition: Chapter 12, Transit Pricing and Fares,” 2003. The National Academies Press. Washington, DC.

Short Trips/Long Trips Discussion

The State Rail Plan Model overpredicts short trips and underpredicts long trips. As shown in Table 4-1 and Table 4-2, the ETO Team adjusted the model to account for this discrepancy in their postprocessing.

Table 4-1: CVS 2017 "No Build" Annual Ridership Between HSR Zone Pairs (Raw Model Outputs)

ANNUAL RIDERSHIP (RAW)	MERCED	MADERA	FRESNO	KINGS-TULARE	BAKERSFIELD	TOTAL
Merced	–	13,000	68,800	41,100	59,300	182,200
Madera	13,000	–	56,400	1,700	6,900	78,000
Fresno	68,800	56,400	–	47,900	59,300	232,400
Kings-Tulare	41,100	1,700	47,900	–	69,800	160,500
Bakersfield	59,300	6,900	59,300	69,800	–	195,300
Total	**182,200**	**78,000**	**232,400**	**160,500**	**195,300**	**848,400**

Source: Central Valley HSR Ridership and Revenue Estimates – Scenario 2028.12.31[28]

Table 4-2: CVS 2017 "No Build" Annual Ridership Between HSR Zone Pairs (Adjusted Model Outputs)

ANNUAL RIDERSHIP (ADJUSTED)	MERCED	MADERA	FRESNO	KINGS-TULARE	BAKERSFIELD	TOTAL
Merced	–	8,400	86,400	31,100	137,000	262,900
Madera	8,400	–	800	1,200	3,100	13,500
Fresno	86,400	800	–	36,800	49,800	173,800
Kings-Tulare	31,100	1,200	36,800	–	24,200	93,300
Bakersfield	137,000	3,100	49,800	24,200	–	214,100
Total	**262,900**	**13,500**	**173,800**	**93,300**	**214,100**	**757,600**

Source: Central Valley HSR Ridership and Revenue Estimates – Scenario 2028.12.31[29]

Assuming all trips under 60 miles are short, this indicates the short trips are overpredicted by 14% (108,000 trips) while long trips (60 miles and over) are underpredicted by 2% (17,600 trips). Table 4-3 shows the adjustment factor between the raw and adjusted annual ridership. For example, trips between Madera and Fresno were overestimated in the model and needed to be adjusted down to just 1% of their predicted ridership; meanwhile, trips between Bakersfield and Merced were underestimated and had to be adjusted to over twice the model's predicted ridership. This is important to recognize as a general bias in the results of the model. However, the ETO Team corrected for this, which resulted in a ridership decrease of 10.7% on average.

Note: The output adjustment has only been documented in the report for five stations. Additionally, this is not true model calibration where the model itself is adjusted. Instead, this is considered postprocessing of the model outputs.

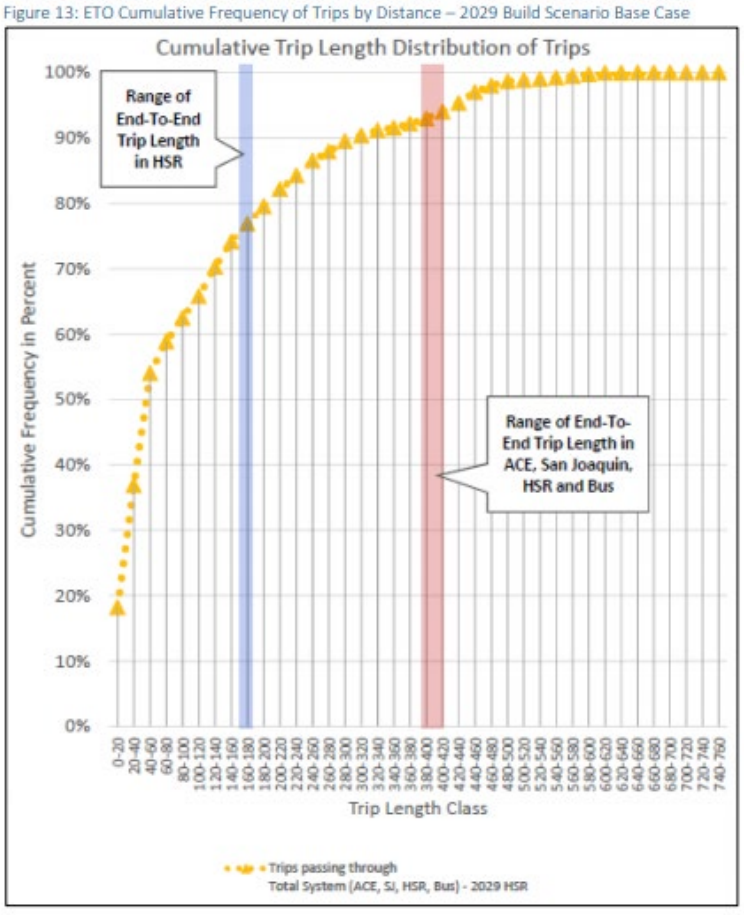
[28] ETO Team. "Central Valley HSR Ridership and Revenue Estimates – Scenario 2028.12.31," November 25, 2019. Prepared for DB Engineering & Consulting, p. 11.
[29] Ibid.

Table 4-3: CVS 2017 "No Build" Annual Ridership Between HSR Zone Pairs (Model Output Adjustment Factor)

ADJUSTMENT FACTOR	MERCED	MADERA	FRESNO	KINGS-TULARE	BAKERSFIELD
Merced	-	0.65	1.26	0.76	2.31
Madera	0.65	-	0.01	0.71	0.45
Fresno	1.26	0.01	-	0.77	0.84
Kings-Tulare	0.76	0.71	0.77	-	0.35
Bakersfield	2.31	0.45	0.84	0.35	-

As shown in Figure 4-1 from the KPMG report, most trips in the CVS are short—approximately 75% are under 160 miles. As a result, the ETO Team needed to adjust many of the trips downward since most are short.

Figure 4-1: CVS—Cumulative Frequency of Trips, by Distance



Source: California High-Speed Rail Merced to Bakersfield Business Case Study [30]

[30] KPMG. "California High-Speed Rail Merced to Bakersfield Business Case Study," February 2020. Prepared for California High-Speed Rail Authority.

Review of Passenger Miles Travel

In reviewing the passenger miles traveled (PMT) metrics in the SBS report, the results included in the study appear to be within reason. The main focus of this review was on the ridership demand forecasts; these were deemed reasonable, and the resulting PMT results are also reasonable based on the ridership and average trip distances in the three corridors.

While the absolute PMT is highest in SoCal due to high existing ridership (16.5 million in Scenario 2) and a relatively long average distance (42.8 miles), the CVS clearly **gains** the most PMT for the $4.8 billion investment when comparing Scenario 2 to Scenario 4 (Table 4-4). The CVS gains 340.3 million PMT, which is over 3 times the gain the other two corridors obtain from the investment. Additionally, the CVS has the lowest cost per PMT for the capital investment.

