CALIFORNIA High-Speed Rail Authority

CALIFORNIA HIGH SPEED RAIL EARLY TRAIN OPERATOR

Central Valley and Peninsula Corridors Operations Financial Plan Study

May 1st, 2019

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Executive Summary

Assumptions and Methodology

This document is strictly for deliberative purposes. It should be noted that this is the first time since the Business Plan 2018 that a study is undertaken with some level of detail in understanding the benefits that early HSR operations will create. Therefore, the ETO completed an analysis in a stepped approach specifically evaluating the following:

Step 1: Analysis of ridership and revenues on HSR operations between Merced – Bakersfield using the existing San Joaquins fare structure, in order to understand how much ridership can be gained and how much service to provide to carry that ridership. Accordingly, the associated operations and maintenance (O&M) costs are also calculated for this segment including costs for a Train Operating Company (TOC). Additionally, analysis of ridership and revenues (using existing Caltrain fare schedule) on HSR operations between 4th & King and Gilroy was conducted with the associated O&M costs in an incremental view to operations on the Central Valley Corridor. This step did not involve running multiple fare levels or any attempt to maximize revenue, as that effort is intended to be part of the optimization efforts in the future.

Step 2: After understanding the ridership and revenues impact in Step 1, the ETO analyzed the HSR operations across the San Joaquins and ACE corridors and the impact on revenue, ridership and cost from a total integrated corridor view. The purpose is to provide an understanding and identify the benefits that HSR operations will bring, in terms of train miles offered, quality of service, efficiency in cost per train mile and improvement in costs covered by fare revenues. The associated O&M costs include the HSR costs calculated in Step 1, in addition to the San Joaquins and ACE O&M costs, including thruway bus. Revenues are evaluated in total since revenue sharing agreements have not yet been established among the operators. Those revenue sharing arrangements will presumably take into account the costs each incur in order to provide service.

Step 3: There will be further optimizations, which include but are not limited to the following:

- Perform an integrated service planning including San Joaquins, ACE and HSR corridors to optimize the connections and maximize the service offerings to the passengers traveling between Sacramento, Oakland and San Jose in the Bay area;
- Design a highly synchronized integrated service timetable for a seamless journey;

- Optimization and integration of ticketing and fare policy in the combined corridor;
- Establish the priorities, required improvements, additional infrastructure, budget and commitments required north of Merced including CalSTA, ACE and San Joaquins;
- Optimization of the required track and systems infrastructure;
- Evaluate further opportunities to optimize bus connections;
- Definition of the required fleet in the integrated corridor;
- Update the service concept;
- Update the ridership and revenue forecasts based on the revised inputs from the operations planning process; and
- The updated ridership forecast and the definitions in the operations planning step will then be used to optimize the required rolling stock fleet and train layout specifications and stations requirements.

The optimization and refinement process in Step 3 are expected to begin in the coming months and are, therefore, not covered in this study.

The study is neither a proposal nor an offer to perform such services and has been carried out from a pure operations and maintenance (O&M) perspective, without regard for the implications related to:

- Infrastructure capital costs, completion dates,[1] etc.;
- Compliance with the CHSRA business plan;
- Compliance with Prop1A;
- Commercial arrangements.

Financial projections included in this document are therefore to be seen as high-level and indicative projections of costs and revenues related to operations on the CVC corridor and subsequently related to incremental operations on the PenC corridor (i.e. *additional* to CVC operations).

[1] At the date of performing this study the master schedule (including the procurement and construction dates) was in the process of being updated by CHSRA. It will be reviewed by the ETO for plausibility once it is available.

The information contained in this report and appendix as they relate to O&M costs and revenues were obtained from the following sources, which includes 3rd party information based on their assumptions:

- HSR costs estimates were calculated by the ETO for CVC and PenC incremental; whereas
- ACE and San Joaquins costs were calculated and provided by San Joaquin Regional Rail Commission (SJRRC) staff for CVC, in the total corridor view;
- Ridership and revenue forecasts were generated from the State Rail Plan Model as the basis and calibrated for purposes of this study. Inputs to the ridership model were provided jointly by the ETO, CalSTA and SJRRC staff (for CVC). As a side note, it was identified that the ridership values in the smaller Central Valley HSR section are not adequately represented in any of the ridership models available to the Authority, which were designed to represent valley to valley and Phase 1 service;
- Further, in consultation with CHSRA and CalSTA, it is assumed the HSR infrastructure assets and HSR train service in the CVC are integrated as part of the regional service of ACE and San Joaquin. This assumption implies that all competing trains from the ACE and San Joaquins corridors will stop in the northmost station of the HSR (Merced) and the passengers will be transferred to the high-speed service.

The financial balance reviewed in the study concerns the projected difference between estimated O&M costs and revenues, analyzed on the basis of the following key assumptions:

- This study provides a high-level review of the financial balance related to early HSR services on the CVC corridor for the time period 1 January, 2026 to 31 December, 2029. The PenC corridor financial balance is projected for the time period 1 January, 2028 to 31 December, 2029. This timeframe is solely used for purposes of this study and is under evaluation by the Authority for implementation.
- All dollar amounts in this study are provided and calculated in 2018 USD, unless stated otherwise.
- This study reviews the operations and maintenance costs of operating the HSR service. For purposes of this study, a 10% profit margin and a 10% contingency margin are included into these cost projections.

- It is also assumed that CHSRA incurs all capital expenditures and that all the necessary assets, systems, equipment, infrastructure, facilities, etc. are already in place prior to “day 1” of operations and revenue service.
- It is assumed that the HSR service is provided by a designated TOC. This TOC will have several pre-existing maintenance contractors assigned to it which, for the purpose of this study, are considered to function as internal departments of the TOC. The TOC, for purposes of this study, represents a stand-alone company and costs calculated for TOC overhead can be further optimized depending on future commercial arrangements.
- Only for purposes of this study, the presence of an HMF between Fresno and Kings/Tulare is assumed (without rental/ lease costs or capital cost depreciation, but costs to maintain are included, e.g. janitorial services, etc.). The final location for the HMF is still to be determined by the Authority.
- This study furthermore looks at a ‘steady’ state projection of costs and revenues, following a presumed ramp-up period. It is assumed that the service ramp-up effects on cost/ efficiency will be covered during the trial operations period.

This study reviews ridership fare revenue on the basis of the following fare assumptions:

- For CVC, the HSR fares are based on current San Joaquin fare structure. For PenC, the HSR fares are calculated based on the 2018/2019 Caltrain fare schedule with the following surcharges:
    - For study purposes PenC Coach class fares shall be calculated at Caltrain fare plus a premium of 10%.
    - Business/First class fares shall be calculated at the PenC coach class fare plus a premium of 75%.
    - Assumed an 80% /20% split of coach versus business users. Weighted surcharge is therefore 23% on top of Caltrain cash fare.
    - The fare assumptions should be re-evaluated at a later time for consideration of yield management and premium services to optimize revenues.

The study furthermore reviews and validates revenue estimates for the most plausible ancillary revenue streams resulting from the operation of the HSR service in both corridors.

Central Valley

The financial balance of HSR services in the Central Valley corridor is reviewed in two steps:

- *First*, HSR service from Merced to Bakersfield from a stand-alone financial perspective, considering revenue and costs in this alignment section, which is covered in the main body of the report. The O&M amounts can also be seen in Figure ES3. The build-up of revenues and costs for this stand-alone financial balance of an early Merced-Bakersfield HSR service is as follows (figures below shown in 2026, Year 1).
    - Operating income of USD 37.4 million is composed of USD 6.9 million in ancillary revenue (primarily composed of carbon credits income, fiber cable data capacity and system naming rights) and USD 30.5 million in fare revenue (based on projected annual ridership of 1.7 million passengers and fare levels equal to today's San Joaquin fares);
    - TOC operations cost of USD 24.5 million is predominantly composed of USD 13.9 million in staffing costs (for 105 FTE), USD 9.5 million in electricity costs mostly for traction power, as well as USD 1.0 million for OCC costs;
    - Rolling stock (RS) and Heavy Maintenance Facility (HMF) cost of USD 12.6 million predominantly includes USD 7.8 million in labor costs (for 67 FTE) and USD 2.4 million in Heavy Maintenance Facility (HMF) related costs alongside USD 2.3 million for rolling stock cleaning costs assuming four operational trainsets (on top of which one trainset is for maintenance and one trainset is for operational reserve);
    - Track & Infrastructure cost of USD 19.7 million is composed of USD 1.2 million for civil structures maintenance, USD 2.2 million for facilities maintenance, and USD 16.3 million for track and systems maintenance (USD 1.1 million for non-revenue vehicles, USD 13.1 million for labor costs and USD 2.1 million for materials and utility costs);
    - Administration and management cost of USD 30.2 million is composed of USD 0.2 million for fare collection, USD 7.2 million for marketing and branding costs, USD 15.6 million for TOC corporate services and management costs (mostly driven by USD 3.0 million for insurance, USD 1.4 million for training, USD 1.5 million for IT, and USD 9.4 million in labor), USD 3.0 million for environmental/health & safety costs and USD 4.2 million for security.

- Contingency is calculated at 10% for a cost of USD 8.7 million.
- Profit Margin is calculated at 10% for an amount of USD 9.6 million.

- *Second*, HSR service from Merced to Bakersfield, connections from Merced to Sacramento in the North and connections to the Bay Area through Oakland and San Jose, as an integrated financial perspective for HSR, San Joaquins and ACE corridors in 2026 (this is covered in detail in Appendix 1 to the report) to see the wider impact and positive benefits.

The review of the logic, underlying assumptions and projected financial balance in these two steps for operation of early HSR services in the Central Valley Corridor leads to the following *principal conclusions*:

1. Central Valley Early HSR Service Creates Significant Value

- Introduction of an early operations HSR service in the Central Valley will produce significant value and benefits to communities, public transport passengers and operators as well as to the State of California.

  Benefits may include:

  - Optimal use of State assets as dependency on the current private freight railroad infrastructure is reduced. The freight railroad infrastructure currently has limited capacity for additional passenger services;
  - Using dedicated high-speed infrastructure allows for higher frequencies of public transport services to be offered;
  - Achievement of higher frequencies in turn helps to improve critical connectivity available to local communities and allows the HSR operator to test and adjust the optimal rail service offered to the communities, while at the same time allowing for familiarization by and instruction to local communities;
  - It will also contribute to economic development and ease of access to economic opportunities throughout the Central Valley;

    Similar to Germany, California has thriving urban areas as well as communities that have less access to opportunities. It is worth noting an actual reference case out of many others, where the impact of integrating the communities with less opportunities with high-speed rail network can have a truly substantial impact. Montabaur was a

disadvantaged community in Germany back in 1999. During this time, there was a 13.8 million Euros CAPEX made as an investment for a 3 platform high-speed rail station. The total construction costs (including new parking slots, industrial area and Highway connection to the City) were 23.6 million Euros. Since the construction and final operation in August 2002 this connectivity opportunity attracted 205 million Euros investment by private entities in the community. A 3.2 million sq. ft big new neighborhood of the city of Montabaur developed between the city and new High-Speed Rail station. The result of this is a creation of 2,200 new permanent jobs, 80 new companies on site in Montabaur and over 2,500 passengers per day riding high speed rail. The passenger number increased since the opening in 2002 by over +130%. Now Montabaur is a thriving community. According to DB's experience, DB is confident that similar positive impacts will happen to the communities in the Central Valley from the introduction of high- speed services creating positive long term and permanent changes.

- Furthermore, HSR service introduction lowers the cost per train mile and reduces CO2 emissions from public transportation across the wider Central Valley corridor;
- Introduction of HSR service also results in shorter travel times for the passengers, enhancing the attractiveness of public transport and resulting in higher ridership as well as in a higher percentage of operations and maintenance costs recovered from fare collection across the wider the corridor;
- Finally, early HSR operations in the Central Valley may reduce the ramp-up time of Valley to Valley (V2V) HSR services once the required infrastructure has been completed.

Description	**Quantitative view on benefits**		**Qualitative view on benefits**
	With HSR (ACE, San Joaquins, HSR)	***Without HSR (ACE and San Joaquins)***	***Impact***
Train Miles Offered	1,932,225	990,838	More than double the service offer to the

			community, with more train frequencies
Description	**Quantitative view on benefits**		**Qualitative view on benefits**
	With HSR (ACE, San Joaquins, HSR)	***Without HSR (ACE and San Joaquins)***	***Impact***
Travel time in the corridor	Reduction of more than 90 min in the overall travel time		Better quality of service for the passengers
Average Cost per Train Mile	USD 110.61	USD 118.04	More efficient cost per mile
Percentage of costs covered by Fare (includes thruway bus)	73%	41%	32% improvement in cost recovery

Figure ES1: Benefits of HSR to Central Valley public transportation

2. Early HSR Service May Improve the Financial Balance of the Total Combined Regional Corridor

- The study shows in the second step that integrating the early HSR service into the regional corridor may improve San Joaquins and ACE's combined existing farebox recovery ratio. It is best practice in railway financial planning to measure the impacts to the total combined regional corridor (instead of one part of the alignment). The details are highlighted as follows:
    - HSR early services analysis of the total corridor, including San Joaquins, ACE and HSR shows the value of HSR services from the passengers' travel perspective and financial point of view. Based on the assumption that the TOC can provide HSR train services as a service provider to the SJJPA, the following advantages can be noted:
        - Increase in farebox recovery ratio for the combined corridor up to an estimated 73%;

- While in parallel, enhancing the train service offered in the total Central Valley Corridor (doubling of train miles).

Therefore, with a view to the preparation of early HSR train operations in the Central Valley, it is recommended to undertake a more detailed study of costs, ridership and revenue potential, as well as commercial/legal structuring for a Merced to Bakersfield HSR service that is integrated into the wider travel chain of the combined San Joaquins, ACE and HSR corridors. Such a follow-up study would also need to explore more carefully technical implications as well as HSR infrastructure CAPEX implications (the current study focuses first and foremost on the financial aspects of operations only).

The following table shows the improvement on the financial balance of the total corridor (ACE, San Joaquin, HSR).

Total 2026 with HSR (in 2018 USD mln) (ACE, San Joaquin, HSR) up to Merced			**Total 2026 without HSR (in 2018 USD mln) (ACE, San Joaquin)**		
Costs	Revenue	Difference	Costs	Revenue	Difference
228.4	165.8	(62.6)	140.3	57.5	(82.8)

Figure ES2: Corridor-level financial balance with/without HSR

3. Early HSR Services to Bakersfield As The Southernmost Station

- Poplar as the southernmost station of a future HSR service presents additional challenges from the operations perspective:
  - Assuming that the HSR corridor will replace the existing private freight railroad as an integral part of the wider corridor, it is noted that an HSR service that stops in Poplar will leave Bakersfield without any rail service. Therefore, all passengers at Bakersfield will only have bus connectivity.
  - Ridership on a Merced to Poplar HSR service would be significantly below a Merced to Bakersfield operating segment.
  - The cost addition related to operating down to Bakersfield instead of Poplar is minimal compared to the loss of ridership resulting from the exclusion of HSR service from Bakersfield.

- From the ridership and the financial balance perspective of public transport operations across the wider corridor, the preferred segment to be further developed, constructed and operated is to Bakersfield.

4. Madera

- The performance of a station is measured by the following two main components:
  - Direct access and direct egress, which reflects the passengers who access the system in this particular station; and
  - Seamless connectivity, which reflects the impact in the passengers who are using the station as a transfer point between connecting services. The behaviour of the passengers, when selecting the mode of transportation is highly sensitive to the transfer times and ease of connections.
- The Merced scenario compared to Madera offers:
  - Better cost efficiency per train mile due to a longer high-speed section;
  - Best option for seamless connectivity. After analyzing the State Rail Plan, Merced offers the best location for an intermodal station between ACE, HSR and San Joaquins;
  - Higher ridership due to Merced's catchment area compared to Madera (direct access / egress); and
  - The main drivers for the increase in Merced ridership compared to the scenario of Madera primarily results from reduced transfer penalties at Merced with the connecting services.

Peninsula

The financial balance of revenues and costs of HSR services in the Peninsula corridor is reviewed for HSR services from San Francisco 4th & King to Gilroy as a service that is operated *incrementally* (additionally) to CVC. The O&M amounts can also be seen in Figure ES3, and for the purposes below a comparison is made between Year 2028 (1st year of PenC assumed operations) and Year 2027 (2nd year of CVC operations) to arrive at the PenC incremental amounts. The build-up of revenues and costs for this incremental PenC service is as follows:

- Operating income of USD 31.4 million is composed of USD 8.2 million in ancillary revenue (primarily composed of carbon credits income, fiber cable data capacity, parking and system naming rights) and USD 22.9 million in fare revenue (based on projected annual ridership of 1.7 million passengers), as well as track access charges paid by Caltrain to HSR in the amount of USD 0.3 million per annum;
- TOC operations cost of USD 33.9 million is predominantly composed of USD 20.2 million in staffing costs (for incremental 168 FTE), USD 4.8 million in electricity costs mostly for traction power, USD 8.8 million in track access charges paid by HSR to Caltrain, and USD 0.1 million in additional costs for vehicles;
- Rolling stock (RS) and Light Maintenance Facility (LMF) cost of USD 9.7 million predominantly includes USD 3.7 million in labor costs (for incremental 31 FTE) and USD 1.1 million in LMF related costs alongside USD 4.8 million for rolling stock cleaning costs assuming six operational trainsets (on top of which one trainset is for maintenance and one trainset is for operational reserve);
- Track & Infrastructure cost of USD 3.0 million is composed of USD 0.1 million for civil structures maintenance, USD 2.7 million for track and systems maintenance (USD 0.4 million for materials, services, utility costs, USD 0.2 million for non-revenue vehicle costs, and USD 2.1 for labor costs), USD 0.2 million for facilities maintenance;
- Administration and management cost of USD 15.5 million is composed of USD 0.1 million for fare collection, USD 5.2 million for marketing and branding costs, USD 1.8 million for environmental/health & safety costs and USD 3.1 million for security, USD 1.0 million for staff training, USD 0.8 million for IT, USD 0.2 million for office supplies and uniforms / safety gear, USD 1.0 million in insurance costs and TOC management and administration salaries of USD 2.3 million.
- Contingency is calculated at 10% for a cost of USD 6.2 million.
- Profit Margin is calculated at 10% for an amount of USD 6.9 million.

The review of the logic, underlying assumptions and projected incremental financial balance for the PenC scenario leads to the following principal conclusion:

1. Operating an Early HSR Service on the Peninsula Corridor Overlaying the Caltrain Service Does Not Create A Substantial Impact

- The study shows that the operations and maintenance costs significantly exceed the forecasted revenues for this segment, San Francisco 4th & King – Gilroy. The PenC incremental O&M costs is approximately USD 75.2 million (including contingency and profit margin) and the incremental revenues (including ancillary revenues) is approximately USD 31.4 million.
- The study shows that overlaying early HSR operations in the Peninsula corridor servicing only 4 HSR stations (difference between the 2028 Electrification Scenario and the 2028 Electrification + HSR Scenario) will result in an incremental increase of only approximately 6% in ridership.
- Most of the improvements are already captured by the 2028 Electrification Scenario by Caltrain (without HSR).
- HSR service attending only these 4 stations cannot produce a significant impact in the Peninsula corridor before the tunnel section connects the Central Valley (these 4 stations represent less than 12% of the total number of passengers traveling in the Peninsula Corridor).
- The proposed HSR service without the connection to the Central Valley will compete with a well- established commuter rail corridor and except for the Gilroy to San Jose segment, adds incremental service to existing service (Caltrain baby bullet service). Therefore, the capture rate of these markets is limited.

The Figure ES3 below shows the total O&M costs for CVC (Merced – Bakersfield) reflected in 2026 – 2029. The total O&M increase in 2028 is driven by the start of PenC operations and calculated as incremental costs to CVC. The O&M incremental costs for PenC are reflected in 2028 and 2029 in addition to the CVC O&M costs reflected in those years.

Figure ES3: O&M Costs for CVC and PenC incremental

1 Introduction

1.1 Context

The CHSRA 2016 Business Plan treated the operations of the V2V section as one continuous segment from San Jose to Poplar Avenue by the end of 2025.

As the project progressed and additional information became available regarding the overall completion schedule and associated development of funding, the CHSRA articulated a strategy for staged introduction of the service in the new 2018 Business Plan as follows:

1) CVC (Central Valley Corridor) stand-alone operations start at the beginning of 2026;

2) PenC (Peninsula Corridor) incremental (i.e. additional) operations start at the beginning of 2028; and

3) V2V operations start at the beginning of 2030.