Table 4-4: Change in PMT by Corridor (Scenario 2 to Scenario 4) and Resulting Dollars per PMT from Capital Expenditures

Corridor	Annual Change in PMT (Mil)	Annualized Capital Costs (Mil)*	$ per Added PMT
NorCal	90.9	223.4	$2.46
CVS	340.3	223.4	$0.66
SoCal	107.9	223.4	$2.07

**Note: Assumes a 4% discount rate over 50 years for a $4.8 billion capital investment*

The costs for CVS are lowest and PMT increases the most, so therefore, a review of PMT confirms that by yet another measure, the CVS makes most sense for the investment.

Frequency and Travel Time Elasticity Tests

RSG performed the elasticity analysis of service-level changes between the “Build” and “No Build” scenarios on each of the three corridors to determine, at a high level, if the forecasted ridership results were within a reasonable range. Based on frequency and travel time improvements, the NorCal and CVS corridors are both within the high and low bounds of the elasticity range, while the SoCal scenario forecasts are above the higher bound (Table 4-5).

Table 4-5: Summary of Elasticity Analysis

Corridor	Base Passengers (Mil)	Low Expected Change	High Expected Change	ETO Team Study Forecast Change	ETO Team Passenger Change (Mil)	Result
NoCal	27.10	6%	28%	7%	1.98	Within range
CVS	3.97	42%	144%	121%	4.81	Within range
SoCal	16.51	2%	11%	15%	2.50	Above range

The elasticity analysis is a simple process that only accounts for current transit ridership and proposed service changes and then forecasts new ridership off the base ridership due to those service changes. It does not account for any other factors that may drive demand and are included in the model, such as competition between modes, overall travel demand, or specific trade-offs between attributes. Elasticities will vary depending on the base LOS characteristics.

For example, the elasticity to go from six trains per hour to eight would not necessarily be the same as the elasticity to go from four trains per hour to six—and a range of other case-specific factors.

The main conclusion of the elasticity analysis is that the model used for analysis in the SBS study is generally producing results within the expected range. Since the model is producing results within the expected range, and was applied consistently across all three corridors, RSG believes that the ridership forecasts in the SBS study are reasonable, especially for a high-level (planning-level) forecast.

The following sections summarize the elasticity analysis performed for each of the three corridors.

Central Valley Segment

The SBS study defines two scenarios for the CVS: 1) the "No Build" scenario (Scenario 2), which assumes the completion of the Valley Rail project; and 2) the "Build" scenario, which includes 18 high-speed trains per day and direction between Bakersfield and Merced, increasing frequency and increasing travel times on this corridor. In addition, expansion of the connecting bus/rail network would increase frequencies for all connecting trips and nonconnecting trips between Merced and points north as well as from Bakersfield south.

Table 4-6 shows the elasticities tested for frequency and travel time and the resulting expected ridership change alongside the forecasted ridership change. The total CVS system estimates are within the expected range and tend to be toward the high end of what would be expected. RSG's analysis shows that based on frequency and travel time alone, the forecasted ridership levels are reasonable.

The elasticity tests for the CVS come with the caveat that the service improvements between the "Build" and "No Build" scenarios represent a fundamental shift in transit service for the region, while the elasticity analysis is better suited to deal with incremental changes.

Table 4-6: CVS—Frequency and Travel Time Elasticity Tests (Scenario 2 vs. Scenario 4)

TEST CASE	TEST CASE	FREQUENCY	TIME	BASE ANNUAL RIDERS	SCENARIO ANNUAL RIDERS	CHANGE IN ANNUAL RIDERS	% CHANGE IN ANNUAL RIDERS
HSR	Low Elasticity	0.1	-0.3	1,033,000	1,301,036	268,036	26%
HSR	High Elasticity	0.5	-0.8	1,033,000	2,126,529	1,093,529	106%
HSR	SBS Study Forecast	–	–	1,033,000	2,049,000	1,016,000	98%
Entirely North of Merced	Low Elasticity	0.1	-0.3	2,936,000	4,336,624	1,400,624	48%
Entirely North of Merced	High Elasticity	0.5	-0.8	2,936,000	7,537,648	4,601,648	157%
Entirely North of Merced	SBS Study Forecast	–	–	2,936,000	6,727,000	3,791,000	129%
Total CVS	**Low Elasticity**	**0.1**	**-0.3**	**3,969,000**	**5,637,660**	**1,668,660**	**42%**
Total CVS	**High Elasticity**	**0.5**	**-0.8**	**3,969,000**	**9,664,176**	**5,695,176**	**144%**
Total CVS	**SBS Study Forecast**	–	–	**3,969,000**	**8,776,000**	**4,807,000**	**121%**

Northern California

According to the SBS study, the Scenario 2 to Scenario 3 service changes include an increase in capacity on the Caltrain corridor due to higher train frequency along the corridor. The Scenario 3 to Scenario 4 improvements include the addition of two high-speed trains per hour, stopping at Gilroy, San Jose, Millbrae, and San Francisco. However, Scenario 2 "No Build" scenario was not modeled and was derived from growth factors from the Caltrain business plan. As a result, comparisons between Scenario 2 "No Build" and "Build" scenarios are not actually comparisons between model runs.

The Scenario 2 ridership is based on the Caltrain business plan, which assumes a 2% increase in ridership demand per year, plus a 20% increase for electrification. The ETO Team used professional judgment to arrive at the ultimate "No Build" ridership, which appears to be at a reasonable level (between Scenario 1 and Scenario 3, both of which were modeled) and due to changes in LOS from Scenario 1. However, the Caltrain business plan does not define a specific service plan that included other improvements; therefore, the ETO Team adjusted the estimates to match the study assumptions.

The SBS report indicates a Caltrain schedule of six trains per hour (four electric and two diesel) in Scenario 2 and eight trains per hour in Scenario 3 (all electric). RSG assumed the station-to-station frequencies as laid out in this schedule and used the Scenario 3 station-to-station ridership distribution from the ETO Team report, but factored it down to the overall ridership in Scenario 2 as a "No Build" case for the elasticity analysis.

Table 4-7 shows the elasticities tested for frequency and travel time and the resulting ridership change using elasticities in the NorCal corridor for Scenario 2 compared to Scenario 4. Overall, the ETO Team forecast falls within the range (at the low end) of the elasticity analysis. The ETO Team forecast for trips between HSR stops only (Gilroy, San Jose, Millbrae, and San Francisco) falls above the high end of the elasticity range, while the ETO Team forecast for other stops falls below the low end of the elasticity range. This suggests that the increase in riders due to high-speed trains on the Caltrain corridor (or the difference between Scenario 3 and Scenario 4) may be optimistic. Conversely, the increase in riders to due increasing capacity from six to eight trains per hour on the full system (or the difference between Scenario 2 and Scenario 3) may be a conservative forecast.

Table 4-7: NoCal Frequency and Travel Time Elasticity Tests (Scenario 2 vs. Scenario 4)

TEST CASE	TEST CASE	FREQUENCY	TIME	BASE ANNUAL RIDERS	SCENARIO ANNUAL RIDERS	CHANGE IN ANNUAL RIDERS	% CHANGE IN ANNUAL RIDERS
HSR Stops Only	Low Elasticity	0.1	-0.3	3,046,443	3,414,035	367,592	12%
HSR Stops Only	High Elasticity	0.5	-0.8	3,046,443	4,484,957	1,438,514	47%
HSR Stops Only	SBS Study Forecast	–	–	3,046,443	4,607,955	1,561,512	51%
Other Caltrain Stops	Low Elasticity	0.1	-0.3	24,050,112	25,298,579	1,248,467	5%
Other Caltrain Stops	High Elasticity	0.5	-0.8	24,050,112	30,292,449	6,242,337	26%

TEST CASE	TEST CASE	FREQUENCY	TIME	BASE ANNUAL RIDERS	SCENARIO ANNUAL RIDERS	CHANGE IN ANNUAL RIDERS	% CHANGE IN ANNUAL RIDERS
Other Caltrain Stops	SBS Study Forecast	–	–	24,050,112	24,466,563	416,451	2%
Total	**Low Elasticity**	**0.1**	**-0.3**	**27,096,555**	**28,712,614**	**1,616,059**	**6%**
Total	**High Elasticity**	**0.5**	**-0.8**	**27,096,555**	**34,777,406**	**7,680,851**	**28%**
Total	**SBS Study Forecast**	**–**	**–**	**27,096,555**	**29,074,518**	**1,977,963**	**7%**

As noted, the “No Build” (Scenario 2) ridership numbers come from a different analysis than the “Build” (Scenario 3 and Scenario 4) ridership numbers. Based on analysis of the Caltrain business plan and assumptions, RSG concluded the “No Build” ridership, as assumed in the SBS study, is reflective of the ridership the Caltrain corridor can achieve without any HSR investment.

Southern California

The SBS study attributes ridership increases in the SoCal corridor primarily to a capacity increase on the existing rail network. Scenario 3 improvements allow portions of some Metrolink commuter rail lines to operate at higher frequencies and provide a travel time savings on the LOSSAN intercity service (Amtrak) and some of the Metrolink service for trips that pass through LA Union Station. Scenario 4 includes the addition of high-speed trainsets, which effectively provides a frequency increase for the LOSSAN service between Burbank and Anaheim from one train per hour to three in addition to the added Metrolink service in Scenario 3; however, it provides no additional travel time savings.

Table 4-8 shows the change in ridership going from Scenario 2 to Scenario 4 in the SoCal corridor at the low- and high-end elasticities for frequency and travel time compared to the ETO Team ridership forecast. Overall, the ETO Team ridership estimates are higher than the range implied by the elasticity analysis based on frequency improvements and travel time savings alone. The increase in ridership forecast for Metrolink falls within the expected range, although at the high end. However, the forecast for the intercity service provided by the combination of LOSSAN and HSR is substantially above the upper bound of the elasticity analysis.

Digging deeper into the elasticity analysis shows that an increase in LOSSAN + HSR trips is primarily due to the frequency increase rather than any travel time savings. This also includes an overall increase of 2.5 million trips between Scenario 2 and Scenario 4, and an overall increase of 2.1 million trips between Scenario 2 and Scenario 3. The ETO Team forecast suggests that an increase in 400,000 trips is due to the two high-speed trains per hour. This change alone is more in line with the elasticity analysis, but the full forecast of 2.5 million additional riders in Scenario 4 is likely an optimistic forecast.

Table 4-8: SoCal—Frequency and Travel Time Elasticity Tests (Scenario 2 vs. Scenario 4)

TEST CASE	TEST CASE	FREQUENCY	TIME	BASE ANNUAL RIDERS	SCENARIO ANNUAL RIDERS	CHANGE IN ANNUAL RIDERS	% CHANGE IN ANNUAL RIDERS
Metrolink	Low Elasticity	0.1	-0.3	14,100,945	14,360,839	259,894	1.8%
Metrolink	High Elasticity	0.5	-0.8	14,100,945	15,400,414	1,299,469	9.2%
Metrolink	SBS Study Forecast	–	–	14,100,945	15,362,812	1,261,867	8.9%
LOSSAN and HSR	Low Elasticity	0.1	-0.3	2,414,840	2,552,151	137,311	5.7%
LOSSAN and HSR	High Elasticity	0.5	-0.8	2,414,840	2,963,937	549,097	22.7%
LOSSAN and HSR	SBS Study Forecast	–	–	2,414,840	3,653,992	1,239,152	51.3%
Total SoCal	**Low Elasticity**	**0.1**	**-0.3**	**16,515,785**	**16,912,989**	**397,204**	**2.4%**
Total SoCal	**High Elasticity**	**0.5**	**-0.8**	**16,515,785**	**18,364,351**	**1,848,566**	**11.2%**
Total SoCal	**SBS Study Forecast**	**–**	**–**	**16,515,785**	**19,016,804**	**2,501,019**	**15.1%**

CVS Ridership and Revenue Benefits

Ridership Benefits from Non-High-Speed-Rail Trips

One of the most important findings of this review is that of all linked trips in the forecast, 77% of them never use the HSR corridor between Bakersfield and Merced (Table 4-9). This was documented in prior reports, including the ETO Team report[31] and KPMG report.[32] The result is that only 23% of the ridership gains are due to the actual HSR segment of the overall CVS corridor. The remaining ridership increase is due to the significant improvements of connecting services in markets outside of the HSR operation.

Table 4-9: CVS—Ridership, by Scenario and Segment

SEGMENT	2017	2029 "NO BUILD"	2029 "BUILD"	2029 "BUILD" % OF LINKED TRIPS
Both Trip Ends in the HSR Corridor (Merced to Bakersfield)	405	504	1,093	12%
One Trip End North of Merced and the Other within the HSR Corridor (Merced to Bakersfield)	401	529	956	11%
Both Trip Ends North of Merced (No HSR Use)	1,800	2,936	6,727	77%
Total LINKED Trips on CVS Corridor	**2,606**	**3,969**	**8,776**	**100%**
Thruway Bus (trips could be a part of either of the first two rows)	728	928	2,109	–
Total UNLINKED Trips	*3,334*	*4,897*	*10,885*	–