This study concerns both the first stage of HSR service introduction in the CVC corridor from 2026, as well as the second stage of HSR service introduction in the PenC corridor starting at the beginning of 2028.

At the CHSRA's request, the ETO (Early Train Operator) has developed a study for both stages listed above in Step 1 (as defined in 1.2.1) followed by Step 2 (as defined in 1.2.1), which analyzed the wider impacts to the total corridors including San Joaquins and ACE (for CVC).

The analysis presented in this document is hereinafter referred to as the CVC and PenC Operations Financial Plan Study or "the study".[2]

[2] ETO has prepared the CVC financial plan, as summarized in this document, in addition to ongoing development of the key deliverables in the ETO contract for the V2V section of the alignment, as foreseen in the CHSRA 2016 Business Plan. The financial and operational plan for analysis of the PenC stand-alone operations will be incremental to that for the CVC corridor.

1.2 Scope of the Study

1.2.1 Stand-Alone and Integrated Corridor Perspective

The ETO completed an analysis in a stepped approach specifically evaluating the following:

Step 1: Analysis of ridership and revenues on HSR operations between Merced – Bakersfield using the existing San Joaquin fare structure, in order to understand how much ridership can be gained and how much service to provide to carry that ridership. Accordingly, the associated operations and maintenance (O&M) costs are also calculated for this segment including costs for a Train Operating Company (TOC). Additionally, analysis of ridership and revenues (using existing Caltrain fare schedule) on HSR operations between 4th & King and Gilroy was conducted with the associated O&M costs in an incremental view to operations on the Central Valley Corridor. This step did not involve running multiple fare levels or any attempt to maximize revenue, as that effort is intended to be part of the optimization efforts in the future.

Step 2: After understanding the ridership and revenues impact in Step 1, the ETO analyzed the HSR operations across the San Joaquins and ACE corridors and the impact on revenue, ridership and cost from a total integrated corridor view. The purpose is to provide an understanding and identify the benefits that HSR operations will bring, in terms of train miles offered, quality of service, efficiency in cost per train mile and improvement in costs covered by fare revenues. The associated O&M costs include the HSR costs calculated in Step 1, in addition to the San Joaquins and ACE O&M costs, including thruway bus. Revenues are evaluated in total since revenue sharing agreements have not yet been established among the operators. Those revenue sharing arrangements will presumably take into account the costs each incur in order to provide service.

In consultation with CHSRA, CalSTA and SJRRC staff, it is assumed that the HSR infrastructure assets and HSR train service in the CVC are integrated as part of the regional service of ACE and San Joaquin. This assumption implies that all competing trains from the ACE and San Joaquins corridors will stop in the northmost station of the HSR (Merced) and the passengers will be transferred to the high-speed service. This will provide a more efficient utilization of state resources across the total corridor and will help reduce the capacity constraints of the private railroads in this section.

Accordingly, the following financial balance (meaning the difference between revenue and costs) of the Central Valley HSR operations is reviewed in the following two steps:

- Stand-alone financial perspective on HSR service (without considering impact of HSR service on the total corridor including San Joaquin and ACE corridors); and
- Integrated corridor financial perspective on HSR service (which considers impact of HSR service on the total corridor including San Joaquin and ACE corridors).

An incremental analysis for Peninsula HSR operations was analyzed for O&M costs and ridership/revenues as incremental to CVC, starting in 2028.

1.2.2 Analysis

The following two steps were taken when conducting an analysis for CVC related to ridership / revenues and O&M costs:

- *Step 1: Stand-alone financial perspective on Merced to Bakersfield HSR service*

  This only considers the ridership and operations costs in the section between Merced and Bakersfield and is reviewed in the main body of this report.
- *Step 2: Impact on integrated corridor, Merced to Bakersfield HSR service, ACE & San Joaquins*

  This considers the impact of the introduction of HSR service on ridership and operation costs across all the relevant Central Valley corridors (San Joaquin, ACE and HSR) and is described in Appendix 1. It provides a holistic view developed to review the impact in the region of starting or not the HSR early operations.

The following analysis was conducted for PenC related to ridership / revenues and O&M costs:

- *HSR service from San Francisco 4th & King to Gilroy*

  This review is analysed in an incremental financial perspective to CVC, considering revenue and O&M costs discussed in the main body of the report.

1.3 CVC Alignment, Stations and Timeline

The CVC study provides cost and revenue projections for a regular revenue service operations on the 175-mile, Merced to Downtown Bakersfield corridor shown in Figure 1-1.

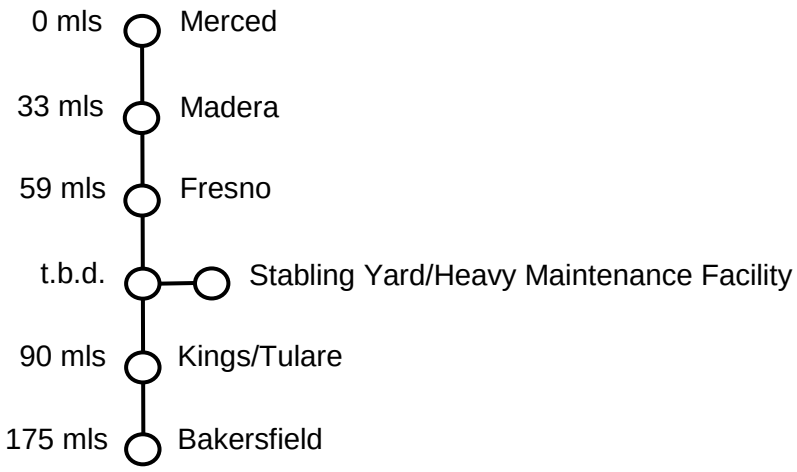


Figure 1-1: Corridor stations and mileage for CVC stand-alone operations

The CVC study is driven by, and limited by, a number of important working assumptions:

- The CVC study covers a four-year period of assumed CVC operations, from 1 January, 2026 to 31 December, 2029. It excludes any financial in and outflows prior to, and subsequent to, this four-year period. It was prepared assuming that all costs related to operations, rolling stock, and infrastructure needed to provide the service, are *direct* to the TOC;
- For this plan, the ETO and CHSRA agreed on a working service concept for CVC operations, which is: one high-speed train per hour per direction. To meet the hourly train schedule, six high-speed trainsets will be required, four in revenue service, one protect train (operational reserve), and one train for maintenance purposes.

In Chapter 3, a number of key characteristics are further described defining the scope of CVC operations, as well as key (working) assumptions on which the operational concepts, service levels, and analytical logic of this study are based.

These have all been discussed expressly and agreed upon with the CHSRA, since they provide very clear limitations and a very clear scope to this study.

1.4 PenC Alignment, Stations and Timeline

The PenC study provides cost and revenue incremental to the CVC for regular revenue service operations on the 77-mile, San Francisco 4th & King to Gilroy corridor shown in Figure 1-2. The PenC incremental study is driven by, and limited by, a number of important working assumptions.

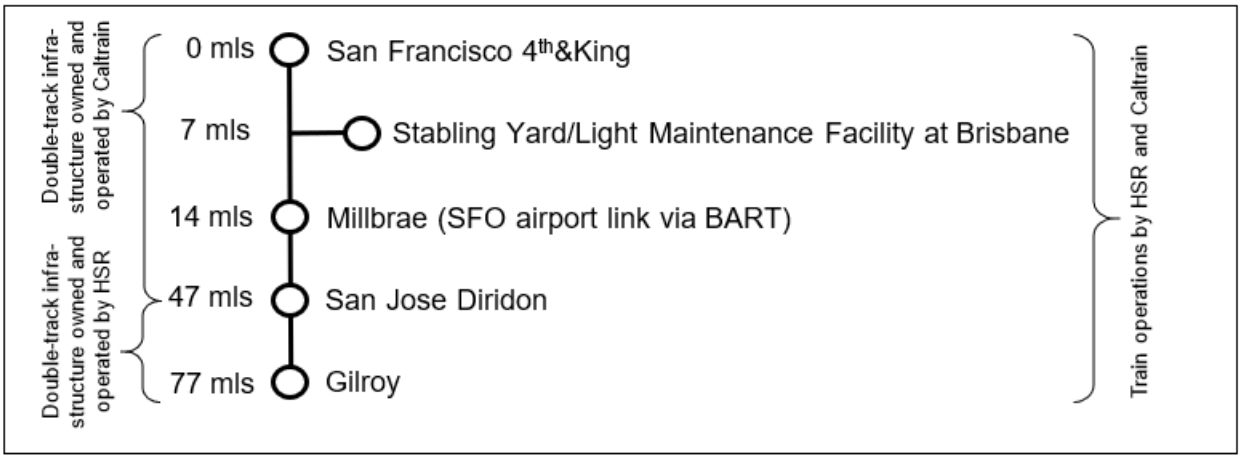


Figure 1-2: Corridor stations and mileage for CVC stand-alone operations

The PenC incremental study covers a two-year period of assumed operations running in parallel to the CVC operations, from 1 January, 2028 to 31 December, 2029. It excludes any financial in and outflows prior to, and subsequent to, this two-year period. It was prepared assuming that all costs related to operations, rolling stock, and infrastructure needed to provide the service, are *direct* to the TOC.

For this plan, ETO and CHSRA agreed on a working service concept for PenC operations, which is: two high-speed trains per hour per direction. To meet the half-hourly train schedule, eight high-speed trainsets will be required, six in revenue service, one protect train (operational reserve), and one train for maintenance purposes.

In Chapter 4, a number of key characteristics are further described defining the scope of PenC operations, as well as key (working) assumptions on which the operational concepts, service levels, and analytical logic of this study are based.

These have all been discussed expressly and agreed upon with the CHSRA, since they provide very clear limitations and a very clear scope to this study.

1.5 Disclaimer

This document is strictly for deliberative purposes. It is neither a proposal nor an offer to perform such services. Financial projections included in this document are to be seen as high-level and indicative projections of costs and revenues.

1.6 This Document

This document contains the following elements:

- Description of agreed-upon characteristics assumed for this study;
- General assumptions impacting TOC operational concepts, costs, and revenues;
- Department-by-department concepts and cost developments;
- Demand, fare, and ancillary revenue projections;
- The resulting baseline projection and optimistic/pessimistic cases for the financial balance of operations and for projected fare coverage ratio levels.
- Appendix 1: Step 2 (as described 1.2.1) review of impact of HSR operations across San Joaquins and ACE corridors.

2 Definitions, Abbreviations and References

Acronym	Definition
ACE	Altamont Corridor Express
ADA	Americans with Disabilities Act
AF	Acre Foot; also Acre Feet
AFC	Automatic Fare Collection
App	Application
APTA	American Public Transportation Association
ATO	Automatic Train Control
BFD	Bakersfield
C&S	Communications and Signalling
CalEPA	California Environmental Protection Agency
CalSTA	California State Transportation Agency
CAPEX	Capital Expenditures
CCTV	Close Circuit Television (Surveillance)
CEQA	California Environmental Quality Act
CHSRA	California High Speed Rail Authority
COO	Chief Operations Officer
CPI	Consumer Price Index
CPUC	California Public Utilities Commission
CRM	Customer Relationship Management
Ct	Cent
CVC	Central Valley Corridor
D&A	Drug and Alcohol
DAS	Data Acquisition System
DB E&C	Deutsche Bahn Engineering and Consulting USA Inc.
DBA	Database Administrator
DES	Data Encryption Standard
DHS	Department of Homeland Security
DSS	Data Security Standard
DTSC	Department of Toxic Substances Control
E&M	Electrical and Mechanical
EIR/EIS	Environmental Impact Report/Environmental Impact Statement

Acronym	Definition
EPA	Environmental Protection Agency
EPP	Emergency Preparedness Plan
ETO	Early Train Operator (DB and its subcontractors)
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
FTE	Full Time Equivalent
GRC	Governance, Risk, and Compliance
HMF	Heavy Maintenance Facility
HSR	High Speed Rail
HVAC	Heating Ventilation and Air Conditioning
ICE3	Intercity-Express 3
IGP	Interior Gateway Protocol
IIPP	Injury and Illness Prevention Plan
ISO	International Organization for Standardization
IT	Information Technology
Km/h	Kilometers per hour
LA	Los Angeles
LAN	Local Area Network
LCFS	Low Carbon Fuel Standard
LMF	Light Maintenance Facility
M&B	Marketing and Branding
MCD	Merced
MOU	Memorandum of Understanding
MOW	Maintenance of Way
NEPA	National Environmental Policy Act
NICS	National Incident Command System
NPDES	National Pollutant Discharge Elimination System
NRV	Non-Revenue Vendors
O&M	Operation and Maintenance
O/D	Origin/Destination
OCC	Operations Control Center
OCS	Overhead Catenary System
OSHA	Occupational Safety and Health Administration

Acronym	Definition
PCI	Payment Card Industry
PenC	Peninsula Corridor
PIN	Personal Identification Number
PLC	Programmable Logic Controller
POS	Point-of-Sale
PR	Public Relations
PTC	Positive Train Control
QR	Quick Response
ROW	Right of Way
RS	Rolling Stock
RWQCB	Regional Water Quality Control Boards
SJJPA	San Joaquin Joint Powers Authority
SJVAPCD	San Joaquin Valley Air Pollution Control District
SOC	Security Operations Center
SPCC	Spill Prevention, Control, and Countermeasure
SROU	Strategic Rail Operating Unit
SWPPP	Storm Water Pollution Prevention Plan
TOC	Train Operating Company
TPSS	Traction Power Substation
TS	Track and Systems
TVA	Threat and Vulnerability Assessment
TVM	Ticket Vending Machine
USD	United States Dollar
V2V	Valley to Valley
WAN	Wide Area Network
Wh	Watt hour

Figure 2-1: Acronyms and Definitions

The following terms are used in this document.

Term	Definition
App	An application, typically a small, specialized program downloaded onto mobile devices
Closed System	A system operated solely for the purposes of a defined population, (e.g., users of transit, or other transportation services).
Credit Card	A card issued by banks, businesses, etc., enabling the holder to obtain goods and services on credit
Data Encryption Standard	The term given to a widely used public-domain symmetric key cryptographic algorithm DES is based on a published algorithm with secret keys. A method for encrypting information (See related term Triple DES)
Encryption	The process of translating information into a code that can only be read if the reader has access to the key that was used to encrypt it. There are two main types of encryption, asymmetric (or public key), and symmetric (or secret key).
EPCRA SARA Title III	Emergency Planning and Community Right-to-Know Act, Superfund Amendments and Reauthorization Act. Title III of the SARA provisions are also known as the Emergency Planning and Community Right-to-Know Act (EPCRA).
Fare Class	A characteristic of a rider, such as age or demographic, as established by law or agency policy (This may also be termed Rider Class)
Fare Gate	A unit that bars passage in one or both directions until it has processed a fare card or determined that the user has paid a valid fare. One customer is allowed passage for each valid fare card, or cash fare, that is presented. Fare gates separate the paid fare area from the unpaid fare area within a station.
Fare Inspector	A person designated to examine and validate the authenticity of a payment for a ticket, receipt, or means of showing proper payment.
Fare Policy	An adopted statement of principle or guideline that defines a desired approach to the establishment of fares for transit services rendered. Fare policies may address issues such as environmental justice or fare equity, governance, etc., logical structure for classifying and organizing an agencies transit fare structure, fare prices, and tariff rules.
Fare Product	Term used to refer to the specific types of pre-paid products (e.g., monthly pass, single ride, T-purse) that are used to gain access to services within a transportation system and that are defined by agency or regional fare policy.

Term	Definition
Fare Structure	A specific schedule of fare categories and respective fare rates that customers must pay for services rendered by a transit agency/operator
HazMat	Hazardous Materials
Local Area Network	A data communication network, conforming to IEEE standards, that connects multiple computer-controlled devices in close proximity to one another, e.g., within one office or building.
Low Carbon Fuel Standard	The purpose of this regulation is to implement a low carbon fuel standard, which will reduce the full fuel-cycle, carbon intensity of the transportation fuel pool used in California, pursuant to the California Global Warming Solutions Act of 2006 (Health & Safety Code, section 38500 et seq
Point-of-Sale Device or Terminal	A device used to make purchase transactions at the point they occur (e.g., at a retailer location)
Proof of Payment	A means to prove that a fare has been paid for the transport of a patron. The 'proof of payment' may be observing the ticket printing, scanning wirelessly with a device, scanning with an optical laser, or scanning with an infrared optical light beam.
Reports	Database information in predetermined format
Ticket Vending Machine	Freestanding, unattended device used by customers to purchase or revalue fare cards. A full-service TVM can provide cash and credit card transaction service. A cashless TVM has all the capabilities of a full service TVM except accepting cash and dispensing change.
Transaction	A collection of interrelated payment steps
Triple DES	Triple Data Encryption Standard (DES) is a type of computerized cryptography in which block cipher algorithms are applied three times to each data block. The key size is increased in Triple DES to ensure additional security through encryption. (Source: Technopedia (https://www.techopedia.com)
VISUM	A software company that specializes in traffic analysis

Figure 2-2: Terms and Definitions

The following documents are referenced within this document.

Number.	Description	Identification/Date
1	APTA Contactless Fare Media System Standard, Part I – Introduction and Overview, Version 1.0	27 Jan 2007

Figure 2-3: Referenced documents

3 Key Characteristics CVC Operations

3.1 Introduction

This chapter describes the vision and assumptions behind the operations of the CVC sections of the CHSRA network between the Merced station at the north end of the segment and the Bakersfield station at the south end of the segment.

3.2 CVC Service Vision

The CVC implementation is not only about offering a new train service at a certain hourly frequency. To account for this, the following concepts were considered in the study as key elements of an overall vision for the CVC service:

- Use of the HSR corridor in this segment as a dedicated passenger service to replace competing third-party passenger service in the San Joaquins corridor;
- Improvement of existing passenger service offered between Merced and Bakersfield, increasing the service frequency and reducing the travel times to and from the Central Valley;
- Integrated end-to-end travel service (Uber/ bus/ LRT/ Amtrak-CHSRA):
    - Optimized schedules and infrastructure for smooth (cross-platform) transfer;
    - High connectivity and consistent travel chains comprising clock face timetables, both for the high-speed trains and for the corresponding rail and bus feeder services, are implemented for customer satisfaction and an economically successful operation of the high-speed rail system;
    - Setting a new high-speed rail operations standard for subsequent expansion to the PenC and later to the V2V service;
    - CHSRA drives economic development of the Central Valley region.

3.3 Characteristics of CVC Operations

This section describes the key characteristics of the CVC operations. These assumptions were defined in consultation with CHSRA prior to the development of this study.

The key characteristics of the CVC standalone operations (Step 1, as defined in 1.2.1) are classified in the following six categories:

1. Timeline, delineating start date and end date of CVC operations; major milestones, and critical path;
2. Physical assets, delineating high-speed rail infrastructure and additional assets and facilities that are shared and/or available for CVC stand-alone operations;
3. Service access, delineating connecting services, infrastructure, and transfer by which passengers can access the CVC train service;
4. Service level, delineating CVC train service characteristics;
5. Revenue policy, delineating fare level, fare structure, and revenue collection approach;
6. Interfaces with subsequent CHSRA service expansion, delineating interfaces with subsequent incremental expansion of train services on the CHSRA system (in two stages: PenC and V2V).

3.3.1 Timeline

3.3.1.1 Characteristics

The analysis and projections of CVC operations costs and revenue starts and ends with the assumed start and end of CVC operations as a regular, full-revenue train service.

This results in a forecasting period from 1 January, 2026 to 31 December 2029. Any cost or revenue prior or subsequent to this period is not included in this analysis. This timeframe is solely used for purposes of this study and is under evaluation by the Authority for implementation.

Figure 3-1 shows the scope of the study.