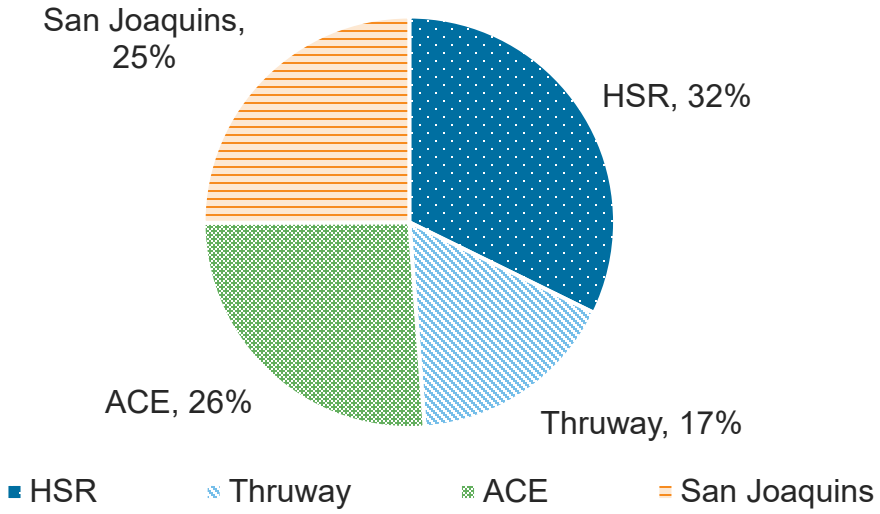
Source: Data provided by the ETO Team

Revenue Benefits from High-Speed Rail

Despite the fact that only 23% of trips in the CVS directly use the HSR, these trips account for approximately 45–50% of the increase in revenues relative to the "No Build" scenario (Figure 4-2). The HSR trips are longer trips and pay higher fares on average than the shorter trips that use only sections of the ACE and San Joaquins as well as bus services north and west of Merced. These trips may use both HSR and Thruway or ACE/San Joaquins services. For this revenue calculation, it was assumed that many of the Thruway Bus trips would ultimately use the HSR and therefore are being included in the revenues.

[31] ETO Team. "Central Valley HSR Ridership and Revenue Estimates – Scenario 2028.12.31," November 25, 2019. Prepared for DB Engineering & Consulting.
[32] KPMG. "California High-Speed Rail Merced to Bakersfield Business Case Study," February 2020. Prepared for California High-Speed Rail Authority.

Figure 4-2:CVS—Percentage of New Revenues, by Service Type



Source: RSG

Discussion of Benefits Attributed to High-Speed Rail Investment

As shown in Figure 4-2, the CVS HSR investment is expected to obtain significant ridership and revenue benefits from trips on the rail and bus services that are entirely north of Merced and that will not use the HSR corridor from Bakersfield to Merced. Despite not using the HSR for these trips, the benefits are attributed to the HSR investment because additional ACE and San Joaquins services (primarily in the form of buses running parallel to the rail network) would not operate without the connection to the HSR, according to the assumptions in the SBS study that were confirmed with the relevant regional rail partners. These services are assumed to be run by a unified operator, which will save the state up to $20.2 million.[33]

The additional ridership, counted as benefits to the HSR, is partially attributable to ACE service running seven days per week instead of only on weekdays in Scenario 2. It is also due to increasing frequency of ACE and San Joaquins services to 18 trips per day on their rail and bus network between Merced and all major northern CVS destinations (Oakland, Stockton, Sacramento, and San Jose). These network improvements are required, according to the ETO Team and KPMG, as being necessary to get the improved ridership between the HSR and the ACE and San Joaquins services. As noted above, it is expected that the unified operator will also create cost improvements.

The additional trips made in the CVS corridor on Thruway Buses and related revenue are also attributed as a benefit to the HSR operation by the ETO Team because without the HSR service to the CVS stations, the regional rail operators would not be providing the additional Thruway Bus services. Ultimately, the main benefit of the potential HSR investment in the CVS is an extensive interconnected rail and bus network that leverages the Bakersfield to Merced HSR segment to create improved travel across a longer distance.

[33] KPMG. “California High-Speed Rail Merced to Bakersfield Business Case Study,” February 2020. Prepared for California High-Speed Rail Authority, p. 17.

5.0 Benchmarking

RSG conducted a benchmarking analysis to locate examples of rail projects in Europe and the United States against which to compare the potential investments in California. This section summarizes this effort.

5.1 Full Los Angeles to San Francisco High-Speed Rail Benchmarking

RSG benchmarked the full Los Angeles to San Francisco corridor to establish a sense of scale prior to reviewing the actual staged implementation over time (i.e., building the HSR in segments) that is occurring in the CVS corridor.

Table 5-1 shows the populations at the terminal points of each rail pair; this analysis indicates that Los Angeles to San Francisco represents the third-largest city pair in the western world, below only New York/Boston and New York/Washington, but above London/Paris and other European cities connected by HSR.

The populations of the Bay Area region and the Los Angeles region together comprise a larger market (about 20 million) than those for London-Paris (19 million), Berlin to the Rhine Ruhr (11 million), or Madrid to Barcelona (9 million). Similarly, the Los Angeles-Bay Area city-pair populations are significantly higher than Paris-Brussels (11 million) or Paris-Rotterdam (12 million).

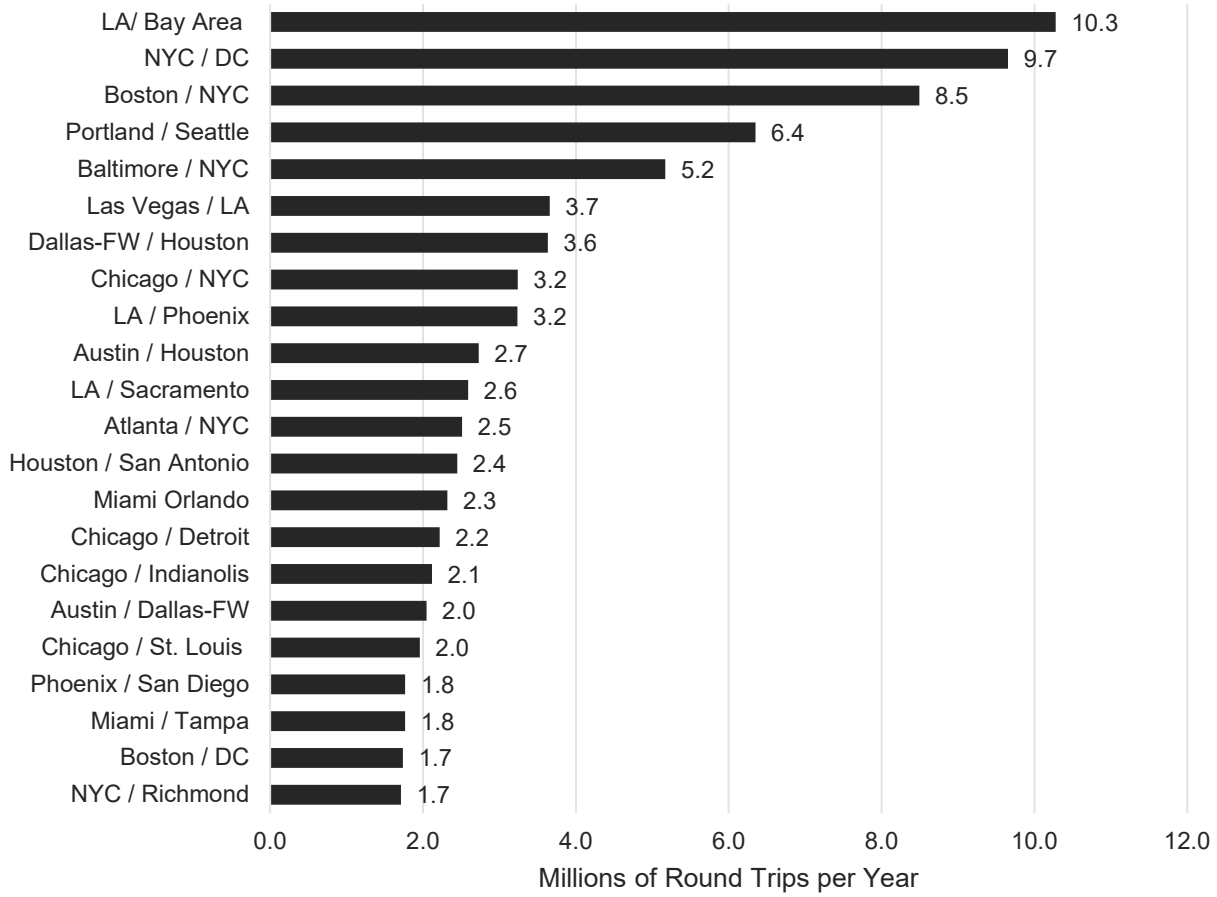
Table 5-1: Selected City-Pair Markets for Corridors with Rail in Europe and the United States

CITY-PAIR	COMBINED POPULATION FOR TERMINAL METRO AREAS
New York/Boston	24,840,000
New York/DC	24,350,000
LA/SF	**20,180,000**
Paris/London	18,750,000
LA/Sacramento	**17,094,000**
Paris/Rotterdam	12,520,000
Paris/Brussels	11,449,000
Rhine Ruhr/Berlin	10,940,000
London/Brussels	9,339,000
London/Amsterdam	9,341,000
Madrid/Barcelona	9,170,000
Milan/Rome	6,930,000
Seattle/Portland	6,472,000
Frankfurt/Berlin	6,010,000
Brussels/Rotterdam	3,109,000
Brussels/Amsterdam	2,040,000

Using air volumes as a surrogate for intercity demand. Air travel between city pairs is useful when analyzing the nature of demand for long-distance rail. RSG estimates that 8 million air trips are taken between the airports in the Los Angeles region and the three airports in the Bay Area. In Europe, the highest volume is 3.2 million air trips between all London airports and Dublin, which is on an island and not a candidate for any form of rail connection. Air trips between Los Angeles and Sacramento are higher than those for any major European HSR corridor, the highest of which is Madrid/Barcelona at 2.5 million air passengers.

Using estimated intercity demand by all modes. Figure 5-1 shows the flows between LA and the Bay Area (including San Jose) as one "city pair" with flows between Los Angeles and Sacramento as a second pair. Volumes for travel to and from cities along the routes are not included. City-pair volumes are revealed to be directly comparable to those in the Northeast Corridor.

Figure 5-1: US Corridors Ranked by Number of Intercity Round Trips, by All Modes



Source: RSG[34]

[34] RSG. "Air Demand in a Dynamic Competitive Context with the Automobile," 2019. Prepared for the National Academies of Sciences, Engineering, and Medicine.

5.2 Building High-Speed Rail in Segments

Case Study: London to Paris High-Speed Rail

The London/Paris HSR project was built as two usable segments instead of all at once, which is analogous to current plans in California. The first segment included high-quality track between Paris and Kent in the British countryside, with the use of older, slower track to connect to London. Transfer from fast trains to slower trains in Kent was not considered an option, as planners wanted a one-seat ride to London. By the time investment decisions were completed in the French part of the corridor, planners had to develop an electrified HSR segment in England that brought benefit to both long- and short-distance rail passengers. Only after it was established that the project would benefit metropolitan commuters was United Kingdom government funding approved. This, in turn, led to a creative use of rail technology to develop electrified service partly over high-speed tracks and partly over low-speed tracks. When pressed into service to support the London Summer Olympics, the train became popularly known as “the Javelin.”

The new central train shed of the St. Pancras terminal supports Javelin commuter rail on the east, the Eurostar tracks in the middle, and a different commuter rail platform on the west. Integration with the needs of the commuter services was considered essential to provide political support for the HSR project.

Serving both commuters and HSR passengers. The integration of the services made major demands on the rolling stock. As a result, a longer-distance commuter rail train was developed as a dual-voltage electric multiple unit. The train operates at 140 mph on the high-speed segment, and at much lower speeds over existing and electrified (but unimproved) track. From one suburb, Rochester, this results in a total average speed of 47 mph, with an average speed of about 70 mph on the high-speed segment.

Figure 5-2: The "Javelin" Train

Benchmarking

The metropolitan population between Bakersfield and Merced is approximately 3 million, and the population between Bakersfield and Sacramento is nearly 6 million. A comparable corridor for benchmarking in terms of population size is between Amsterdam and Brussels. This service covers nearly 130 miles, and the metro population is approximately 5 to 6 million people, similar to the total populations between Bakersfield and Sacramento. This service is an example of a high-speed line designed to provide hourly service between the two cities, with investment in new full HSR infrastructure for most of the route in the Netherlands, and more investment expected in Belgium. While some trains continue from Brussels to Paris, the Amsterdam-Brussels services is advertised and marketed as a corridor in and of itself.

Benchmarking against Brussels/Amsterdam. The HSR service operated by Thalys can operate at the speed the track was designed for (185 mph), but it usually operates much slower. RSG calculates the average running time between Amsterdam and near the Belgian border at 81 mph for the 1-hour-and-15-minute journey. Between Brussels and Amsterdam, that terminal-to-terminal speed is slightly under 60 mph for a one hour and 52-minute journey. With the arrival of its newest high-speed trains, most trains on the new Dutch high-speed line will operate at under 125 mph at their top speed. In short, HSR technology is used on a relatively short corridor, but one with populations twice the size of that for Bakersfield/Merced and more similar to Bakersfield/Sacramento. Thus, it serves as a valuable case study, but not quite similar in

market size or operational speed of the HSR service in the Central Valley, which is assumed to be initially up to 180 mph.

Benchmarking against London/Manchester. At 170 miles in distance, Bakersfield to Merced could be compared with London to Manchester at 210 miles—and similar to the distance between Bakersfield and Stockton at about 240 miles. In terms of population size, Manchester, with 2.3 million people, is similar in size to Sacramento with approximately 2.4 million people. Thus, the Manchester metro area similar to cities in this study area, both in terms of scale of population and distances for rail services.

The Manchester-London case study provides an alternative approach to investing in a line to a moderate-scale city destination, in this case Manchester. Unlike the approach taken by the Dutch government—to build new right-of-way for true high-speed rail characteristics—the rail service from London to Manchester runs over traditional, non-HSR tracks at a top speed of 125 mph. Major investment in improving the track has not been made by its owner, Network Rail.