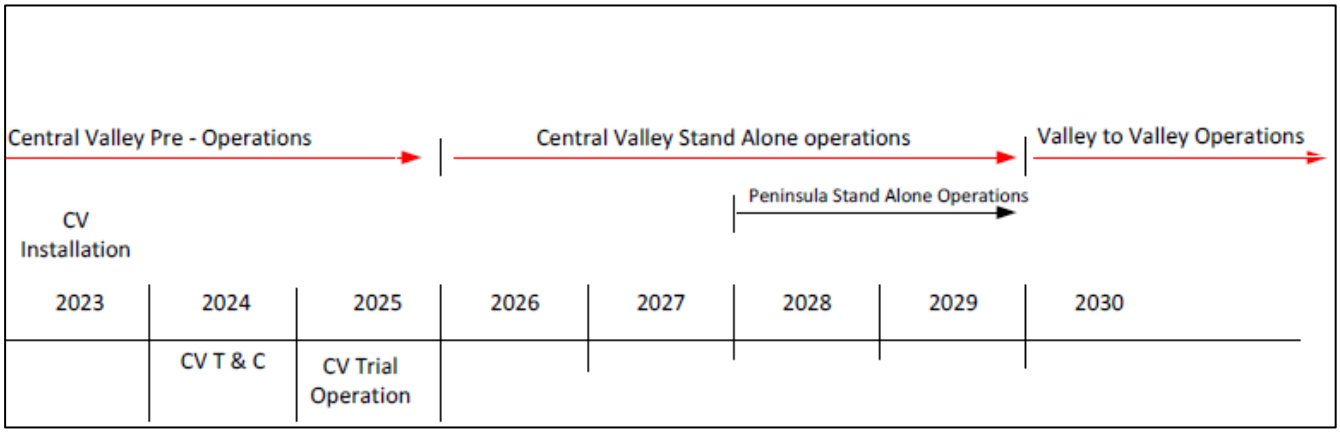


Figure 3-1: CVC scenario characteristics, timeline

This timeline implies that prior to the start of regular full revenue service on 1 January, 2026, the following requirements must be met:

- CHSRA infrastructure completed for testing and commissioning by: 1 January, 2024;
- CHSRA delivery of rolling stock by: 1 January, 2024;
- Testing and commissioning of CVC train service to take place between 1 January, 2024 and 31 December, 2024;
- Trial operations take place approximately between 1 January, 2025 and (latest) 31 December, 2025, such that the required contractual gateways for full acceptance and for commencement of regular full-revenue service are achieved.

3.3.2 Physical Assets

3.3.2.1 Approach

The CHSRA system will consist of numerous complex asset classes with unique maintenance requirements and varying lifespans. These assets must be maintained on a schedule that is consistent with original equipment manufacturers' recommendations supplemented by regular condition and performance assessments. Proper asset maintenance directly impacts safety, service reliability, customer satisfaction, and, ultimately, cost.

The approach to developing the cost estimates for asset maintenance focuses on keeping all assets in a state of good repair throughout their useful lives until they must be renewed or replaced.

Investments must be sufficient at all times to avoid the negative consequences of deferred maintenance. This perspective applies whether the time horizon is four years or 40 years.

For the purpose of this study the renewal or replacement cost at the end of the asset lifecycle is not included in the calculation.

3.3.2.2 Characteristics

Key physical assets in the form of stations, HMF (Heavy Maintenance Facility), TOC office facilities, HSR infrastructure, and other assets are assumed to be the following:

- Stations - HSR stations (from north to south) are assumed to be the following:
  - Merced;
  - Madera;
  - Fresno;
  - Kings/Tulare;
  - Bakersfield.

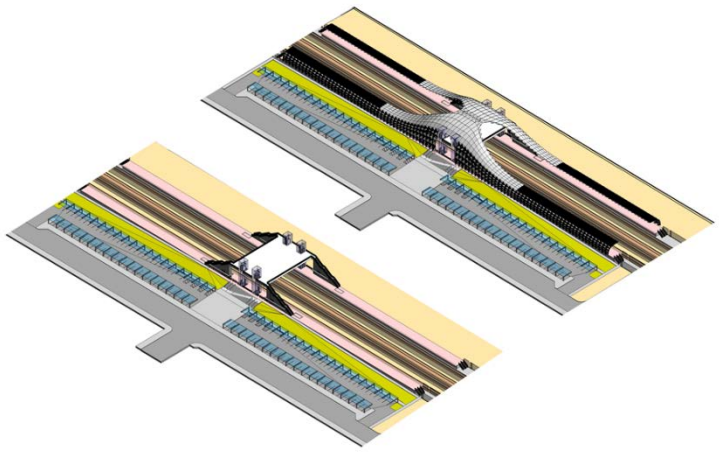


Figure 3-2: Station graph: Assumed typical foot print for stations

Stations are assumed to be basic canopies and platforms with access tunnels/bridges. As a working assumption, no distinction between stations is applied in terms of size, passenger numbers, etc. that would affect station-related costs.

- HMF – Only for purposes of this study, the presence of an HMF between Fresno and Kings/Tulare is assumed (without rental/ lease costs or capital cost depreciation, but costs to maintain are included, e.g. janitorial services, etc.). The final location for the HMF is still to be determined by the Authority. The HMF is assumed to comprise/accommodate the following facilities and functions:
    - Rolling stock workshop;
    - Stabling yard;
    - Warehouse facilitating:
        - Stocking of spare parts for rolling stock;
        - Stocking of tools for rolling stock;
        - Stabling/parking of maintenance fleet and non-revenue vehicles ("yellow plant").

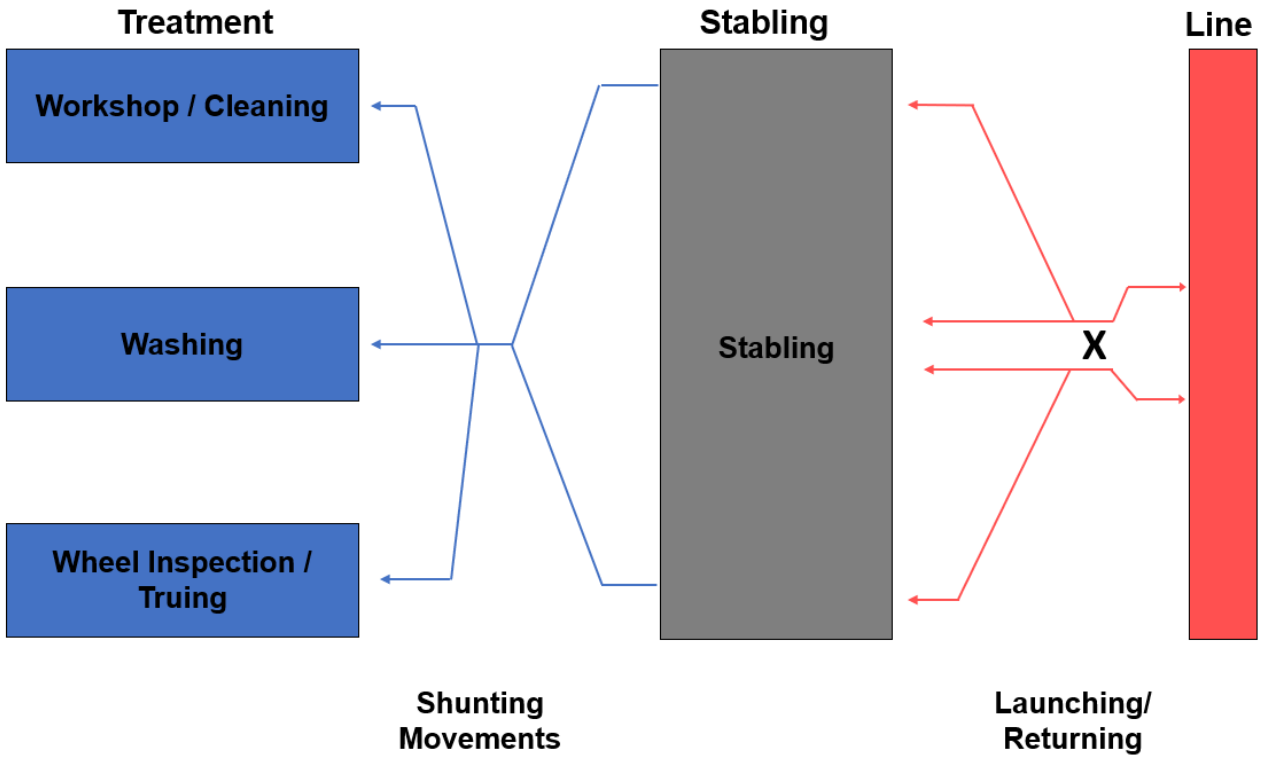


Figure 3-3: Depot concept: Stabling yard as an interface between operations and heavy maintenance

As shown in Figure 3-3, the stabling yard serves as an interface between operations and heavy maintenance, while also providing a clear delineation for the signaling systems. The stabling yard is part of the core operations, located in the depot and designed such that there are no conflicting movements between the workshop shunting and daily operations.

- TOC administrative building - The availability of a TOC administrative facility in Fresno is assumed with a minimum area of 15,000 square feet. It is assumed to be provided by the CHSRA. Rental/lease costs or capital cost depreciation are not included in this study, but costs to maintain are included, e.g. janitorial services, etc.
- HSR track, systems and infrastructure - For the purposes of this study, it is assumed that all track, systems, and structures are completed, and the system accepted and safety certified.

The following infrastructure operations, inspections and maintenance is included in the scope: track, systems, and substructure between Merced and Bakersfield.

It is assumed that the TOC will be the only operator on the HSR alignment for the purpose of CVC operations.

3.3.3 Service Access

It is assumed that the San Joaquins corridor services will use the HSR section between Merced in the north and Bakersfield in the south, replacing competing service the third-party freight corridors. No competing parallel passenger rail service will exist in that section.

It is assumed that continued rail and bus connections in Merced and Bakersfield are cross-platform transfers, ensuring a seamless connection for the passengers.

It is assumed that required additional infrastructure for providing the above-mentioned connections will be available for the start of revenue service.

This CVC study does not calculate required rail connecting infrastructure, or similar services connecting to the CVC stations.

3.3.4 Service Level

It is assumed that there will be one train per hour operating in both directions from ~5:00 a.m. to midnight (365 days per year, with no distinction between weekdays, weekend days, and holidays).

It is assumed that the service ramp-up effects on cost/ efficiency will be covered during the trial operations period prior to full revenue service starting 1 January, 2026.

3.3.5 Revenue Policy

It is assumed that the fare structure on the CVC train service reflects distance-based fares (in USD 2018), which corresponds with the existing San Joaquins fares charged for rail travel in the Central Valley between Merced and Bakersfield.

Revenue collection will be done via mobile/ online ticket sales and on-station ticket sales (from ticket vending machines). Platform access requires ticket validation.

3.3.6 Interfaces with Subsequent CHSRA Service Expansion

It is assumed that PenC train services will commence one year after commencement of CVC services, i.e. on 1 January, 2028.

PenC operations are therefore assumed to be incremental and parallel to CVC operations.

3.4 Status of Characteristics

These scenario characteristics have been discussed and agreed upon with the CHSRA as assumptions.

4 Key Characteristics PenC Operations

4.1 Introduction

This chapter describes the vision and assumptions behind the operations of the PenC section of the CHSRA network between the 77-mile corridor San Francisco 4th & King station at the north end of the segment and the Gilroy station at the south end of the segment.

4.2 PenC Service Vision

The following concepts were considered in the study as key elements of an overall vision for the PenC service:

- Use of the double-track infrastructure owned and operated by Caltrain between San Francisco 4th & King – San Jose Diridon corridor; use of the double-track infrastructure owned and operated by HSR between San Jose Diridon and Gilroy;
- Improvement of existing passenger service offered between San Francisco 4th & King and Gilroy, increasing the service frequency but not replacing existing Caltrain service;
- The complete double-track corridor San Francisco 4th & King-Gilroy will be electrified at 25 kV, 50 Hz AC before HSR operations are assumed to commence. State-of-the-art signaling at ETCS II level or equivalent will be installed and curves straightened.

4.3 Characteristics of PenC Operations

This section describes the key characteristics of the PenC operations. These assumptions were defined in consultation with CHSRA prior to the development of this study. The key characteristics of PenC operations scenario are described in the same six categories as is done for CVC operations in Chapter 3.3.

4.3.1 PenC Timeline

The analysis of incremental (i.e. additional to CVC) PenC costs and revenues starts at the beginning of the third year of CVC operations, is projected for two years of operation and ends in lockstep with the horizon for analysis of CVC operations on 31 December 2029. This results in a forecasting period from 1 January, 2028 to 31 December 2029. Any cost or revenue prior or subsequent to this period

is not included in this analysis. This timeframe is solely used for purposes of this study and is under evaluation by the Authority for implementation.

Figure 4-1 shows the scope of the study, highlighted in red.

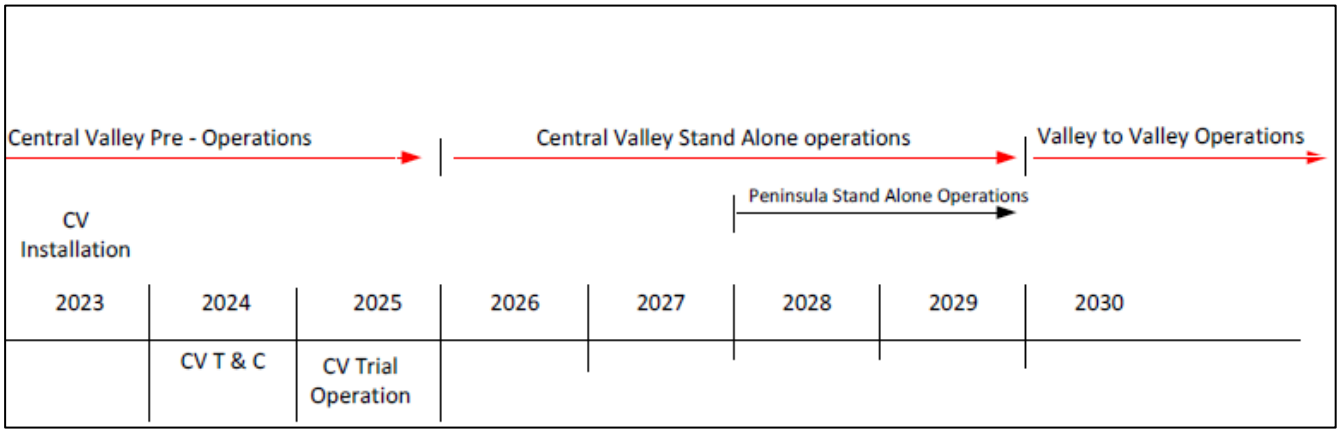


Figure 4-1: PenC scenario characteristics, timeline

4.3.2 PenC Physical Assets

4.3.2.1 Approach

Refer to Section 3.2.2.

4.3.2.2 Characteristics

Key physical assets in the form of stations, HMF (same as established for CVC), LMF (Light Maintenance Facility), TOC office facilities (same as established for CVC), HSR infrastructure, and other assets are assumed to be the following:

- Stations - HSR stations (from north to south) are assumed to be the following:
  - San Francisco 4th & King;
  - Millbrae;
  - San Jose Diridon;
  - Gilroy.

  Stations are assumed to be owned by Caltrain with HSR as a tenant;

- HMF - The same HMF established in the CVC study between Fresno and Kings/Tulare is assumed to also serve the HSR trains in operations on the PenC (it should be noted that the final location for the HMF is still to be determined by the Authority);
- Light Maintenance Facility (LMF) - During PenC operations, all HSR trains will be stored in the LMF at Brisbane;
- TOC administrative building – This same building established in the CVC study will also serve the PenC corporate function positions;
- HSR track, systems and infrastructure - For the purposes of this study, it is assumed that all track, systems, and structures are completed, and the system accepted and safety certified for the segment south of Tamien.

It is assumed that the TOC will not be the only operator on the HSR alignment for the purpose of PenC operations.

4.3.3 PenC Service Access

It is assumed that there will be parallel passenger rail service existing on the Peninsula Corridor, with Caltrain and HSR both operating services.

Considering the intensive utilization of track capacity mainly on the 4th & King-San Jose section, efforts spent on harmonization between HSR and connecting rail or bus services might be subject to practical constraints caused by such dense headways, which might not always allow for the full flexibility needed to precisely optimize transfer times.

This study does not calculate or include any costs related to feeder bus services, required rail connecting infrastructure, or similar services connecting to the PenC stations.

4.3.4 PenC Service Level

All high-speed trains are scheduled according to a half-hourly clock face timetable, in which departures and arrivals occur at the same minute of each half hour. Similar to CVC, the daily revenue service extends over 19 hours per day for seven days per week for PenC. Additional peak or reduced off-peak hour services are not planned for the purpose of this study.

Considering the technical restrictions on the 4th & King Station-Gilroy section (existence of 72 level-crossings), the scheduled maximum operational speed is 110 mph.

It is assumed that the service effects on cost/ efficiency will be covered during the trial operations period (full revenue service starting 1 January, 2026 on the CVC).

4.3.5 PenC Revenue Policy

The basis for HSR PenC fares is assumed for this study:

- PenC Coach class fares shall be calculated at Caltrain fare plus a premium of 10%;
- Business/First class fares shall be calculated at the PenC coach class fare plus a premium of 75%;
- An 80% /20% split of coach versus business users. Weighted surcharge is therefore 23% on top of Caltrain cash fare.

Revenue collection will be done via mobile/ online ticket sales and on-station ticket sales (from ticket vending machines). Platform access requires ticket validation.

4.3.6 PenC Track Access & Stations Charges

Between San Francisco 4th & King and San Jose, the line dedicated to electrically operated passenger traffic is owned and operated by Caltrain. South of Tamien the line is assumed to be owned and operated by HSR. Track access charges were calculated for each of these lines and it should be noted that the basis for the calculations were only assumptions for purposes of this study and does not reflect any commercial discussions with Caltrain. The track access charges assumed is calculated using the same cost basis as what was estimated for CVC between Merced and Bakersfield. The track access costs includes the following cost components: infrastructure maintenance at USD 2.76 per train mile, infrastructure operation at USD 2.10 per train mile, and a % for TOC administration. This results in USD 6.24 track access charges per train mile. It should be noted that depreciation costs were excluded from the track access charges per train mile because at the time of this study the information about the CAPEX funding related to the mixed Peninsula Corridor service (commuter rail, freight, and HSR) was not available. See below for track access charges assumed to be paid by

Caltrain to HSR for use of the line south of Tamien and to be paid by HSR to Caltrain for use of the line between San Francisco 4th & King and San Jose.

Category	Infrastructure maintenance	Infrastructure operations	Admin. Overhead	Track access charges per train mile
Unit cost	USD 2.76	USD 2.10	28.45%	USD 6.24

Figure 4-2: Unit costs for access charge calculations

Category	Total train miles	Total track access charges
Caltrain train miles on HSR section (Tamien – Gilroy)	44,148	USD 0.28 mln
HSR miles on Caltrain section (SF – Tamien)	880,854	USD 5.5 mln

Figure 4-3: Track access charge summary

The stations at San Francisco 4th & King, Millbrae, San Jose Diridon and Gilroy are assumed to be owned by Caltrain with HSR as a tenant. The stations access charges were calculated on the basis of looking at the CVC stations maintenance costs and the number of trains per direction per year assumed to be operated HSR on PenC. See below for stations access charges assumed to be paid by HSR to Caltrain for use of the four stations, San Francisco 4th & King, Millbrae, San Jose Diridon and Gilroy.

Category	Number of trains	Total paid by HSR for PenC station use
HSR use of Caltrain network & stations	17,940	3.3 mln USD

Figure 4-4: HSR use of Caltrain network & stations

4.3.7 PenC Interfaces with Subsequent CHSRA Service Expansion

It is assumed that PenC train services will commence two years after commencement of CVC services, i.e. on 1 January, 2028 – running in parallel and incremental to CVC operations.

4.3.8 Status of Characteristics

These scenario characteristics have been discussed and agreed upon with the CHSRA as assumptions.

5 General Assumptions

5.1 Business Structure

5.1.1 Expected Scope of TOC

The TOC, for purposes of this study, represents a stand-alone company and costs calculated for TOC overhead can be further optimized depending on future commercial arrangements.

The direct TOC scope is expected to be as follows:

- Operations:
  - Train operations;
  - Scheduling, dispatching, and control;
  - Rail possession management.
- Facilities management:
  - CVC Station management and operation;
  - Security (and county police);
  - Cleaning;
  - Escalators/elevators;
  - Electricity wiring, plumbing pipes, sanitation, etc. (E&M);
  - Landscape/station greening;
  - HMF, LMF and TOC office management.
- Alignment/right-of-way clearing;
- Revenue collection: It should be highlighted that for purposes of this study and in order to estimate costs for fare collection systems, traditional solutions of TVMs (Ticket Vending Machines) are presented in addition to mobile applications. However, future concepts to be considered will also include a wider range of payment options, including contactless smart cards and emerging technologies such as biometrics.