If investment were made in support of in-cab signaling, the existing equipment would run at 140 mph. Thus, higher speeds have been established in a 210-mile corridor, but one that is anchored in a much larger city (London) than in this study corridor. Based on a review of schedules, the train to Manchester attains an average speed of 100 mph over track limited to 125 mph, while the Thalys train attains an average speed of 81 mph over track designed to support 186 mph speed.

A comparable HSR corridor segment in Europe? RSG could *not* identify a freestanding, independent HSR rail corridor in Europe with a population as small as that between Bakersfield and Merced since most of these corridors are part of a larger network of HSR trains or are just temporary solutions until full completion of an HSR alignment and related ridership or revenue numbers are not published. Further investigations could be made concerning corridors that do not upgrade to full HSR speed capabilities, but that was not undertaken as part of this benchmarking task.

American Case Studies for Comparison with the CVS Corridor? Rail service between Las Vegas to Victorville/Apple Valley was projected to attract 5.4 million passengers in 2030, with the present developer expecting 10 million passengers. This line is 170 miles long, with a two-directional, one-track alignment and passing sidings. This project should be monitored by CHSRA and others interested in the Bakersfield to Merced segment because it has one end in an isolated area. While the Las Vegas population at 2.2 million people is like Sacramento, its trip-generating characteristics will be uniquely high. With no rail terminal directly in the Los Angeles area for its initial usable segment, it mirrors the challenge of operating service out of Bakersfield and should be closely monitored.

5.3 Integrating New Segments into Systems

The local metropolitan populations directly served by proposed stations from Bakersfield to Merced are significantly smaller than the shorter HSR corridors in Europe, whose lines are

always anchored by at least one major city. In this case, much of the demand influencing the total rail system (San Joaquins, ACE, buses, and HSR) comes from an area north of the initial HSR segment's terminal and connections to and from the populous areas (LA basin, Bay Area) require a transfer to a connecting service. The end goal of the HSR system is to connect to large anchor metro areas (e.g., Los Angeles, San Francisco); however, at present, the CVS is being built currently as a standalone piece and there are no true comparable systems.

Understanding Demand for Services north of Merced. Importantly, the market for rail services in the area north of Merced is quite strong per the ETO Team estimates. The ETO Team report breaks down the geographical characteristics of the total demand by noting that ridership within the HSR segment accounts for about 2 million users; trips with one end within the HSR segment account for somewhat under 1 million users; and, trips with both trip ends north of Merced provide about 6.7 million users of those using the full systems improved by the project.

The concept that trip-making within a regional, commuter-oriented system would be greater than volumes on long-distance rail services is not new or surprising. As noted, in the British case, demand on the London system was for regional—not intercity—flows, which is a concept that has dominated the last 10 years of planning in the Northeast Corridor in the United States. In both the British and Northeast scenarios, investments are being examined in terms of their ability to improve travel for both categories of riders at once.

In this project's case, analysis finding a strong market for rail services north of Merced is good news for the longer-term segment between Bakersfield and Sacramento. The size of these trip-making volumes emphasizes the need to continue planning for the best way in which to maximize the positive impact of both HSR investments and local rail service investments in this area. Given the scale of demand forecast by the ETO Team in support of the SBS study, it is clear that there will be many opportunities for the designers of the HSR project to continue to work closely with local rail planners to maximize the quality of service offered by the new systems.

Learning from the benchmarking process. Thirty years ago, the designers of the new line from Kent to London had to find the optimal solution for investment and financing of the end of the Paris London line. Remarkably, they challenged existing assumptions and found a new approach—in their case, one in which local electrified commuter rail lines would use the newly created two-track HSR system into St. Pancras station. The Javelin train was the result of this strategy to bring together the needs of the long-distance rail user with those of the short-distance rail user. Based on the results of the ETO Team analysis of demand, the areas to the north of the present terminus at Merced look like areas of strong demand for integrated rail services, with great opportunities for continued cooperative planning.

All of this supports the results of the SBS study that the next major investment from the CHSRA should focus investment on getting the CVS into successful operation.

6.0 Discussion of Risks

The primary unknown, as noted previously, is whether ridership will materialize as expected in the Central Valley and the connecting corridors. In the CVS corridor, forecasts show triple the demand from where it was in 2017 for HSR and all connecting services. Elasticity analysis show that demand is reasonable based on the LOS changes. In other words, if the demand is there, then the ridership should happen.

Any analyses that can be made by the ETO Team or others to clarify further the demand for the proposed services will only strengthen the forecasts. Scenarios that seek to further understand congestion on competing corridors or running different rail model scenarios would help evaluate how ridership changes under different system changes in the CVS. RSG recognizes there are costs associated with this work and that many scenarios are technically not valid due to Proposition 1A limitations for HSR investment.

6.1 Downside and Low Case Scenarios

The ETO Team put together a downside scenario for the CVS in addition to the main scenarios. It was intended to be a sensitivity test to demonstrate what would happen to ridership if the regional connections were not optimized (i.e., transfers not timed). Additionally, the KPMG report constructed a “low case” analysis that focused on understanding the additional risk of delays in supporting infrastructure investments and potential downturn events.[35] This low case analysis occurred as a postmodel analysis outside of the original forecasting study. This analysis assumed hourly HSR service, like the downside case, but also assumed “No Build” service levels for ACE, San Joaquins, and the Thruway Bus. This scenario assumes hypothetically that none of the improvements of the connecting services would materialize and only HSR would be implemented.

As expected, downside results in a reduction in HSR use and connections to the other services, but it is still a substantial increase in riders from the “No Build” scenario. The low case results in similar ridership levels on existing services as in the “No Build,” but with the addition of 1.7 million HSR trips (Table 6-1). The costs increase from the “No Build,” but so do revenues, resulting in a difference of approximately $10 million extra cost for the state (Table 6-2). This extra cost may be deemed worthwhile because it removes vehicles from congested roads and reduces greenhouse gas emissions, while also laying the building blocks for HSR in California.

[35] KPMG. “California High-Speed Rail Merced to Bakersfield Business Case Study,” February 2020. Prepared for California High-Speed Rail Authority.

Table 6-1: CVS Ridership—"No Build" vs. Base case vs. Downside vs. Low Case

SCENARIO UNLINKED TRIPS (000/YEAR)	CURRENT 2017	"NO BUILD" 2029	HSR 2029 "BUILD" CASE	HSR 2029 DOWNSIDE	HSR 2029 LOW CASE	% DIFF HSR 2029 LOW - BASE
HSR	–	–	2,049	1,656	1,656	-19%
San Joaquins	1,102	1,778	3,111	2,983	1,170	-62%
ACE	1,503	2,191	4,572	4,394	2,516	-45%
Thruway Buses	375	341	668	594	341	-49%
Other Thruway	–	587	1,441	1,395	587	-59%
Total Unlinked	**2,980**	**4,897**	**11,841**	**11,022**	**6,270**	**-47%**
Total Linked (from ETO report)	**2,606**	**3,969**	**8,776**	**–**	**–**	**–**
Imputed average boardings	1.14	1.23	1.35	–	–	–

Table 6-2: CVS Cost and Revenues—"No Build" vs. Base Case vs. Downside vs. Low Case

SCENARIO COST AND REVENUE (MIL $/YEAR)	CURRENT 2017	"NO BUILD" 2029	HSR 2029 "BUILD" CASE	HSR 2029 DOWNSIDE	HSR 2029 LOW CASE	% DIFF HSR 2029 LOW - BASE
Cost	–	144.4	237.1	237.1	191.4	-19%
Fare Revenue	45.2	61.6	178.8	163.3	81.9	-54%
Ancillary Revenue	–	0.0	16.5	16.5	16.5	0%
Remaining State Cost	–	82.8	41.8	57.3	93.0	122%
Cost Recovery	–	42.7%	82.4%	75.8%	51.4%	-38%

7.0 Southern California Cost Operations and Maintenance Peer Review

The SoCal HSR Corridor extends 44 miles from Burbank North (Airport) station to Anaheim station. HSR trains would make intermediate stops at Los Angeles Union Station and Fullerton. Metrolink connections would be available at all four stations while Amtrak (LOSSAN Corridor) connections would be available at all stations except for the Burbank Airport (HSR) station. HSR trains and Metrolink and LOSSAN service between Burbank and Anaheim would leverage the "Link US" project at Los Angeles Union Station that will initially construct a two-track viaduct over Highway 101 (Phase A), reconfiguring at least four station tracks to run through to the south and connect with the mainline near Amtrak's 8th Street Yard. Phase B of the project (Scenario 3 and Scenario 4) will include the full conversion of Union Station.

7.1 Side-by-Side Analysis Scenario Operations and Maintenance Costs

RSG team member, LTK, compared the SBS O&M costs for SoCal to peer operations. This was done due to the lack of "built-up" cost data reflecting crews, vehicle maintenance, dispatching, agency overhead, and similar cost considerations for the SoCal analysis where the ETO Team had to rely on existing information to estimate the O&M cost for each scenario for Metrolink and LOSSAN. To accomplish this task, the team converted train miles provided by the ETO Team to vehicle miles based on the number of cars per train consist assumed for each rail service. The breakdown of annual service delivery by rail operator for each scenario is shown in Table 7-1.

Table 7-1: SBS Analysis Annual Service Delivery, by SoCal Rail Operator

SCEN.	LOSSAN TRAIN MILES	LOSSAN VEHICLE MILES	METROLINK TRAIN MILES	METROLINK VEHICLE MILES	HSR TRAIN MILES	HSR VEHICLE MILES	TOTAL TRAIN MILES	TOTAL VEHICLE MILES
1	1,733,032	10,398,192	2,958,571	14,792,855	–	–	4,691,603	25,191,047
2	2,607,402	15,644,412	5,932,403	29,662,014	–	–	8,539,805	45,306,426
3	2,607,402	15,644,412	6,788,684	33,943,420	–	–	9,396,086	49,587,833
4	2,607,402	15,644,412	6,788,684	33,943,420	835,120	6,680,960	10,231,206	56,268,793

Based on these service levels and the O&M costs provided in the SBS study, the improved efficiency of each scenario versus the Scenario 1 baseline was computed. Based on SBS analysis statistics, Scenario 1 is projected to deliver service at a cost of $15.35 per revenue Vehicle Mile (RVM), as shown in Table 7-2.

Table 7-2: SoCal Scenario Operating Costs per Vehicle Mile

SCENARIO	OPERATING EXPENSES	VEHICLE MILES	OPERATING COSTS PER VEHICLE MILE	IMPROVED EFFICIENCY (PCT) VS. SCENARIO 1
SoCal Scenario 1 (LOSSAN, Metrolink)	$386,570,000	25,191,047	$15.35	–
SoCal Scenario 2 (LOSSAN, Metrolink)	$603,700,000	45,306,426	$13.32	13%
SoCal Scenario 3 (LOSSAN, Metrolink)	$610,080,000	49,587,833	$12.30	20%
SoCal Scenario 4 (LOSSAN, Metrolink, CHSR)	$659,580,000	56,268,793	$11.72	24%

The progressively more intense rail operations of the four SBS study scenarios demonstrate improved efficiencies due to more productive crew and fleet utilization as well as a reduction in overhead costs as a function of service delivered. Adding a third type of service—HSR express service—in Scenario 4 reinforces this improving efficiency trend. As vehicle miles increase, the efficiencies improve at a reasonable rate of 24% when comparing SoCal Scenario 4 with Scenario 1, as shown in Table 7-2.

Table 7-3 presents the SBS analysis costs per RVM by operator, as derived by the RSG team. Scenario 1 uses the LOSSAN 2018 cost of $11.06 per RVM to derive the Metrolink cost of $18.35 per RVM by applying the known vehicle mileages of the two operators. These values produce the weighted average of $15.35 per RVM shown in Table 7-3. The Scenario 2 costs by operator were derived for both LOSSAN and Metrolink by reviewing the SBS analysis's relative intensification of the two services. Compared with Scenario 1, the LOSSAN service in Scenario 2 increased by about 50% while the Metrolink service doubled. Therefore, the relative operating efficiency improvement for Metrolink was set to approximately double that of LOSSAN: 22% improvement for Metrolink and an 11% improvement for LOSSAN. The weighted average of the LOSSAN cost of $10.00 and Metrolink cost of $15.08 yields the overall scenario cost of $13.32 per RVM.

Table 7-3: SoCal Scenario Operating Costs per Vehicle Mile, by Operator

SCENARIO	OVERALL COST PER RVM	LOSSAN COST PER RVM	DERIVED METROLINK COST PER RVM	DERIVED HSR COST PER RVM
SoCal Scenario 1 (LOSSAN, Metrolink)	$15.35	$11.06	$18.35	–
SoCal Scenario 2 (LOSSAN, Metrolink)	$13.32	$10.00	$15.08	–
SoCal Scenario 3 (LOSSAN, Metrolink)	$12.30	$10.00	$12.87	–
SoCal Scenario 4 (LOSSAN, Metrolink, CHSR)	$11.72	$10.00	$12.87	$9.90

The LOSSAN costs for Scenario 3 and Scenario 4 were held constant given that LOSSAN service delivery for Scenario 2, Scenario 3, and Scenario 4 are identical. Similarly, Metrolink costs for Scenario 4 are the same as Scenario 3 given identical service delivery. The two known

Scenario 4 costs were used to derive the third cost in Scenario 4: the HSR cost per RVM of $9.90.

Side-by-Side Analysis Trends in Service Delivery Cost Efficiency

According to Metrolink's 2018 National Transit Database (NTD) data, Metrolink has a cost efficiency of $17.39 operating expenses per RVM. Table 7-2 shows that the combination of LOSSAN and Metrolink operations creates a more efficient baseline metric of $15.35 per vehicle mile than Metrolink's 2018 NTD rate.