- Security: It should be highlighted that the Authority is currently evaluating a policing plan with the CHP. For purposes of this study and in order to estimate security costs, the basis for the cost estimates reflect the establishment of MOUs (Memorandums of Understanding) with local and county police departments along the CVC corridor in addition to local law enforcement assumed to provide supplemental security to the TOC;
- Customer service;
- Marketing and branding;
- TOC management:
    - Administration;
    - Training, quality assurance, and compliance;
    - Development of ancillary revenue potential (including Low Carbon Fuel Standard Credits);
    - Insurance.

For these elements of direct TOC scope, operational concepts and, on that basis, indicative cost/ revenue projections have been developed. The TOC may subcontract some of these elements out.

5.1.2 Expected Novated Subcontracts Scope

The expected scope of contracts being procured by the CHSRA, and subsequently novated to the TOC for contract management purposes, is expected to be as follows:

- Maintenance of rolling stock:
    - Planned and corrective maintenance;
    - Rolling stock cleaning.
- Maintenance of civil structures (infrastructure, buildings, etc.);
- Maintenance of track and systems.

For the purpose of this study only, it is assumed that these subcontracts to be implemented as if by the TOC's internal departments. This means that they have been included in operational concepts and cost projections without substantial organizational overheads, capital costs incurred prior to commencement of maintenance services, profit margins, etc.

5.2 Capital Assets and Inventory

For the purpose of the study, no capital costs for significant assets, inventory, or yellow plant have been included. This means that the operational concepts and cost projections assume that all significant assets, inventory, and yellow plant capital costs have been incurred and paid-for prior to the start of revenue service and provided to the TOC at no charge.

It is assumed that most of assets and inventory are purchased and owned by CHSRA or by another designated State of California entity. The study consequently does not account for capitalized assets or amortization/ depreciation of any assets.

Given this absence of capital costing and the limited, four-year duration of the study, no assumptions have been made regarding the replacement costs or mid-life overhauls/ refurbishment of equipment or assets.

5.3 Labor Rates and Overhead

5.3.1 Standard Pay Grades

Standardized pay grades are assumed to be as shown in Figure 5-1.

# No	Pay Grade	Average salary per annum (in USD)
1	Assistant	60,000
2	Analyst	80,000
3	Manager	100,000
4	Senior Manager (fewer than ten years' experience)	120,000
5	Senior Manager (greater than ten years' experience)	150,000
6	Director	175,000
7	Senior Director	200,000

Figure 5-1: Standardized TOC pay grades for use in this study

Assumptions related to productivity per FTE, such as shift differential, overtime premium etc., are included in these labor rates.

Assumptions concerning fringe benefits, employer's costs, labor overheads etc. are not included in these rates and are detailed in the sub-paragraphs below.

5.3.2 Fringe Benefits and Employer Costs

This study assumes a general healthcare contribution of USD 22,909 per FTE paid for by the TOC, plus a 35% markup in addition to 'unloaded' labor rates shown above. This markup accounts for benefits contributions paid by the TOC.

5.3.3 Labor Overhead

Work uniforms, safety gear, telephone/ laptops, etc. are detailed separately for each TOC department.

5.3.4 Unionization

This study assumes unionization as appropriate in the California railway sector context.

5.3.5 Buy America(n)

No impact is assumed in relation to any specific Buy American requirements that would impact costs.

5.4 Quality, Efficiency and Productivity

5.4.1 Labor Productivity

For blue collar labor, this study assumes a productivity factor of 80% of FTE (the remaining 20% being absorbed by non-core activities, administration, shift preparations, etc.).

For white collar labor this study assumes 1,750 work hours per FTE per year.

Some efficiency trends and learning curves are assumed and detailed out (e.g. for rolling stock maintenance).

5.5 Escalations

5.5.1 Currency

All dollar amounts in this study are provided and calculated in 2018 USD, unless stated otherwise.

5.5.2 Labor Rate Indexation

Where applicable for calculation purposes, labor rates are indexed at a presumed labor cost inflation rate of 2.9% per annum.

5.5.3 Electricity Price Indexation

Where applicable for calculation purposes, electricity prices are indexed at a presumed electricity price inflation rate of 2.35% per annum. As a working assumption, electricity will be sourced/ procured from renewable sources or providers.

5.5.4 CPI/Other Indexation

Where applicable for calculation purposes, other costs and revenue rates are indexed at a presumed CPI (Consumer Price Index) rate of 2.35% per annum.

5.6 Warranties

It has been assumed that all relevant warranties related to subcontracts, rolling stock, equipment, HSR infrastructure, and other relevant assets are transferred to the TOC. It is further assumed that all warranties extend at least for the four-year duration of the CVC forecasting period and two- year duration of the PenC forecasting period.

Further assumptions for warranties related to specific assets used by the TOC (rolling stock, track and system assets, etc.) are detailed in the respective chapters of this study.

5.7 Compliance

5.7.1 FRA Compliance

It is assumed that the applicability of FRA regarding track inspections will be negotiated between CHSRA and FRA. Therefore, for purposes of this study, no costs have been included. The civil

structures cost estimate covers the maintenance cost for all bridges, culverts, drainage systems, retaining walls, trenches, and fencing. This includes inspections based on FRA requirements for bridges and annual structure inspections.

In addition to its oversight of operational safety matters, the FRA has a number of regulatory requirements related to plans, certifications, reports, inspections and other documentation. Those requirements are delineated primarily in 49 CFR 200 series. Among the plans required by the FRA are those for transporting individuals with disabilities, railroad safety, operating rules, maintenance and repair of signal and train control systems, emergency preparedness, roadway worker protection, random drug testing, and electronic communication devices, etc. Among the documentation and report topics required by the FRA are those for alcohol misuse prevention program results, railroad injuries and illness, accidents, hours of service, passenger equipment safety, and emergency simulations, etc. In addition, railroads must have written certification programs for training of locomotive engineers and conductors. In some cases, documentation must be submitted to FRA on a scheduled basis for review and approval. In other cases, records are subject to periodic audit by the FRA to verify that they are accurate and up to date. FRA compliance is incorporated into the day-to-day work responsibilities of the TOC's health and safety, training, maintenance, operations, environmental and governance and compliance headcount for CVC and PenC.

5.7.2 Safety, Health and Environmental Compliance

OSHA (Occupational Safety and Health Administration) sets and enforces standards, requires specific types of training programs and mandates reports related to employee health and safety in the workplace. OHSA's jurisdiction covers most private sector employers and their workers. Among the specific areas regulated by OSHA are indoor air quality, noise, sanitation, hazardous chemicals, worker's hours, fall protection, fire prevention, worker injuries and illnesses.

Most of OSHA's regulations are contained in 29 Code of Federal Regulations, Parts 1904 and 1910. Some examples of specific regulations include:

- Walking-working surfaces must be inspected regularly and maintained in safe condition, free of hazards, loads, etc.;

- Employer must provide training for fall protection, overhead cranes, welding, bloodborne pathogens, electrical safety, etc.;
- Employer must keep certain records related to employee injuries, illness and death; employee fatalities must be reported to OSHA within eight hours, or within 24 hours for employee hospitalization for loss of limb or and loss of an eye.

In some cases, OSHA accepts records and practices that comply with other regulatory agencies. OSHA compliance is incorporated into the day-to-day work responsibilities of TOC's health and safety and training headcount for CVC and PenC.

California has stringent laws, regulations, and state agencies that will provide environmental compliance oversight of the TOC. Each of these requires the TOC to develop plans and procedures, conduct inspections, obtain permits, track data, and provide reports, as mandated by the respective agencies. Costs for these activities are included in this study.

5.7.3 ISO Compliance

ETO is currently ISO-certified in Germany and intends that the TOC for California high speed rail will have both 9001 and 14001 certifications. Costs for these certifications have been included in the study.

ISO is the International Organization for Standardization, a worldwide federation of national standards bodies. In ISO 9000, the fundamental concepts and principles for quality management systems (QMS) are explained in order to help organizations, including railroads, fulfil the needs and expectations of their customers and to achieve satisfaction with their products and services. The ISO 9000 standard contains seven quality management principles related to customer focus, leadership, engagement of people, process approach, improvement, evidence abased decision making, and relationship management.

ISO 9001, based on the quality management principles described in ISO 9000, sets out the criteria and requirements for a quality management system. It is the only standard in the ISO 9000 family that can be certified to. Key to achieving an effective quality management system is the concept of risk-based thinking. Addressing both risks and opportunities establishes a basis for increasing the

effectiveness of the quality management system, achieving improved results and preventing negative effect.

Implementation of ISO 9001 is based on the idea of continual improvement and is intended to result in:

a. The ability to consistently provide products and services that meet customer needs and applicable statutory and regulatory requirements;

b. Opportunities to enhance customer satisfaction;

c. Addressing risks and opportunities associated with its context and objectives;

d. The ability to demonstrate conformity to specified quality management system requirements.

ISO 9001 has a range of standards adapted to specific sectors and industries. For example, ISO/TS 22163 applies the ISO 9001 concepts to the railway industry and addresses principles such as RAMS (reliability, availability, maintainability and safety); KPIs (key performance indicators); failure reporting analysis and corrective action system, and rail quality management system, among others.

ISO 14000 is a family of standards for organizations looking to manage their environmental responsibilities. ISO 14001 sets out the criteria for an environmental management system and can be certified to. It requires organizations to consider all environmental issues related to their operations, such as air pollution, water and sewage issues, waste management, soil contamination, climate change mitigation and adaptation, and resource use and efficiency. It is intended to help organizations make efficient use of resources and reduce waste.

5.8 Tax, Contractual Performance and Profit

5.8.1 Taxation

This study does not assume corporate income tax, i.e. net profit/ loss projections provided for the TOC are pre-tax.

5.8.2 Contractual Performance

This study does not account for any windfall revenues or unexpected costs related to performance below or above contractual requirements or limits.

5.8.3 Profit

At the TOC level, this study applies an ‘overall’ profit margin of 10% over gross costs. This 10% is a working assumption required by the CHSRA as per Federal Acquisition Regulations, which allow for profit within a certain range. It is not based on ETO’s commercial requirements.

For rolling stock, track and systems, and civil structure maintenance services to be provided through novated (sub)contracts, costs and revenues are calculated without any added commercial margins for specific subcontractors.

6 Train Operations

6.1 Key Assumptions

6.1.1 Introduction

CVC and PenC train operations plan for following high-speed service:

- All high-speed trains are scheduled according to a clock face timetable, in which departures and arrivals occur at the same minute of each hour at CVC and at the same minute of each half hour at PenC;
- The daily revenue service extends over 19 hours per day for seven days per week for both CVC and PenC. Additional peak or reduced off-peak hour services are not planned for the purpose of this study;
- The timetables for CVC and PenC are valid and uniform across all 365 days per year without distinct timetables for holiday periods;
- For maintenance, nightly operations-free time slots are scheduled for a minimum of five hours per track;
- Seamless and barrier-free changes at the stations are envisioned for a high degree of connectivity.

6.1.2 CVC assumptions

6.1.2.1 CVC Service Concept

The service concept for the CVC operations plans for one high-speed train per hour, per direction. To meet the hourly train schedule, six high-speed trainsets will be required, thereof four in revenue service, one protect train (operational reserve) and one train for maintenance purposes.

The schedule also provides for conveniently-timed transfers between high speed trains and corresponding San Joaquins and ACE (Altamont Corridor Express) trains, as well as busses.

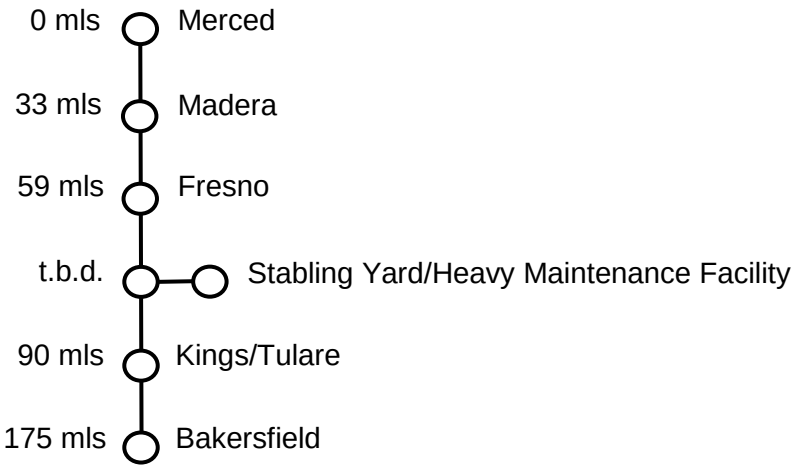


Figure 6-1: CVC stations and mileage

6.1.2.2 CVC Stations

The study assumes a 175-mile travel corridor between the northern terminus Merced and the southern terminus Bakersfield, with intermediate stops at Madera, Fresno, Kings/Tulare and Bakersfield.

- Merced is the northern terminus of CVC stand-alone operations. It is assumed that the Merced HSR Station (also known as: Merced Intermodal Station) will bring conventional trains (San Joaquins, ACE) and high-speed trains together at one platform, so as to allow easy cross-platform transfer.

  To make this possible, connecting ACE and San Joaquins trains approaching Merced from the north will change the infrastructure from BNSF tracks (Stockton Subdivision) to Union Pacific tracks (Fresno Subdivision) through cross-over tracks or a loop, and will not call at today's Amtrak station anymore. Instead, they will terminate at the future Merced HSR Station.

- The ETO has considered Madera a full access station for the purpose of this study, even with a simple track layout. This might not be consistent with the current environmental documents. It is considered necessary, however, to get a realistic picture of the potential ridership and to avoid the need for a double transfer of bus feeder passengers from/to North bus-train at Merced and train-train at the otherwise closed Madera transfer point, with highly unattractive transfer times of more than one hour.

6.1.2.3 CVC Timetable

The Figure 6-2 and 6-3 illustrate the southbound and northbound timetables.

SOUTHBOUND HIGH-SPEED TRAINS

Train Number	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2
Trip Number	ST-2	ST-4	102	104	106	108	110	112	114	116	118	120	122	124	126	128	130	132	ST-6	ST-8
Trip Departure	4:57 AM	5:57 AM	6:08 AM	7:08 AM	8:08 AM	9:08 AM	10:08 AM	11:08 AM	12:08 PM	1:08 PM	2:08 PM	3:08 PM	4:08 PM	5:08 PM	6:08 PM	7:08 PM	8:08 PM	9:08 PM	10:08 PM	11:08 PM
MERCED			6:08 AM	7:08 AM	8:08 AM	9:08 AM	10:08 AM	11:08 AM	12:08 PM	1:08 PM	2:08 PM	3:08 PM	4:08 PM	5:08 PM	6:08 PM	7:08 PM	8:08 PM	9:08 PM	10:08 PM	11:08 PM
MADERA			6:25 AM	7:25 AM	8:25 AM	9:25 AM	10:25 AM	11:25 AM	12:25 PM	1:25 PM	2:25 PM	3:25 PM	4:25 PM	5:25 PM	6:25 PM	7:25 PM	8:25 PM	9:25 PM	10:25 PM	11:25 PM
FRESNO			6:40 AM	7:40 AM	8:40 AM	9:40 AM	10:40 AM	11:40 AM	12:40 PM	1:40 PM	2:40 PM	3:40 PM	4:40 PM	5:40 PM	6:40 PM	7:40 PM	8:40 PM	9:40 PM	10:40 PM	11:40 PM
KINGS/TULARE	4:57 AM	5:57 AM	6:57 AM	7:57 AM	8:57 AM	9:57 AM	10:57 AM	11:57 AM	12:57 PM	1:57 PM	2:57 PM	3:57 PM	4:57 PM	5:57 PM	6:57 PM	7:57 PM	8:57 PM	9:57 PM		
BAKERSFIELD	5:29 AM	6:29 AM	7:29 AM	8:29 AM	9:29 AM	10:29 AM	11:29 AM	12:29 PM	1:29 PM	2:29 PM	3:29 PM	4:29 PM	5:29 PM	6:29 PM	7:29 PM	8:29 PM	9:29 PM	10:29 PM		
Turn Time	00:52	00:52	00:52	00:52	00:52	00:52	00:52	00:52	00:52	00:52	00:52	00:52	00:52	00:52	00:52	00:52	00:52	00:52		
	6:21 AM	7:21 AM	8:21 AM	9:21 AM	10:21 AM	11:21 AM	12:21 PM	1:21 PM	2:21 PM	3:21 PM	4:21 PM	5:21 PM	6:21 PM	7:21 PM	8:21 PM	9:21 PM	10:21 PM	11:21 PM		

Figure 6-2: Timetable southbound high-speed trains

NORTHBOUND HIGH-SPEED TRAINS

Train Number	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Trip Number	ST-1	ST-3	101	103	105	107	109	111	113	115	117	119	121	123	125	127	129	131	ST-5	ST-7
Trip Departure	5:12 AM	6:12 AM	6:21 AM	7:21 AM	8:21 AM	9:21 AM	10:21 AM	11:21 AM	12:21 PM	1:21 PM	2:21 PM	3:21 PM	4:21 PM	5:21 PM	6:21 PM	7:21 PM	8:21 PM	9:21 PM	10:21 PM	11:21 PM
BAKERSFIELD			6:21 AM	7:21 AM	8:21 AM	9:21 AM	10:21 AM	11:21 AM	12:21 PM	1:21 PM	2:21 PM	3:21 PM	4:21 PM	5:21 PM	6:21 PM	7:21 PM	8:21 PM	9:21 PM	10:21 PM	11:21 PM
KINGS/TULARE			6:55 AM	7:55 AM	8:55 AM	9:55 AM	10:55 AM	11:55 AM	12:55 PM	1:55 PM	2:55 PM	3:55 PM	4:55 PM	5:55 PM	6:55 PM	7:55 PM	8:55 PM	9:55 PM	10:55 PM	11:55 PM
FRESNO	5:12 AM	6:12 AM	7:12 AM	8:12 AM	9:12 AM	10:12 AM	11:12 AM	12:12 PM	1:12 PM	2:12 PM	3:12 PM	4:12 PM	5:12 PM	6:12 PM	7:12 PM	8:12 PM	9:12 PM	10:12 PM		
MADERA	5:27 AM	6:27 AM	7:27 AM	8:27 AM	9:27 AM	10:27 AM	11:27 AM	12:27 PM	1:27 PM	2:27 PM	3:27 PM	4:27 PM	5:27 PM	6:27 PM	7:27 PM	8:27 PM	9:27 PM	10:27 PM		
MERCED	5:42 AM	6:42 AM	7:42 AM	8:42 AM	9:42 AM	10:42 AM	11:42 AM	12:42 PM	1:42 PM	2:42 PM	3:42 PM	4:42 PM	5:42 PM	6:42 PM	7:42 PM	8:42 PM	9:42 PM	10:42 PM		
Turn time	00:26	00:26	00:26	00:26	00:26	00:26	00:26	00:26	00:26	00:26	00:26	00:26	00:26	00:26	00:26	00:26	00:26	00:26		
	6:08 AM	7:08 AM	8:08 AM	9:08 AM	10:08 AM	11:08 AM	12:08 PM	1:08 PM	2:08 PM	3:08 PM	4:08 PM	5:08 PM	6:08 PM	7:08 PM	8:08 PM	9:08 PM	10:08 PM	11:08 PM		

Figure 6-3: Timetable northbound high-speed trains

The resulting timetable is for an hourly high-speed train service that starts from, and terminates in, the stabling yard/ HMF located south of Fresno. It should be noted that the final location for the HMF is still to be determine by the Authority.

All high-speed trains have corresponding services in Merced, connecting to San Joaquins / ACE trains and optionally additional buses, and in Bakersfield, connecting to bus services.

6.1.2.4 CVC Connectivity

As per the CVC service vision, customer satisfaction and an economically successful operation of the HSR system are central success factors. A high degree of connectivity, and the creation of consistent, integrated travel chains throughout California, is a must for achieving these goals. Clock face timetables, both for the high-speed trains and the corresponding rail and bus feeder services, are integral success factors. CalSTA (California State Transportation Agency) should establish additional

train connections, in lieu of previously planned bus feeder services, to ensure rail-bound feeder services from and to all high-speed trains departing from and terminating in Merced.

All high-speed trains will link with corresponding feeder services as follows:

- At Merced (northern terminus) from/to:
  - San José via Lathrop/Manteca (ACE trains or bus);
  - Oakland via Richmond (San Joaquins trains or buses);
  - Natomas via Sacramento (San Joaquins trains or buses).
- At Bakersfield (southern terminus) from/to:
  - Newhall (bus), major rail transfer point (from/ to Metrolink and Surfliner);
  - Burbank Airport (bus), major rail transfer point;
  - Van Nuys (bus);
  - LAX Los Angeles Airport (bus);
  - Pasadena (bus);
  - Claremont (bus);
  - Ontario Airport (bus);
  - All other buses (as currently operated by Amtrak Thruway) in their current timetable.

To keep transfer times short and the overall travel experience attractive, the following is assumed:

- Train–train (cross-platform transfer; transfer times calculated between eight and twelve minutes);
- Train–bus (short distance transfer).

Figure 6-4: Seamless cross-platform transfer train–train and train–bus in Germany

Note: ETO recommends that the CHSRA provide a single station in Merced for cross-platform transfers between high speed rail and San Joaquins and ACE services. As currently planned, the HSR station would be 1.2 miles from the existing Amtrak Merced station, which means transferring passengers will have to board shuttle buses and add at least 20 minutes to their travel time. This will also expose passengers to inclement weather, create anxieties about missing connections, and present challenges for those who are elderly or physically challenged. Industry research points to the fact that passengers' perception of time is much longer when they are waiting than when they are actually moving. It is referred to as "transfer penalty." Multiple studies over the past ten years have shown that transfer inconvenience can significantly affect peoples' travel decisions. Introducing a new service that is intended to be a showcase for high speed rail while at the same time forcing passengers to make a lengthy shuttle bus transfer in Merced will undoubtedly draw criticism, impair the ability to effectively market the service and likely result in depressed ridership.

6.1.2.5 CVC Rolling Stock

Operating one train per hour per direction in the CVC will require six trainsets:

- Four operational trainsets;
- One protect trainset (operational reserve);
- One trainset in maintenance.

The high-speed trains in use will support two classes, business class and economy, but for the specific purpose of this study no differentiation among the two classes will be made price-wise.

This study assumes that four out of the eight cars will not be accessible to passengers, to reduce the number of personnel on board as well as cleaning and maintenance cost.

Considering the relatively short distance between the stations on the CVC, the scheduled maximum operational speed during CVC operations will be 180 mph.

During CVC operations, the trains will be stored in the HMF south of Fresno where also the dispatch of the trains is planned to be located.

Note: TOC recommends that responsibility for train dispatch shall be directly paired with train operations in order to ensure operational safety, efficiency and quality for the passenger. Accountability, customer satisfaction and commercial interest will best be served by assigning dispatch to the TOC rather than the track and systems contractor.

This approach recognizes that service quality is directly related to the effectiveness of the interactions between dispatchers, train crews, and transportation field personnel.

Consolidating all passenger-related operations into one entity avoids the potential for conflicts when service problems arise. It also acknowledges that the TOC has an incentivized interest in efficient management of train operations.

Moreover, it is common in the U.S. for train operations personnel to move into the ranks of the dispatch office. This flow of personnel creates a highly desirable level of shared understanding between train crews and dispatchers.

Finally, dispatch is not typically a core competency of an infrastructure contractor. Access to the right of way for maintenance can be governed by maintenance plans and agreed-upon protocols for track allocation.

Figure 6-5: Dispatchers in the Central Operations Control Center of DB Netz in Frankfurt (Main), Germany

6.1.3 PenC Assumptions

6.1.3.1 PenC Service concept

The service concept for PenC operations plans for two high-speed trains per hour per direction. All high-speed trains are scheduled according to a half-hourly clock face timetable, in which departures and arrivals occur at the same minute of each half hour.

Between San Francisco 4th & King and San Jose, the line dedicated to electrically operated passenger traffic is owned and operated by Caltrain. South of San Jose the line is owned and operated by HSR.

The complete double-track corridor 4th & King – Gilroy will be electrified at 25 kV, 50 Hz AC timely before HSR operations start. State-of-the-art signaling at ETCS II level or equivalent will be installed and curves straightened.

For maintenance purposes, a five-hour window without revenue service is scheduled for the HSR-owned and operated section south of San Jose. On the Caltrain-owned and operated section north of San Jose, HSR timetables respect nightly operations-free time slots of five hours per individual track.

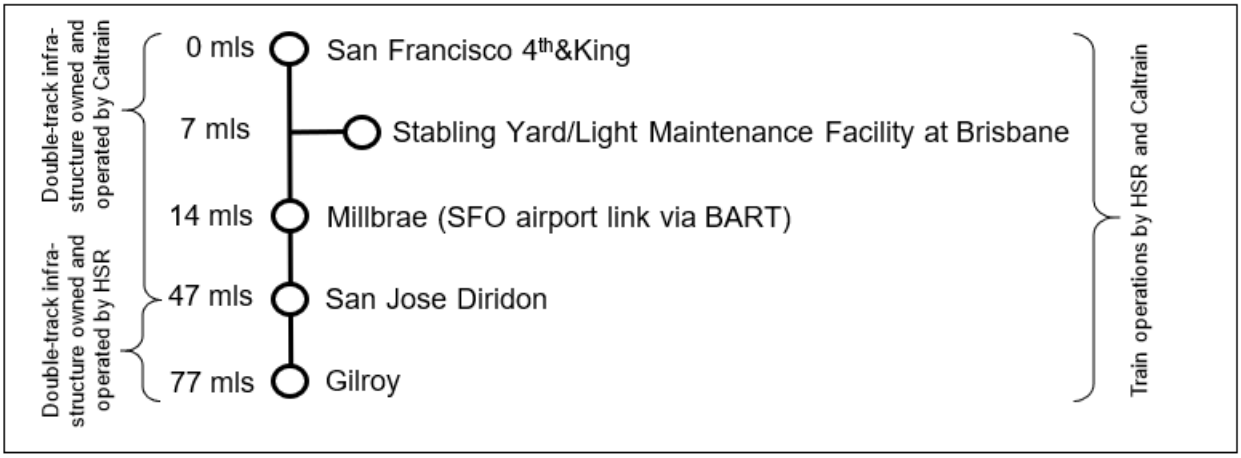


Figure 6-6: PenC stations; mileage; infrastructure and train operations

For a half-hourly train service, eight high-speed trainsets will be required, including six in revenue service, one protect train (operational reserve) and one train for maintenance. During PenC operations, all HSR trains will be stored in the LMF at Brisbane.

One HSR line controller's work station will be installed in Caltrain's Operation Control Center (OCC) in Menlo Park, so as to facilitate efficient handoff of trains between HSR and Caltrain dispatchers, to promote good communication and cooperation between the parties and to represent HSR's interests regarding Caltrain's dispatching decisions on the Caltrain-owned and -operated section San Francisco–San Jose.

Moreover, the HSR line controller will operationally take over the line controlling of the HSR-owned San Jose–Gilroy section from the HSR's OCC in Central Valley, whenever necessary.

6.1.3.2 PenC Stations

The analysis refers to the 77-mile corridor between the Northern terminus 4th & King Station and the Southern terminus Gilroy with intermediate stops at Millbrae and San Jose Diridon:

- 4th & King Station is the northern terminus for the PenC HSR and for Caltrain operations. The future plan to extend the line to Transbay Terminal is not assumed for this study;

- Millbrae Station provides the connection with Bay Area Rapid Transit (BART) to San Francisco Airport (SFO) and further northbound and was included as one of the stations for the ridership forecast;
- Gilroy Station is the southern terminus for the PenC HSR operations as well as for some Caltrain operations going beyond San Jose Diridon Station, where most Caltrain services terminate.

6.1.3.3 PenC Timetable and capacity allocation

Timetabling on the PenC requires a high degree of coordination with Caltrain, which will operate a steadily increasing number of trains facilitated by several improvements, such as electrification and re-signalling on an ETCS II level or equivalent, allowing for a three minutes headway, and curve straightening.

Coordination with Caltrain began a few years ago and results in well-balanced capacity allocation both to HSR and Caltrain services operating on the same double-tracks. The existing section of four tracks at the Caltrain station in Lawrence will be used for an overtake.

San Francisco 4th&King – Millbrae – San Jose Diridon – Gilroy and back

Trip number		1000A	1000B	1000C	1002	1004	1006	1008	1010	1012	1014	1016	1018	1020	1022	1024	1026	1028	1030
Trainset number		4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3
	From:	Bris.	Bris.	Bris.	Bris.	Bris.	Bris.	1001	1003	1005	1007	1009	1011	1013	1015	1017	1019	1021	1023
SAN FRANCISCO / 4th&KING					6:10	6:40	7:10	7:40	8:10	8:40	9:10	9:40	10:10	10:40	11:10	11:40	12:10	12:40	13:10
MILLBRAE		4:55	5:25	5:55	6:25	6:55	7:25	7:55	8:25	8:55	9:25	9:55	10:25	10:55	11:25	11:55	12:25	12:55	13:25
SAN JOSE		5:24	5:54	6:24	6:54	7:24	7:54	8:24	8:54	9:24	9:54	10:24	10:54	11:24	11:54	12:24	12:54	13:24	13:54
GILROY		5:50	6:20	6:50	7:20	7:50	8:20	8:50	9:20	9:50	10:20	10:50	11:20	11:50	12:20	12:50	13:20	13:50	14:20
	To:	1001	1003	1005	1007	1009	1011	1013	1015	1017	1019	1021	1023	1025	1027	1029	1031	1033	1035

Trip number		1001	1003	1005	1007	1009	1011	1013	1015	1017	1019	1021	1023	1025	1027	1029	1031	1033	1035
Trainset number		4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3
	From:	1000A	1000B	1000C	1002	1004	1006	1008	1010	1012	1014	1016	1018	1020	1022	1024	1026	1028	1030
GILROY		6:10	6:40	7:10	7:40	8:10	8:40	9:10	9:40	10:10	10:40	11:10	11:40	12:10	12:40	13:10	13:40	14:10	14:40
SAN JOSE		6:38	7:08	7:38	8:08	8:38	9:08	9:38	10:08	10:38	11:08	11:38	12:08	12:38	13:08	13:38	14:08	14:38	15:08
MILLBRAE		7:06	7:36	8:06	8:36	9:06	9:36	10:06	10:36	11:06	11:36	12:06	12:36	13:06	13:36	14:06	14:36	15:06	15:36
SAN FRANCISCO / 4th&KING		7:20	7:50	8:20	8:50	9:20	9:50	10:20	10:50	11:20	11:50	12:20	12:50	13:20	13:50	14:20	14:50	15:20	15:50
	To:	1008	1010	1012	1014	1016	1018	1020	1022	1024	1026	1028	1030	1032	1034	1036	1038	1040	1042

Trip number		1032	1034	1036	1038	1040	1042	1044	1046	1048	1050	1052	1054	1056	1058	1060	1062	1064	1066
Trainset number		4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3
	From:	1025	1027	1029	1031	1033	1035	1037	1039	1041	1043	1045	1047	1049	1051	1053	1055	1057	1059
SAN FRANCISCO / 4th&KING		13:40	14:10	14:40	15:10	15:40	16:10	16:40	17:10	17:40	18:10	18:40	19:10	19:40	20:10	20:40	21:10	21:40	22:10
MILLBRAE		13:55	14:25	14:55	15:25	15:55	16:25	16:55	17:25	17:55	18:25	18:55	19:25	19:55	20:25	20:55	21:25	21:55	22:25
SAN JOSE		14:24	14:54	15:24	15:54	16:24	16:54	17:24	17:54	18:24	18:54	19:24	19:54	20:24	20:54	21:24	21:54	22:24	22:54
GILROY		14:50	15:20	15:50	16:20	16:50	17:20	17:50	18:20	18:50	19:20	19:50	20:20	20:50	21:20	21:50	22:20	22:50	23:20
	To:	1037	1039	1041	1043	1045	1047	1049	1051	1053	1055	1057	1059	1061	1063	1065	1067	1069	1071

Trip number		1037	1039	1041	1043	1045	1047	1049	1051	1053	1055	1057	1059	1061	1063	1065	1067	1069	1071
Trainset number		4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3
	From:	1032	1034	1036	1038	1040	1042	1044	1046	1048	1050	1052	1054	1056	1058	1060	1062	1064	1066
GILROY		15:10	15:40	16:10	16:40	17:10	17:40	18:10	18:40	19:10	19:40	20:10	20:40	21:10	21:40	22:10	22:40	23:10	23:40
SAN JOSE		15:38	16:08	16:38	17:08	17:38	18:08	18:38	19:08	19:38	20:08	20:38	21:08	21:38	22:08	22:38	23:08	23:38	0:08
MILLBRAE		16:06	16:36	17:06	17:36	18:06	18:36	19:06	19:36	20:06	20:36	21:06	21:36	22:06	22:36	23:06	23:36	0:06	0:36
SAN FRANCISCO / 4th&KING		16:20	16:50	17:20	17:50	18:20	18:50	19:20	19:50	20:20	20:50	21:20	21:50	22:20	22:50	23:20	23:50	0:20	0:50
	To:	1044	1046	1048	1050	1052	1054	1056	1058	1060	1062	1064	1066	Bris.	Bris.	Bris.	Bris.	Bris.	Bris.

Figure 6-7: PenC Timetable (4th & King to Gilroy return)

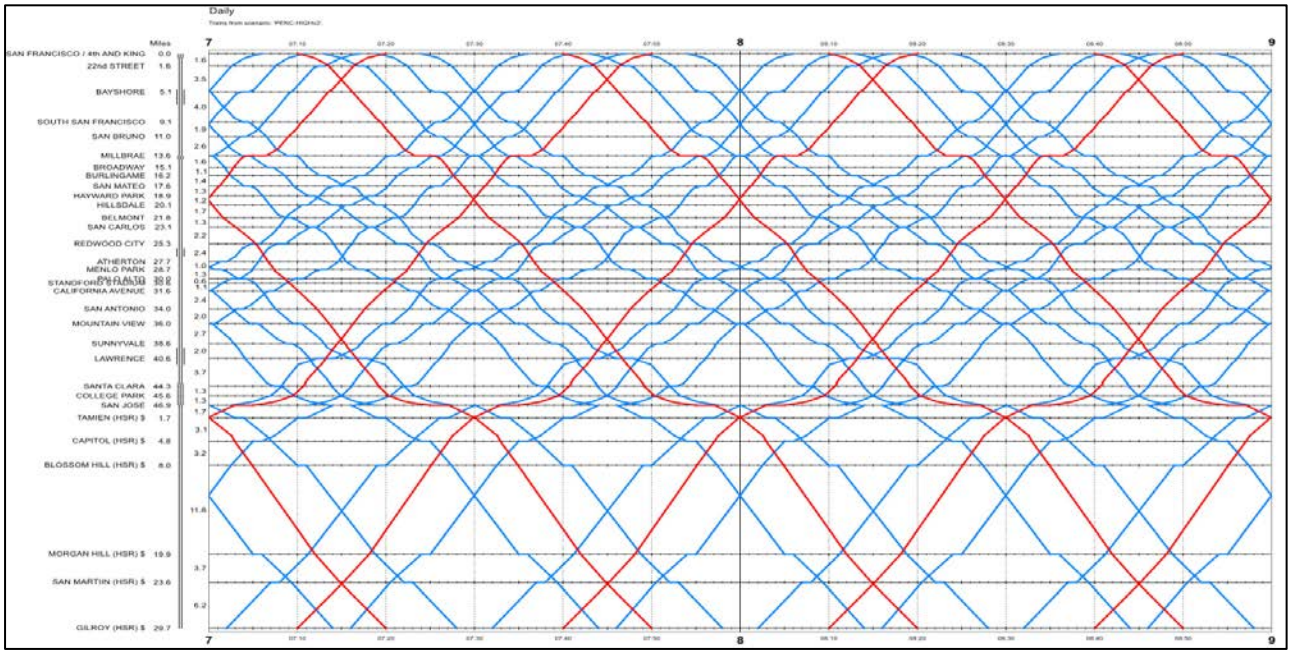


Figure 6-8: Stringlines of HSR (red) and Caltrain (blue) services

6.1.3.4 PenC Connectivity

As per the TOC's service vision, customer satisfaction and economically successful operation of the high-speed rail system are central success factors. To achieve these, a high degree of connectivity and the creation of consistent and integrated travel chains throughout California comprising clock face timetables, both for the high-speed trains and the corresponding rail and bus feeder services, are a *must*.

Already today, connectivity of HSR and Caltrain train services with other means of public transportation is on a relatively high level in the PenC area:

- 4th & King Station: MUNI Metro: Lines N and T; several bus lines, etc.;
- Millbrae Station: BART: Red Line to Richmond, Yellow Line to Pittsburg/Bay Point (via San Francisco Airport SFO); several bus lines, etc.;
- San Jose Diridon Station: Amtrak: Capitol Corridor, Coast Starlight; Altamont Corridor Express (ACE); VTA Light Rail: Green Line Mountain View–Winchester; several bus lines; BART (Berryessa Station, possibly to be built in the future), etc.

Considering the intensive use of track capacities mainly on the 4th & King–San Jose section, efforts spent on harmonization between HSR and connecting rail or bus services might be subject to practical constraints caused by such dense headways, which might not always allow for the full flexibility needed to precisely optimize transfer times.

Taking into account the relatively high level of connectivity already existing on the PenC, however, possibly suboptimal connections – regarding transfer times – will be compensated by the variety, large number and short headways of connecting services.

Barrier-free, seamless change between the different means of public transportation is similarly crucial as it is in the CVC or any other public transport context.

6.1.3.5 PenC Rolling Stock

To operate half-hourly train service in both directions in the PenC, the previously described eight trainsets with eight-cars each are required.

There will be two fare classes (such as economy and business) each priced differently. Two cars will be open to passengers of the business class, five cars will be open to passengers travelling economy class and one will be used as a restaurant car.

Considering the technical restrictions on the 4th & King Station–Gilroy section (existence of 72 level-crossings), the scheduled maximum operational speed is 110 mph.

Note: Not only from a railway operations standpoint, level-crossings can turn out to be a weak point for the stability of timetables. ETO performed a preliminary calculation, which highlighted that in the future the level crossings might be activated up to 18 times per hour with an estimated gate-down time of 2.5 min. This could lead to severe traffic delays on local roads and isolate neighborhoods, causing negative impacts to local economies.

ETO therefore suggests performing an impact analysis on the crossing road traffic and reviewing the advisability of grade separation between road and rail in the affected sections.

6.2 Organization and Personnel

The organizational structure of the CVC and PenC operations will provide the basis for best operational quality, customer satisfaction, and economic viability. This will be ensured through highly integrated operational functions.

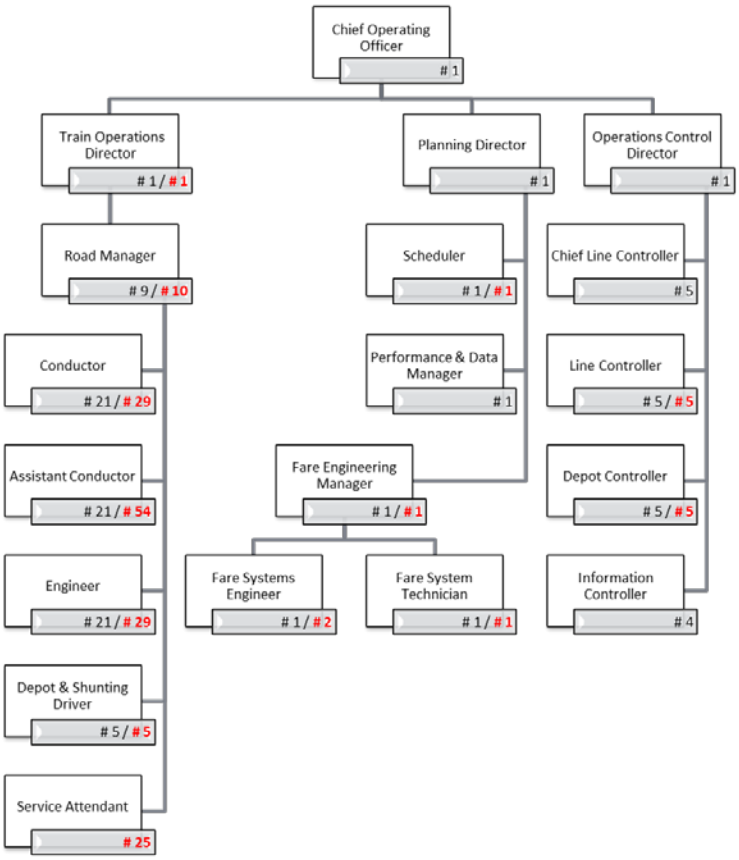


Figure 6-9: Organizational structure of operations department (CVC in black / PenC incremental in red)

The number of FTEs shown in the organization chart above reflects the specific requirements of multi-shift operations. The required numbers and qualifications of CVC and PenC operations personnel have been derived from the specific experience of rail operations both in Germany and in the U.S.