The incremental improvement in service delivery cost efficiency shown in Table 7-3 is consistent with the assumptions made in Metrolink's 10-Year Strategic Plan developed in 2015.[36] This plan included an evaluation of three increased service-level scenarios. Scenario 3 considered the integration of HSR. Based on the plan, Metrolink anticipated a 72% growth in service levels between the strategic plan's "No-Build" scenario and Scenario 3. When factoring in the increased vehicle miles, a 31% increase in efficiency between the "No Build" scenario and Scenario 3 is anticipated.

7.2 Peer Systems Operating Cost Comparison

The RSG team identified peer commuter rail systems based on their location, type of service, rail vehicle technology, and LOS (Table 7-4). The list includes California commuter rail operators and medium-size commuter rail operators from other parts of the United States. Based on the peer systems shown in Table 7-4, the simple average of efficiency is $19.26 per RVM. When systems with larger RVMs are weighted more heavily, the weighted average efficiency drops to $17.45 per RVM.

Table 7-4: Peer System 2018 Operating Cost per RVM

PEER SYSTEM	OPERATING EXPENSES	RVM	OPERATING EXPENSES PER REVENUE MILE
Minneapolis Northstar	$16,153,136.00	599,814	$26.93
San Jose Altamont Corridor Express	$19,184,963.00	1,102,574	$17.40
San Diego Coaster	$16,592,479.00	1,376,954	$12.05
Dallas/Fort Worth Trinity Railway Express	$29,486,784.00	1,627,050	$18.12
Seattle Sounder	$52,241,469.00	2,233,332	$23.39
Washington DC Virginia Railway Express	$78,506,599.00	2,416,319	$32.49
Miami Tri-Rail	$96,233,640.00	3,607,386	$26.68
Chicago-South Bend South Shore Line	$51,197,364.00	4,211,197	$12.16
Salt Lake City FrontRunner	$43,421,951.00	5,429,232	$8.00
Baltimore-Washington MARC	$161,020,606.00	6,508,708	$24.74
San Francisco Caltrain	$127,431,635.00	7,202,308	$17.69
Los Angeles Metrolink	$235,027,282.00	13,513,335	$17.39
Boston MBTA	$371,909,742.00	24,565,346	$15.14
Chicago Metra	$761,950,331.00	43,674,979	$17.45

[36] Metrolink. "Our Future is on Track: 10-Year Strategic Plan (2015-2025)," 2015.

Comparison of Peer System Operations and Maintenance Costs with Side-by-Side Analysis

The SBS analysis operating costs were compared with peer properties and found to be lower than most comparable statistics.

Excluding those for Scenario 1 (the SoCal “No Build”), the derived Metrolink operating cost range of $12.87 (Scenario 4) to $15.08 (Scenario 2) was found to be:

- Lower than the simple average of peer commuter rail operations ($19.26).
- Lower than the average of peer commuter rail operations when weighted by service delivered ($17.45).
- Lower than the current Metrolink operating cost ($17.39).

In addition, the operating costs of SBS analysis scenarios 2, 3, and 4 were lower than most of the “large system” peer commuter rail property operating costs, which include MBTA ($15.14), Metra system ($17.45), the BNSF component of Metra ($12.98), and Union Pacific component of Metra ($15.02).

The SBS analysis LOSSAN operating cost range of $10.00 (Scenario 2, Scenario 3, and Scenario 4) to $11.06 (Scenario 1) was found to be:

- Lower than the simple average of peer commuter rail operations ($19.26).
- Lower than the average of peer commuter rail operations when weighted by service delivered ($17.45).
- Lower than the current Metrolink operating cost ($17.39).
- Lower than all of the “large system” peer commuter rail property operating costs, which include MBTA ($15.14), Metra system ($17.45), the BNSF Railway component of Metra ($12.98), and Union Pacific component of Metra ($15.02).

The Side-by-Side Analysis derived HSR operating cost of $9.90, which applies only to Scenario 4, was found to be lower than all the peer O&M costs.

7.3 Summary of Operations and Maintenance Analysis

The operating costs used in HSR’s SBS analysis for Metrolink, LOSSAN, and HSR operations in the LA Basin were found to be lower than most peer passenger rail operating costs. Because these costs reflect the preponderance of overall costs required to deliver service, the SBS analysis presents an optimistic assessment of the financial feasibility of HSR service in Southern California. It is unlikely that service could be delivered for the costs cited in the SBS analysis, despite overall network operating efficiency improvements as richer LOS are operated in the future. A more likely outcome is higher operating costs than are predicted in the SBS analysis, thereby requiring greater-than-predicted public operating subsidies to sustain the SoCal service.

8.0 Conclusions

This peer review report summarizes the RSG team's review and analysis of the SBS study. RSG's peer review evaluated whether the ETO Team's ridership forecasts were reasonable, whether the ridership benefits assigned to CHSRA were correctly allocated, and whether the model inputs and assumptions were correctly defined and fairly provided across all three corridors.

The RSG team determined that the ETO Team's ridership analysis is reasonable. While the ridership forecasts used in the SBS study are high-level and meant for corridor comparison purposes, they were made and used appropriately to help understand which corridor obtained the most ridership increase, among other benefits. Moreover, the assumptions and benefits were fair and assigned correctly. That said, the O&M cost analysis for the SoCal corridor found that the assumed operating cost estimates were low compared to other peer systems in the United States.

This peer review also found that the CVS corridor obtains the highest forecast gain in ridership and does so at the lowest increase in cost, relative to a "No Build" scenario. This corridor includes the HSR service from Bakersfield to Merced and improvements in supporting ACE and San Joaquins rail and bus services. This peer review also found revenues to be reasonable given the significant change the CVS would create in that corridor's transportation system.

Over 75% of the trips included in this increase in ridership in the CVS corridor are *not* riding on the HSR system itself, between Merced and Bakersfield. Should these still be counted as valid trips in the CVS corridor and the HSR network? Yes, as added bus service in the northern CVS works only with connections to the HSR.

This peer review also analyzed the more incremental changes in the NorCal and SoCal corridors. While the review focused on the CVS, it also confirmed the NorCal and SoCal ridership estimates were sound. While the SoCal estimates appear slightly high, overall things look reasonable.

A remaining risk is that the demand for the services may not materialize in the CVS as forecast. However, this risk has more margin for error to still achieve the financial benefits as compared to the NorCal and SoCal corridors, which have higher costs and lower forecasted ridership and revenue.

Finally, there is some risk that the connecting transportation services expected in the CVS "Build" scenario will not fully materialize. This risk seems relatively low compared to the NorCal/SoCal corridors since there is much less need for additional regional funding in the "Build" scenario of the CVS relative to the other corridors.

9.0 Disclaimers and Caveats

This peer review report represents a high-level review of the SBS study results. RSG has reviewed the reports as well as model inputs, assumptions, and outputs that were made available to RSG. This peer review leveraged RSG's professional experience in travel demand forecasting and judgment, using information available to it at the time. As such, any new information could alter the validity of the results and conclusions made.

The original ridership and revenue models were intended for use in comparing the three corridors and are being used to inform decision-making at a high level.