6.3 Cost Drivers

The three key operations costs are:

- Staffing costs;
- Traction power costs;
- Costs related to NRVs (Non-Revenue Vehicles).

6.3.1 Staffing costs

Labor cost in operations is mainly characterized by the need for alignment between overall operations hours and the shifts to be filled by the employees with their respective net working times. A mark-up factor reflects inevitable inefficiencies in such crew shift planning. The resulting cost driver is the number of staff, expressed in full-time employees (FTE).

6.3.1.1 CVC Staffing Cost Drivers

A total of 106 FTEs will be needed to fill all operational positions for a total of 27,206 train hours per year.

- *Operations control personnel* (line and depot controllers[3]) will work in a three-shift system. To cover a position in a three-shift system over 24 hours, 365 days per year, and assuming a full-time operational employee's net working time of 1,794 hours per year, a total of five FTEs is required:

$$365d * \frac{24h}{1{,}794\frac{h}{yr}} = 4.88FTE \approx 5FTE$$

  Respectively, the positions of chief line controller, line controller and depot controller require five FTEs each.

- Train operations personnel (road managers, train crews) will work in a two-shift system[4].

  For trains in revenue service, the daily operation of four high-speed trains in revenue service for around 19 hours[5] results in a total of 27,206 annual train hours, including turn times.

  Adding a 12.5% mark-up factor for inevitable inefficiencies in crew shift planning etc., a total of 30,607 hours must be filled; a yearly networking time of 1,794 hours per operational FTE can be assumed:

[3] Information controllers will work in a two-shift system, i.e. during the revenue operation times of the high-speed trains
[4] The depot and shunting drivers work in a three-shift scheme
[5] For precise operational data see above timetable

$$\frac{30{,}607h}{1{,}794\ \frac{h}{FTE}} = 17.06FTE \approx 17FTE$$

The four trains in revenue service, therefore, require 17 engineers, 17 conductors, and 17 assistant conductors.

Protect train: A fifth train serves as an operational reserve during the other four trains' 18 hours of revenue service. It is in stand-by mode, fully equipped with engineer, conductor and assistant conductor to be activated quickly, when needed.

$$365d * \frac{18h}{1{,}794\frac{h}{yr}} = 3.66FTE \approx 4FTE$$

An additional four engineers, four conductors, and four assistant conductors will be needed for a fully functional protect train. During stand-by, the protect train's engineer will help the depot and shunting driver shunt trains in the stabling yard and HMF.

Planning personnel (scheduler, performance and data manager, fare collection personnel) will work in a single-shift system.

6.3.1.2 PenC Staffing Cost Drivers

A total of 193 FTEs will be needed to fill all operational positions of PenC to cover a total of 39,822 train hours per year in all operational aspects.

- *Operations control personnel* (line and depot controllers[6]) will work in a three-shift system. To cover a position in a 3-shift system for the positions allocated to the PenC operations, five line controllers and five depot controllers are required. The position of the chief line controller is located at CVC.

- *Train operations personnel* (road managers, train crews) will work in a 2-shift system[7].

[6] Information controllers will work in a 2-shift system, i.e. during the revenue operation times of the high-speed trains; they are allocated to CVC.
[7] The depot & shunting drivers work in a 3-shift scheme.

For trains in revenue service: The daily operation of six high-speed trains in revenue service for around 19 hours[8] results in a total of 39,822 annual train hours, including turn times.
Adding again a 12,5% mark-up factor for inevitable inefficiencies in crew shift planning etc., a total of 44,799 hours must be filled with the assumed net working time of 1,794 hours per operational FTE:

$$\frac{44{,}799}{1{,}794\ \frac{h}{FTE}} = 24{,}97\ FTE \approx 25 FTE$$

The six trains in revenue service therefore require 25 engineers, 25 conductors and 25 attendants.
As all eight cars of the trainsets will be open to the passengers, two assistant conductors per train will be needed. Therefore, 50 assistant conductors are required for the six trains in revenue service.

This brings the train crew total to 29 engineers, 29 conductors, 54 assistant conductors, 25 service attendants and 5 depot/shunting drivers.

Protect train: Additional four engineers, four conductors and four assistant conductors will be needed for a fully functional operational reserve to cover two shifts of daily revenue service. During stand-by, the engineer of the protect train will assist the depot & shunting driver in shunting trains in the stabling yard and LMF in Brisbane.

6.3.2 Traction Power Costs

The traction power costs for both CVC and PenC operations are based on the electricity consumptions of DB's BR407 (ICE 3[9]). Figure: 6-10 shows the power input from the overhead catenary line at the respective operational speed for each corridor based on a DB's BR407 empty train set.

[8] For precise operational data see timetable above.
[9] Siemens Velaro D

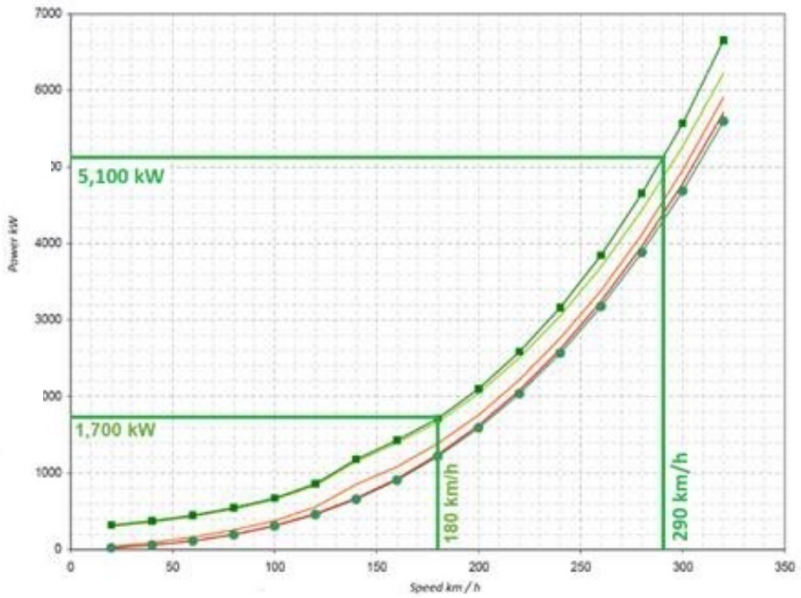


Figure: 6-10: Power input from overhead catenary line [kW] at constant speed [km/h] for PenC and CVC operations based on DB's BR407

6.3.2.1 CVC Traction Power Cost Drivers

The electricity consumption at a speed of 180 mph (290 km/h) will according to Figure: 6-10 be approximately:

$$\frac{5{,}100\ kW}{290\ km/h} = 17.6\ \frac{kWh}{train\ kilometer} \approx 28.3\ \frac{kWh}{train\ mile}$$

Assuming a half-loaded trainset at 462 tons[10], with four out of eight cars accessible to passengers, a full high-speed train trip from Merced to Bakersfield (175 miles) consumes:

$$\frac{28.3\frac{kWh}{mile}}{439\ t} * 462\ t * \ 175\ miles \approx 5.21\ \text{MWh}.$$

[10] 439tons (empty train-set) + 23tons (50% of passenger maximum load).

An additional 10% for stand-by during turn-times and in the stabling yard as well as for pull-in/pull-out need to be added. Therefore, the overall electricity consumption per full trip results in 5.73 MWh.

6.3.2.2 PenC Traction Power Cost Drivers

Due to an operational speed of 110 mph (i.e. 180 km/h), less traction power and therefore lower energy consumption per train is needed at the PenC, see Figure: 6-10:

$$\frac{1{,}700\ kW}{180\ km/h} = 9.44\ \frac{kWh}{train\ kilometer} \approx 15.2\ \frac{kWh}{train\ mile}$$

Assuming now a fully loaded train-set at 485tons[11], the energy consumption per high-speed train full trip from 4th & King to Gilroy (77mls) is approximately:

$$\frac{15.2\frac{kWh}{mile}}{439\ t} * 485\ t * \ 175\ miles \approx 1.29\ Mwh.$$

With the additional mark-up of 10%, the overall electricity consumption per full trip is assumed to be 1.42 MWh.

6.3.3 NRV Costs

NRV cost drivers are shown below.

Type of NRV	Number of NRVs	Annual fuel consumption per NRV (gallons)	Annual maintenance and insurance cost per NRV (in USD)
CVC			
SUV	2	1,000	7,800
Mini bus	1	1,340	7,800
Pick-up	5	1,684	7,800

[11] 439 tons (empty train-set) + 46 tons (100% of passenger maximum load).

Type of NRV	Number of NRVs	Annual fuel consumption per NRV (gallons)	Annual maintenance and insurance cost per NRV (in USD)
Sedan	1	783	6,750
PenC			
SUV	1	1,000	7,800
Mini bus	1	1,340	7,800
Pickup	4	1,684	7,800

Figure 6-11: NRV cost drivers

6.3.4 Unit Costs

This section highlights the corresponding unit costs for operations staff, traction power consumption, NRV fuel consumption, and related NRV costs.

6.3.4.1 Staffing Unit Costs

The Figure 6-12 shows unit costs per FTE. These unit costs are shown in line with the general pay grades defined in the Chapter 5 of the study.

# No	Position	CVC FTE	PenC FTE	Short task description	Annual salary (in USD)	Pay grade allocation
1	Chief Operating Officer	1	-	Senior executive, responsible for train and landside train operations	200,000	Senior Director
2	Train Operations Director	1	-	Director level, responsible for all train-related operations and on-board services for CVC segment	150,000	Senior Manager (greater ten years' experience)

# No	Position	CVC FTE	PenC FTE	Short task description	Annual salary (in USD)	Pay grade allocation
2.1	Deputy Train Operations Director	-	1	Senior manager's level, responsible for all train-related operations and on-board services for PenC segment	120,000	Senior Manager (fewer than ten years' experience)
2.2	Road Manager (merged: Road Foreman/ Road Master)	9	10	Supervision and quality assurance of train operations, disposition of train crews, operational emergency management	100,000	Manager
2.2.1	Conductor	21	29	Train manager	80,000	Equivalent to Analyst
2.2.2	Assistant Conductor	21	54	Assistant train manager	60,000	Assistant
2.2.3	Engineer	21	29	Train driver: open track	80,000	Equivalent to Analyst
2.2.4	Depot and Shunting Driver (full engineer's qualification)	5	5	Train driver: stabling yard/ HMF/ LMF, pull-in/pull-out services	80,000	Equivalent to Analyst
3	Planning Director	1	-	Director's level, responsible for scheduling, performance management, fare collection	150,000	Senior Manager (greater ten years' experience)
3.1	Scheduler	1	1	Long-term, ad-hoc, and construction-related scheduling	80,000	Analyst
3.2	Performance and Data Manager	1	-	Evaluation of operations-related	80,000	Analyst

# No	Position	CVC FTE	PenC FTE	Short task description	Annual salary (in USD)	Pay grade allocation
				data; introduction lean management		
3.3	Fare Engineering Manager	1	1	Supervision and quality assurance for all fare collection-related processes	100,000	Manager
3.3.1	Fare Systems Engineer	1	2	Technical management of fare collection devices	80,000	Equivalent to Analyst
3.3.2	Fare System Technician	1	1	Maintenance of fare collection devices	80,000	Equivalent to Analyst
4	Operations Control Director (including Incident Manager's role)	1	-	Director's level, responsible for OCC, dispatching, operational controlling, info provision, chief incident management	150,000	Senior Manager (greater ten years' experience)
4.1	Chief Line Controller (including Dispatcher's role)	5	-	Operational head of OCC, regulator, operational dispatching	100,000	Manager
4.2	Line Controller	5	5	Operational line dispatching	80,000	Equivalent to Analyst
4.3	Depot Controller	5	5	Operational depot and shunting movement dispatching	80,000	Equivalent to Analyst
4.4	Information Controller	4	-	Information provider to passengers and stakeholders	60,000	Assistant

# No	Position	CVC FTE	PenC FTE	Short task description	Annual salary (in USD)	Pay grade allocation
5	Attendants	-	25	Service personnel for on-board catering/bar	60,000	Assistant

Figure 6-12: Staffing unit costs

6.3.4.2 Traction Power Unit Costs

The sole electricity supplier in the Central Valley is PG&E (Pacific Gas and Electric Company), with its "E20" industrial tariff at 12.51 USD cents/kWh. TOC assumes that PG&E technically absorbs recuperation of brake energy into the system without reimbursement.

6.3.4.3 Non-Revenue Street Vehicles Unit Cost

TOC assumes a fuel price of USD 4.25/gallon.

6.4 Uncertainties and Contingencies

The main uncertainties related to the projection of operations costs are related to:

- The possibility of an increase in labour unit costs caused by a potential shortage of suitable high-speed rail operations personnel driving up wages;
- The possibility of future increases in energy tariffs caused by California's plans to increase the weight of sustainable energy significantly as a share of its overall energy mix in the coming years.

6.5 Cost Projection

The Figure 6-13 shows the resulting cost projection for operations in 2018 USD.

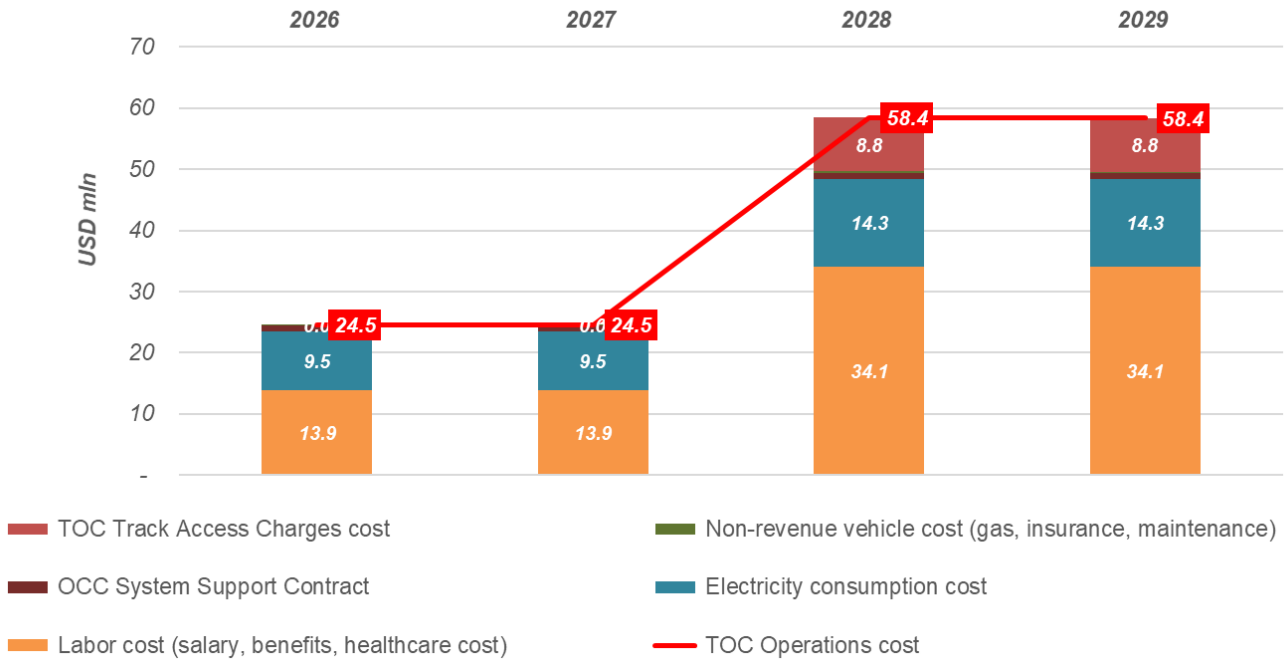


Figure 6-13: Cost projection for operations

7 Maintenance of Rolling Stock, HMF and LMF

7.1 Key Assumptions

7.1.1 Introduction

The trainsets must perform each and every day. They must be fully available, absolutely reliable, and safe. In addition to the technical design, maintenance is key to spotless reliability, availability and safety performance. Besides the technical design for reliability, availability and safety, maintenance is the additional means to ensure this spotless performance.

For the trainsets operating on the CVC segment, all inspections, operational maintenance, and heavy maintenance work will be executed in the HMF. It should be noted that the final location for the HMF is still to be determined by the Authority and for purposes of this study is only assumed at Fresno. For the trainsets operating on the PenC segment, due to two year operational period, only inspections and operational maintenance Levels 1 and 2 will have to be executed. Inspections and operational maintenance Level 1 are to be executed in Brisbane Workshop. Operational maintenance Level 2 which has to be performed once a year per trainset is expected to be performed in the HMF. The Level 2 comprises among others full brakes inspections and maintenance, full bogie inspections and maintenance as well as full train control inspections and maintenance. Moreover, major repairs of damages from accidents will be performed in the HMF as well.

The cost calculation for rolling stock maintenance comprises all tasks necessary to keep the trains in a safe and proper shape for customer oriented, commercial revenue-service and all resources needed to perform the maintenance work.

Rolling stock maintenance costs comprise variable and fixed components:

- Variable recurrent costs for maintaining the trainsets according to maintenance intervals defined by the trainset supplier, and which generally vary with mileage;
- Fixed costs related to the HMF and LMF needed to maintain the trainsets.

Note: Assumptions have been made about synergies between various maintenance contractors active within the HMF and LMF. This calculation will be replaced by input from the future rolling stock

supplier responsible for maintaining all trainsets as soon as it is available from the bids and later from the contract.

7.1.1.1 Rolling Stock Maintenance Variable Costs

As part of the variable costs, the following types of recurrent rolling stock maintenance are assumed to be performed:

- Planned maintenance to ensure safe, reliable, and highly available operations;
- Corrective maintenance to repair any damages and install spares to replace components that failed during operation;
- Trainset cleaning (daily inside cleaning and regular car wash).

Planned maintenance is based on maintenance cycles derived from ETO's experience with high-speed trains. It is therefore assumed, that the maintenance intervals will be defined in a similar way as in Europe and Asia. This is based on mileage, instead of time intervals. Mileage intervals are more suitable for high-speed trains because they perform at much higher annual mileage than slower freight or urban trains.

Cost projections are based on man-hours and materials cost per maintenance interval according to ETO's experience.

Several further key assumptions are highlighted:

- It is assumed that CHSRA will procure 95% of the material needed in planned maintenance—all but consumables—together with the trainsets. The industry will deliver the material tailored to maintenance work;
- Since the CHSRA plans on a five-year contract-warranty for the rolling stock. The TOC assumes that the warranty covers 75% of the costs for corrective maintenance, staff and materials;
- It should be noted that corrective maintenance costs do not comprise costs for repairs caused by accidents and vandalism;
- It is assumed that procurement and handling of spares for maintenance will be managed by the same team fielded by the rolling stock supplier that manages the supply chains for

manufacturing the trainsets which will be deployed both for CVC and PenC. The work capacity needed to procure and handle spares is calculated as an extension of the team already available for managing the supply chains to manufacture the trainsets.

7.1.1.2 HMF and LMF Fixed Costs

For CVC operations, all maintenance work for the rolling stock will be executed in one central HMF. For PenC only Level 2 maintenance will be performed at the HMF, since the regular and Level 1 operational maintenance will be performed at the LMF. The HMF will be fully equipped for the envisaged level of maintenance and repair work and the staff available in Fresno will have enough capacity to perform the maintenance on CVC and PenC trainsets.

Both HMF and LMF will comprise of the following:

- Workshop facility;
- Overhaul workshop for components;
- Warehouse;
- Nearby carwash facility;
- Nearby stabling yard;
- Office space.

The individual maintenance regime per railway segment defines the frequency for visiting a workshop and the amount of work to be executed on each trainset, as well as the materials needed for repairs. Similarly, each trainset will visit a carwash facility as part of the workflow, according to the different maintenance intervals.

ETO assumes that both stabling yards will be designed and built early in the construction project for parking up to 30% of the V2V fleet that is not in maintenance.

The size of the HMF and LMF is derived from the trainsets' number of workshop visits and the time during which the trainsets dwell in the workshop. The dwelling time is roughly derived from the maintenance regime, which is also input for the calculation of the maintenance costs. The proposed

regime defines the frequency of train visits, the amount of work to be executed on each trainset, as well as materials needed for the repairs.

It is assumed that both the HMF and LMF will be designed and built in three stages:

- The initial size of the HMF, including a warehouse, carwash and offices, will be about 118,000 square feet. In 2028 and 2029 the next part will be constructed. The resulting size of the HMF will be 211,000 square feet. The final size of the HMF will be constructed in 2030, when the total size of the HMF will reach 300,000 square feet. The design of the HMF will accommodate two tracks for two trainsets for each phase and additional space for refurbishment of components and for the warehouse. The final phase will become operational in time for the first full overhaul.

- The initial size of the LMF including warehouse, car wash and offices is about 106,000 square, including three tracks only. The final size of the LMF is assumed to comprise nine tracks and to be about 268,000 square foot. Although it has more tracks than the HMF, LMF will be smaller because there will be no refurbishment areas and the size of the warehouse will be smaller.

- For equipping both facilities, ETO used the state-of-the-art technology of a DB depot and workshop as reference to derive the annual maintenance and cleaning costs for the workshop and all its equipment. The major pieces of equipment to be located in both facilities will include cranes, specialized lifts for heavy components, turning machines, measuring devices, NRVs like fork lifts, etc.

- In both facilities, the single-track carwash will be built right at the beginning.

7.2 Cost Drivers

The major inputs for calculating the rolling stock maintenance costs are:

- The mileage of the trainsets to fulfill the timetable service;
- The number of operational trainsets needed to fulfill this service at the high level of reliability, availability and safety set for California high-speed in general;

- The costs to haul the trainsets from San Jose to Merced and from Merced to Fresno are assumed to be hauled on Union Pacific. This is for operations maintenance Level 2, which has to be performed once a year per trainset;
- The size of the HMF and LMF, including the equipment necessary to execute all maintenance tasks.

From these cost drivers, required numbers of staffing has been derived.

7.2.1 Mileage

The following recurrent maintenance cost types are driven by mileage:

Two levels of inspection, from daily inspection to inspections combined with minor maintenance work:

- In CVC's case every five days every two weeks;
- In PenC's case every seven days every three weeks;

Three levels of regular maintenance work:

- In CVC's case every two months to approximately every eighteen months;
- In PenC's case every three months to approximately once a year;

Two levels of heavy overhaul—in CVC's case a minor one approximately every 2.5 years (every million miles); a major one approximately every five years (therefore there will not be a major overhaul during CVC operation). Given the two year operation of PenC, heavy haul is not necessary yet.

The corrective maintenance cost projection is based on a cost-per-mile assumption taken from the ETO's experience for both segments of the railway.

Maintenance frequencies for different maintenance levels are shown below.

# No	Maintenance level	Frequency in miles	Frequency in years for CVC	Frequency in years for PenC
1.1	Inspection 1	5,000	5 days	7 days
1.2	Inspection 2	15,000	2 weeks	3 weeks
2.1	Maintenance 1	62,500	2 months	3 months

# No	Maintenance level	Frequency in miles	Frequency in years for CVC	Frequency in years for PenC
2.2	Maintenance 2	250,000	8 months	12 months
2.3	Maintenance 3	500,000	16 months	-
3.1	Heavy Overhaul 1	1 million	2.5 years	-
3.2	Heavy Overhaul 2	2 million	5 years	-

Figure 7-1: Trainset mileage assumption bases on and summary

7.2.2 Trainsets

The maintenance costs are based on trainsets as follows:

- Number of operational trainsets:
  - For CVC operations *four* trainsets will be used for the operations, out of six in total, of which one trainset each is assumed for standby requirements and one for maintenance;
  - For PenC operations *six* trainsets will be used for the operations, out of eight in total, of which one trainset each is assumed for standby requirements and one for maintenance;
  - While for PenC all cars are used for revenue service, in case of CVC only four out of eight cars are in use. This has a direct impact on some of the maintenance and cleaning costs;
  - All trainsets will include catering equipment as part of one car. It is assumed that the cart will not be fully operated on the CVC segment;
  - There will be a car wash facility at each depot; it is assumed that each trainset will be cleaned every five days for CVC and every three days for PenC;
  - It is assumed that five out of eight cars are powered;

- Cleaning comprises both car interior cleaning and carwash. Train cars interior cleaning is assumed to be purchased from small businesses and performed daily, including regular 'rough' cleaning of the train cars at terminal stations or onboard (mobile cleaning).

7.2.3 HMF & LMF Cost Drivers

Two cost drivers influence costs for management, operation, and maintenance of the HMF and LMF:

- The size of the facility, with the number of tracks needed to maintain and clean the trainsets;
- The state-of-the-art technology, machinery and equipment needed to execute the inspection and maintenance work.

7.2.4 Organization and Personnel

The Train Delivery Director will be responsible for managing both HMF and LMF and the maintenance of the entire trainset fleet used on CVC and PenC, so they will be available on time and on the service level for commercial revenue-service as stipulated in the contract. The vehicle engineers who maintain the trains in the workshop and overhaul components are part of his team. Vehicle engineers responsible for the PenC fleet will be located in Brisbane. Since the fleet is small, it is assumed that the staff will spend considerable time waiting for the next train to be maintained. The assumed productivity rate for CVC is 60%, while for PenC 70%.

In addition to the operational maintenance staff, managers are needed to:

- Plan and manage the train inspections, maintenance, cleaning, and the staff needed;
- Operate, maintain, and clean the HMF and LMF and their respective equipment.

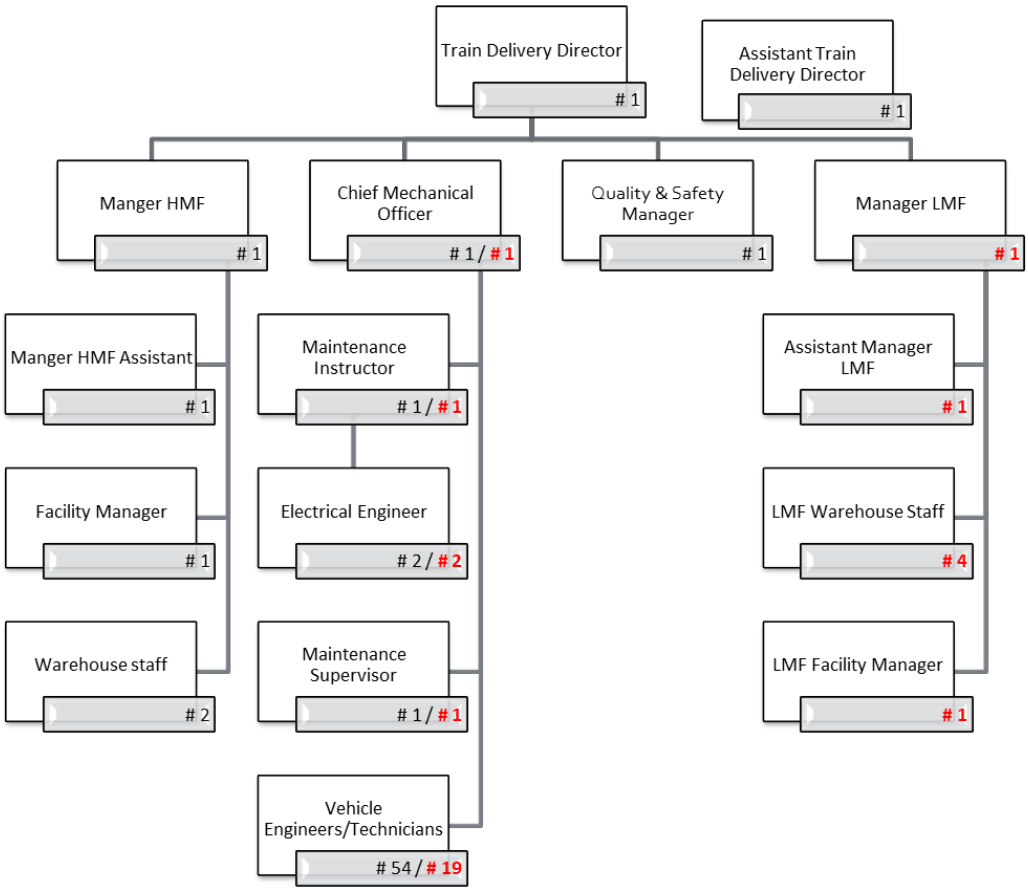


Figure 7-2: Organizational structure of train delivery department (CVC in black / PenC incremental in red)

# No	Position	CVC FTE	PenC FTE	Short task description	CVC Annual salary (in USD)	Pay grade allocation
1	Train Delivery Director	1	-	Responsible to deliver the trainsets ready for revenue operation	200,000	Senior Director
1.1	Assistant Train Delivery Director	1	-	Managing Assistant responsible for train delivery and cooperation with operation	60,000	Assistant
2	Quality and Safety Manager	1	-	Responsible for quality of maintenance and workshop safety and security	115,000	Senior Manager (fewer than ten years' experience)
3	Chief Mechanical Officer	1	1	Manage the maintenance regime in the workshop	150,000	Senior Manager (greater ten years' experience)
3.1	Maintenance Instructor	1	1	Responsible for the correct execution of all maintenance work	100,000	Equivalent to Manager
3.2	Maintenance Supervisor	1	1	Technical team leader	73,000	Equivalent to Analyst
3.1.2	Electrical Engineer	2	2	Technician who maintains electrical parts	71,000	Equivalent to Analyst
3.2.1	Vehicle Technicians/Engineers	54	19	Technician / Engineer who maintains mechanical parts	58,000	Equivalent to Assistant

Figure 7-3: Rolling stock maintenance organization

# No	Position	HMF FTE	LMF FTE	Short task description	HMF Annual salary (in USD)	HMF Pay grade allocation	LMF Annual salary (in USD)	LMF Pay grade allocation
1	Manager	1	1	Manage the heavy maintenance facility on site	160,000	Senior Manager (greater ten years' experience)	160,000	Senior Manager (greater ten years' experience)
1.1	Assistant Manager	1	1	Assistant Managers to manage the workshop as an entrepreneurial unit	110,000	Senior Manager (fewer than ten years' experience)	110,000	Senior Manager (fewer than ten years' experience)
1.2	Facility Manager	1	1	Keep the facility in good shape and operation	80,000	Equivalent to Analyst	80,000	Equivalent to Analyst
1.3	Warehouse Staff	2	4	Manage and assign spares	36,000	Equivalent to Assistant	36,000	Equivalent to Assistant

Figure 7-4: HMF and LMF organization

Type of NRV	Number of NRV	Annual fuel consumption per NRV (gallons)	Annual maintenance and insurance cost per NRV (in USD)
CVC			
Car mover	1	-	15,500
Forklift-four ton	1	-	7,450
Forklift-narrow aisle	1	-	8,750
Pick-up truck	2	2,250	7,000
Stake body truck	1	1,500	13,250

Type of NRV	Number of NRV	Annual fuel consumption per NRV (gallons)	Annual maintenance and insurance cost per NRV (in USD)
SUV	2	2,250	7,000
PenC			
Forklift-4 ton	1	-	7,450
Forklift-Narrow aisle	1	-	8,750
Stake Body Truck	1	1,500	13,250

Figure 7-5: NRVs for rolling stock operations

7.2.5 Unit Costs

Labor and material costs per trainset-mile and per maintenance interval are derived from:

- ETO's experience with high-speed train maintenance with regard to the number of man-hours and materials
- ETO's U.S. benchmark information and experience with regard to salary costs.

The following unit costs are assumed:

- Depending on the maintenance level to be fulfilled in each year of commercial revenue operation labor costs for planned maintenance vary. The respective material costs are low because it is assumed that CHSRA will procure 95% of the material needed in planned maintenance—all but consumables—together with the trainsets. The industry will deliver the material tailored to maintenance work.
- Corrective maintenance deals, reactively with repairs and replacements that are not safety critical and not directly mobility critical. Material costs for the corrective maintenance are low because of the assumed supplier's warranty. The CHSRA plans on a five-year contract-warranty for the rolling stock. Therefore, TOC assumes that the warranty covers 75% of the costs for corrective maintenance, staff and materials.
- CVC dedicated trainset cleaning (inside and out) is calculated at about USD 200,000 per year and trainset, assuming daily inside cleaning and one carwash every five days. PenC dedicated

cleaning is calculated at USD 600,000 per year and trainset, assuming daily inside-cleaning and one carwash every three days. The frequency is higher due to and a higher risk of vandalism and littering in the trainsets.

- Maintenance and janitorial services for the HMF and LMF are based on cost per square foot (USD 2.32 per year), considering the first two stages of HMF construction, and only the first stage construction of the LMF.

Unit costs	CVC (in USD)	PenC (in USD)
Average cost per train-mile for materials used for the planned maintenance	0.03	0.004
Average cost per train mile for materials used for the corrective maintenance	0.003	0.005
Annual trainset cleaning (inside and out)	2.7 mln	4.7 mln
Annual maintenance and janitorial services for the HMF	385,000	n/a
Annual maintenance and janitorial services for the LMF	n/a	248,000
Annual maintenance cost of all workshop equipment at HMF	431,000	n/a
Annual maintenance cost of all workshop equipment at LMF	n/a	144,000
Annual utility cost at HMF (electricity, gas and water)	1,542,450	n/a
Annual utility cost at LMF (electricity, gas and water)	n/a	714,116
Annual trainset hauling fee from LMF to HMF	n/a	22,286

Figure 7-6: Rolling stock, HMF and LMF maintenance unit costs

7.3 Uncertainties and Contingencies

The following risks and opportunities are identified related to rolling stock maintenance:

- The maintenance costs per trainset depend on the design of the trainset, which might differ from manufacturer to manufacturer. For example, the number of bogies and wheelsets, as the most expensive components to maintain in a trainset, can differ depending on the design of the trainsets.

- As an opportunity, it is expected that the maintenance entity can leverage operations data and experience to achieve a continuous improvement process. It is further expected the maintenance entity can optimize procurement management, and deployment of spares and components, continuously. This presents an opportunity for cost efficiencies that must be accounted for in the rolling stock maintenance contract as potential benefits that should be shared.
- Operation and maintenance for the V2V Corridor are not yet planned in detail. Therefore, rough assumptions have been used to estimate the dwelling times of the trainsets in the workshop. Comparison with ETO's workshops shows that the assumptions are within a plausible range.

It is possible that the supplier of the trainsets integrates the final assembly and maintenance in the same workshop, especially since the workshop will be operated far from the capacity utility.

Should the contract with the supplier of the trainsets include agreements for warranty and procurement of spares that differ from those described in these assumptions, the calculation must be adapted.

7.4 Cost Projection

The Figure 7-7 shows the resulting cost projection for rolling stock maintenance, including HMF and LMF in 2018 USD.

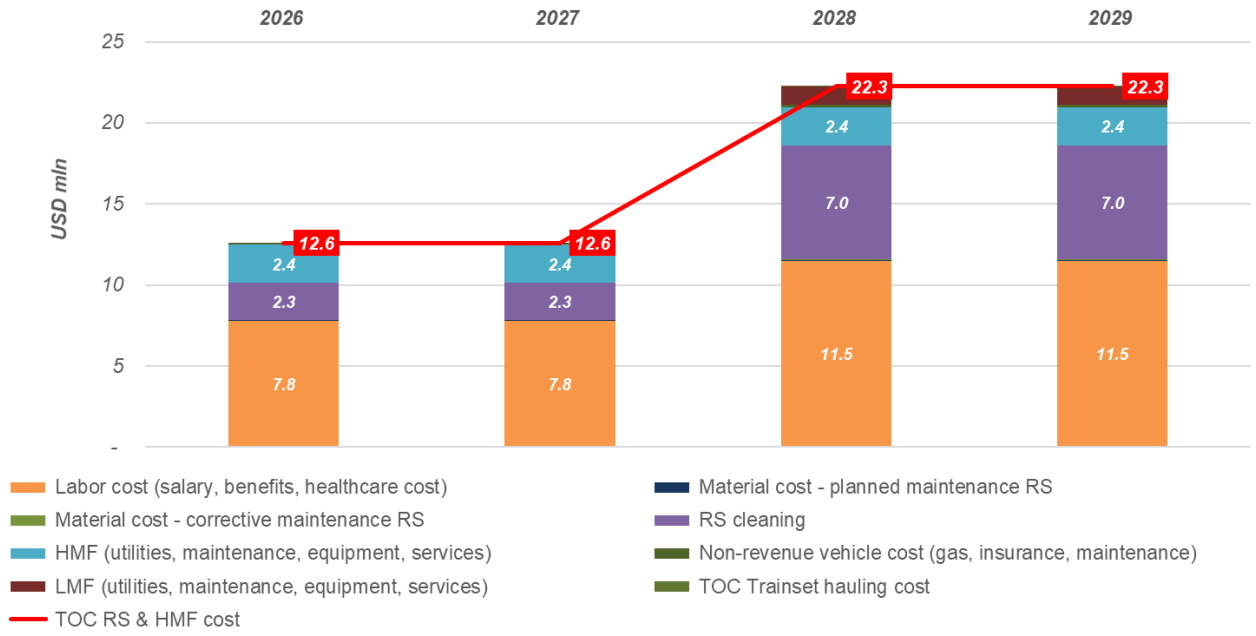


Figure 7-7: Cost projection for rolling stock maintenance, HMF and LMF

8 Maintenance of Civil Structures

For these three main cost elements of maintenance, this study assumes a comprehensive management organization that is portrayed in Chapters 8, 9 and 10. In each chapter the relevant organizational unit for that competence area (civils, track and systems, and facilities) has been detailed out.

8.1 Key Assumptions

8.1.1 Scope

The civil structures cost estimate covers the maintenance cost for all bridges, culverts, drainage systems, retaining walls, trenches, and fencing. This includes inspections based on FRA requirements for bridges and annual structural inspections.

The estimate includes regular visual inspections of the all structures on the alignment. All structures are assumed to be standard in design and made of concrete to ensure a long life and minimal maintenance.

Staff will perform a weekly visual inspection of the right of way.

The highlighted portion of the organization chart in Figure 8-1 shows the headcount for civil structures.

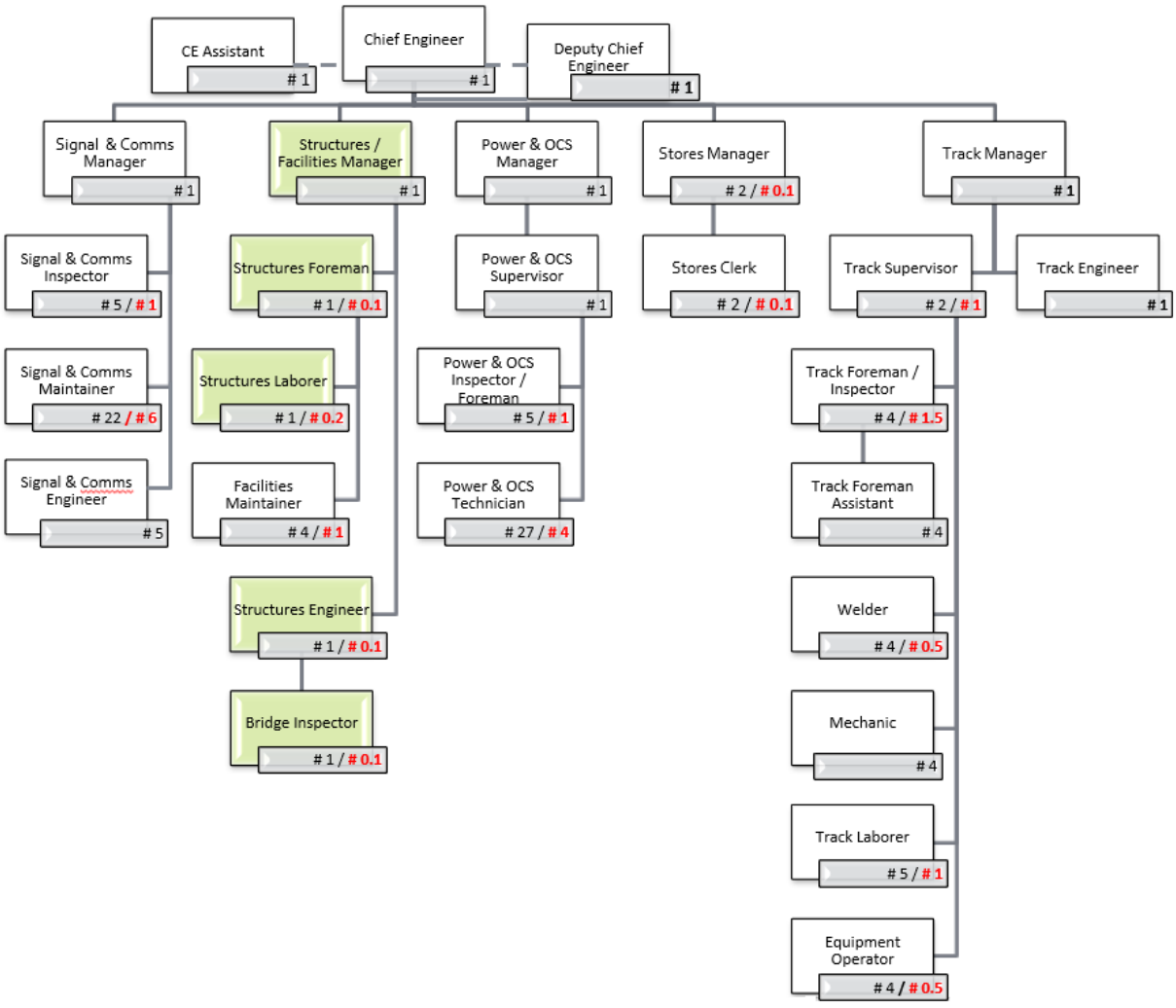


Figure 8-1: Organizational structure of civil structures department (CVC in black / PenC incremental in red)

The Figure 8-2 presents a staffing chart for civil structures maintenance.

# No	Position	CVC FTE	PenC FTE	Short task description	Annual Salary (in USD)	Pay Grade Allocation
1	Structures /Facilities Manager	1	-	Oversight of Structures and Facilities Department	120,000	Senior Manager (greater ten years' experience)
2	Structures Engineer	1	0.1	Manage/perform structural inspections	150,000	Senior Manager (greater ten years' experience)
3	Bridge Inspector	1	0.1	Perform bridge inspections	100,000	Manager
4	Structures Foreman	1	0.1	Maintain and inspect structures	71,000	Manager
5	Structures Laborer	2	0.2	Support Structures Foreman	64,016	Analyst

Figure 8-2: Staffing for civil structures maintenance

Based on the limited amount of civil structures on PenC segment, all staff will be shared with CVC with no dedicated civil structures staff on the PenC. An incremental FTE of 10% for most positions on the CVC was allocated to PenC to cover the inspection responsibilities on the PenC.

8.2 Cost Drivers

The following items are the main cost drivers for civils structure maintenance:

- Inspections of bridges, culverts, tunnels and drainage systems;
- Fencing is assumed to be necessary on the entire alignment:
    - In case of CVC, 175 miles with fencing on both sides for a total of 350 miles; 0.5% of the fencing is assumed to require repair or replacement annually which totals 1.75 miles (i.e. 9,240 ft).

- In case of PenC, 27.5 miles with fencing on both sides for a total of 55 miles; 1% of the fencing is assumed to require repair or replacement annually which totals 0.55 miles (i.e. 2,904 ft).

In addition, dedicated NRVs must be taken into account.

Type of NRV	Number of NRV	Annual fuel consumption per NRV (gallons)	Annual maintenance and insurance cost per NRV (in USD)
CVC & PenC			
4X4 HR crew cab truck	1	1,667	8,750
Bridge Inspection truck-HR	1	2,000	60,846
Pick-up truck-extended cab	5	2,000	7,000
Vacuum truck-HR	1	500	26,000

Figure 8-3: Type of NRV

The existing NRV fleet of the CVC will be used to service the PenC segment.

8.3 Unit Costs

The Figure 8-4 indicates the materials costs estimate for civils structures maintenance.

The assumptions underlying the estimate are as follows:

- The costs listed below are for materials that in-house staff would purchase to repair or replace items as necessary. These costs were developed based on a comparison to other systems maintained in the U.S.;
- For all structural elements it is assumed that the warranty period will cover all major repairs/replacement work during the operations;
- It is assumed that all material and spares required for the first 2 years will be included and procured with the initial investment budget;

- The number of culverts and drainage systems are not determinable based on the information provided but the culverts will require some ballast and/or rip rap to be replaced as a result of water displacing the stones from the inlet and outfall; a lump sum had been estimated;
- In case of the CVC segment, the trenches are assumed to have drainage systems and pump houses, lighting and fire alarm systems that will require regular maintenance. A lump sum is estimated for each trench as the details of the trench are not known;
- The following has been taken into account to estimate the cost of bridge maintenance:
    - The CVC system has 76 bridges that are anticipated to require no maintenance during the initial four years of operation, the cost only includes inspection;
    - The PenC system has 5 bridges ranging in length from 60 feet to 160 feet for a total length of 547 feet that are anticipated to require no maintenance during the initial 2 years of operation; the cost only includes inspection;
    - The cost of bridge inspection has been captured in the maintenance cost of culverts.

Type of infra	Units	CVC Quantity	PenC Quantity	CVC Unit cost (in USD)	PenC Unit cost (in USD)	Notes
Trench/retaining walls	Trench	2	-	50,000	-	Material for pumps, lights etc., in the trench.
Bridges	Bridges	76	5	-		No bridge maintenance will be required.
Drainage	Culverts	1	1	15,000	10,000	Ballast, rip/rap to repair washed-away materials.
Right of way fencing/gates	Feet	9,240	2,904	10		Assumes 0.5% of the entire ROW will require repairs/ replacement

Figure 8-4: Materials cost estimate

8.4 Uncertainties and Contingencies

The design of the system is not complete and may change from the information that is currently available. The main assumption impacting this is that approximately 15% for CVC and 1% for PenC

of the alignment is built on structures (bridges, tunnels or trenches). The final quantities for culverts, drainage systems, retaining walls and fencing are to be determined.

In the CVC segment, tunnels are assumed to be less than 500 feet in length and will not require ventilation or fire suppression systems.

There is no available information in terms of trespassers or egress along the alignment. This may impact the amount of fencing requiring repair during operations. There is no data in terms of vandalism/graffiti which may require additional repairs or painting.

8.5 Cost Projection

The Figure 8-5 shows the resulting cost projection for maintenance of civil structures in 2018 USD.

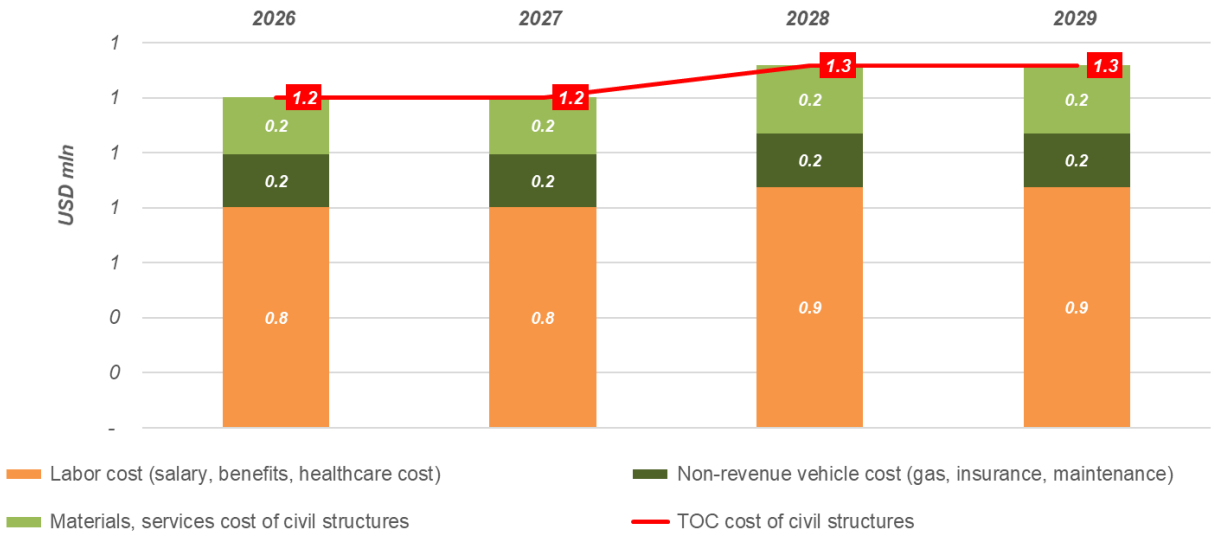


Figure 8-5: Cost projection for maintenance of civil structures

9 Maintenance of Track and Systems

9.1 Key Assumptions

9.1.1 General assumptions

- The alignment does not include any tight curves which would require increased rail replacement;
- Traction power substations, and communications and signal houses are placed at regular intervals along the alignment;
- The signal system will include PTC (Positive Train Control) and ATO (Automatic Train Control);
- Wi-Fi communications will be made available to passengers on the trains. There will be a Wi-Fi network along the alignment;
- Based on expected negotiations with the FRA, ETO has excluded from this study the estimate for labor and equipment maintenance cost of performing visual track inspections, per the CHSRA's direction;
- Signalling and communication staff will be combined;
- Signalling and communication houses will be combined;
- Staffing level assume that inspections and maintenance will be performed during non-revenue hours, as discussed with CHSRA;
- Inspections and maintenance will be performed during non-revenue hours, as discussed with CHSRA;
- Track geometry testing will be performed by equipment installed on rolling stock and will be maintained by rolling stock manufacturer. Data from testing will be provided to TOC at no cost.

9.1.1.1 CVC Specific Assumptions

- The alignment is 175 miles of double track with 25kV catenary systems along the entire length;
- The track will be approximately 87% ballasted track and 13% direct fixation;
- Three maintenance bases, with response time any place in the corridor of one to one and a half hours during revenue hours;

Base crew during revenue hours	Maintenance crew during non-revenue hours
1 person x 18 hours x 365 days x 3 bases = 19,710 hours 1 FTE = 1794 hours per year Total FTE= 11 FTE Signal/ Communication Tech/ Maintainer + 1 Support = 12 FTE Signal/ Communication Tech/ Maintainers	3 persons x 8 hours x 365 days x 2 crews = 17,520 hours 1 FTE = 1794 hours per year Total FTE = 10 FTE Signal/ Communication Tech/ Maintainers Total FTE 22 Signal/ Communication Tech/ Maintainers

- It is assumed that the inspector will perform an initial inspection to prepare the work for the night crew;
  - Maintenance crew during non-revenue hours:
    - One Foreman;
    - One Equipment Operator;
    - One Welder;
    - Two laborers.

Base crew during revenue hours
1 person x 18 hours x 365 days x 1 base = 6,570 hours 1 FTE = 1794 hours per year **Total FTE = four FTE Track Inspectors** 5 persons x 8 hours x 365 days x 2 crews = 29,200 hours 1 FTE = 1794 hours per year **Total FTE = 17 FTE Track**

- The power and OCS personnel will be tasked with performing the non-invasive inspections of the traction power substations in addition to responding to incidents with the power and/or OCS systems;

Base crew during revenue hours	Maintenance crew during non-revenue hours
One person x 18 hours x 365 days x three bases = 19,710 hours **Total FTE = 11 FTE Power and OCS Technicians**	OCS - three persons x eight hours x 365 days x two crews = 17,520 hours Power - two persons x eight hours x 365 days x two crews = 11,680 hours One FTE = 1794 hours per year **Total FTE = 17 FTE Power and OCS Techs**

- The personnel in the power crew listed above must be licensed electricians to perform the required inspections. There is a total of 28 FTEs employed as power and OCS technicians.

9.1.1.2 PenC Specific Assumptions

- The alignment is 55 miles of track with a 25Kv catenary system along the entire length;
- The design speed will be 110 mph;
- Some staffing and work vehicles will be shared with the CVC;
- There will be over 6 million gross tons operated over each main line annually. This is based on 72 high speed trains per day and 6 Caltrain trains per day. The Caltrain trains are assumed to have the same weight as high-speed trains. Freight traffic is unknown on this corridor and has not been included in the calculation of annual gross tonnage;
- A single maintenance base, with response time any place in the corridor of one to one and a half hours during operational hours;

Base crew during revenue hours	Maintenance crew during non-revenue hours
1 person x 18 hours x 365 days x 1 base = 6,570 hours 1 FTE = 1794 hours per year **Total FTE = 4 FTE Signal / Communication Tech / Maintainer.**	1 person x 8 hours x 365 days = 2,920 hours 1 FTE = 1794 hours per year Total FTE = 2 FTE Signal / Communication Tech / Maintainers **Total FTE = 6 Signal/ Communication Tech/ Maintainers**

- It is assumed that the inspector will perform an initial inspection to prepare the work for the night crew;
- Maintenance crew during non-revenue hours will be shared with the CVC and will consist of the following staff:
  - One Foreman;
  - One Equipment Operator;
  - One Welder;
  - Two laborers.

Base crew during revenue hours

1 person x 8 hours x 365 days x 1 base = 1,792 hours

1 FTE = 1794 hours per year

Total FTE = 1 FTE Track Inspectors

30% X 5 Person x 8 hours x 365 days x 2 Crews = 4,380 hours

1 FTE = 1794 hours per year

Total FTE = 2.5 FTE Track

- The power and OCS personnel will be tasked with performing the non-invasive inspections of the traction power substations in addition to responding to incidents with the power and/or OCS systems;
- The personnel in the Power crew listed above will need to be licensed electricians to perform the required inspections.

Maintenance crew during non-revenue hours

hours

1,752 hours

1 FTE = 1794 hours per year

Total FTE = 3 FTE Power and OCS Techs, Pus 1 support FTE

9.1.2 Staffing of Track & Systems

The estimate is based on a goal of ensuring that the maintenance organization is staffed and resourced sufficiently to maintain all assets in a constant state of good repair and to respond within a

range of one to one and a half hours for service interruptions on the right of way in order to minimize the impact on high-speed rail passengers.

Salaries are based on an analysis of similar positions in the industry with a focus on California when California data was available. This was gathered through researching California agencies, salaries, and current job postings for positions in California, when possible.

The highlighted portion of Figure 9-1 shows the headcount for the track and systems department including the chief engineer, deputy chief engineer and chief engineer assistant.

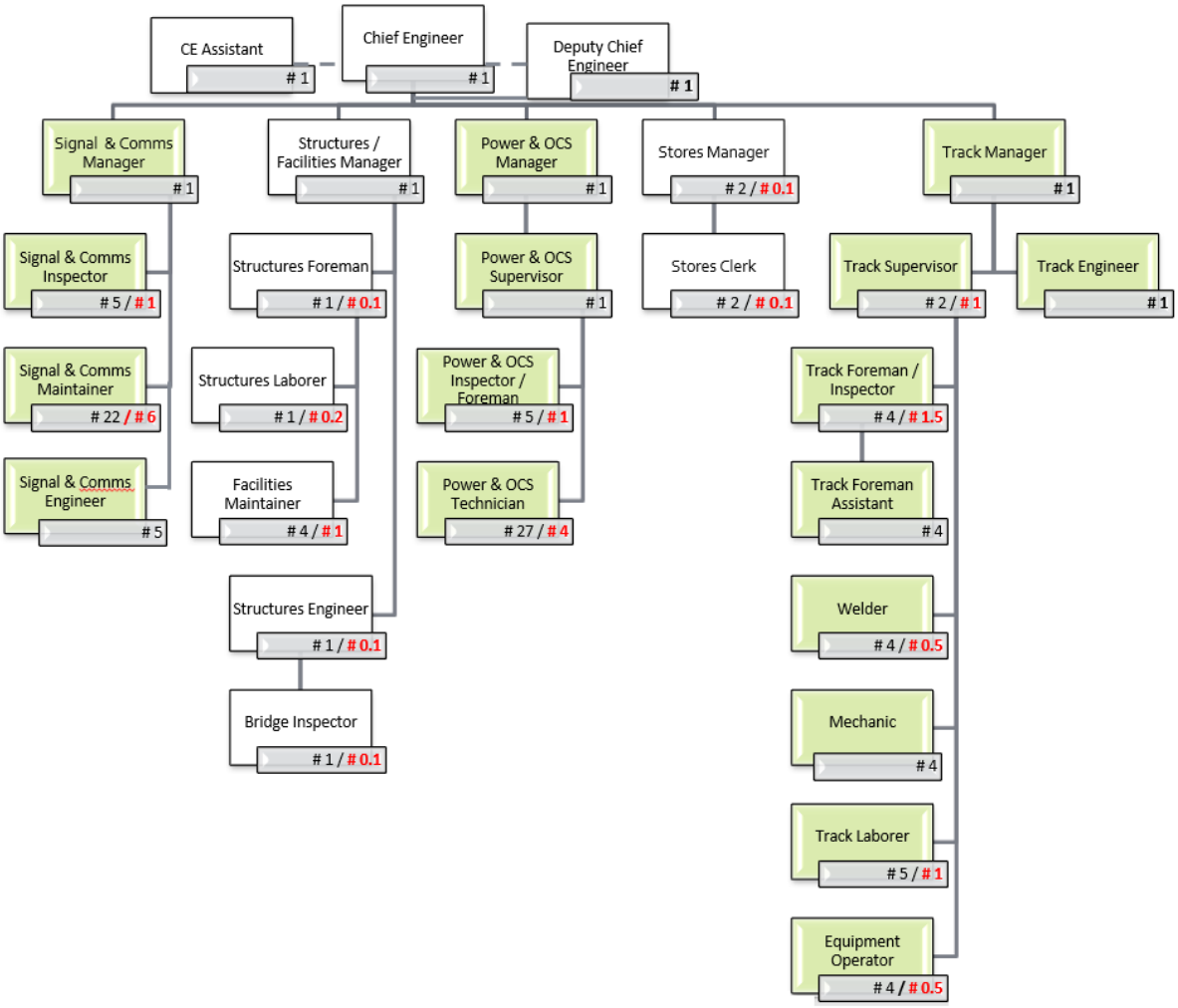


Figure 9-1: Organizational structure of track & systems department (CVC in black / PenC incremental in red)

9.2 Cost Drivers

The Figure 9-2 provides quantities that have been used to develop the costs.

Category	CVC Units	PenC Units	Type	Notes
ROW miles	175	27.5	Miles	
Track miles	350	55	Miles	
Ballasted track	307		Miles	
Direct fixation track	43		Miles	
Switches	56	20	Each	
Yard switches	-	-	Each	▪ CVC: Quantity not yet determined
Interlockings	12		Each	
Signaling and Comm Control Houses	50	10	Each	
Radio houses	-	6		
TPSS	44	5	Each	▪ CVC: 1 every 4.25 miles, 2 at HMF ▪ PenC: 4 main line, 1 Brisbane
Catenary	350	55	Miles	
Yard/ Facility Catenary	-	-		▪ CVC: Quantity not yet determined

Figure 9-2: Quantities used to develop costs

9.3 Unit Costs

The Figure 9-3 indicates salary costs for track and systems maintenance labor.

# No	Position	CVC FTE	PenC FTE	Short task description	Annual salary (in USD)	Pay Grade Allocation
1	Chief Engineer	1	-	Responsible for all aspects of department	200,000	Senior Director
2	Deputy Chief Engineer	1	-	Supports Chief Engineer	175,000	Director
3	Chief Eng. Asst.	1	-	Performs administrative tasks for Chief Engineer	60,000	Assistant
4	Track Manager	1	-	Responsible for all aspects of track	130,000	Senior Manager (fewer than ten years' experience)
5	Track Engineer	1	-	Monitors track infrastructure	100,000	Manager
6	Track Supervisor	2	1	Supervises track maintenance tasks	90,000	Manager
7	Track Inspector / Foreman	4	1.5	Performs track inspections and manage track maintenance crews	69,912	Manager
8	Track Foreman Assistant	4	-	Leads track maintenance crews	64,753	Analyst
9	Track Laborer	5	1	Performs track maintenance activities	58,190	Analyst
10	Track Equipment Operator	4	0.5	Operates various types of equipment	66,789	Manager
11	Track Welder	4	0.5	Performs track welding	70,404	Manager

# No	Position	CVC FTE	PenC FTE	Short task description	Annual salary (in USD)	Pay Grade Allocation
12	Non-Revenue Eq. Mechanic	4	-	Maintains non-revenue equipment	67,315	Analyst
13	Signal and Communications Manager	1	-	Responsible for all aspects of train control systems	130,000	Senior Manager (greater than ten years' experience)
14	Signal and Communications Inspector	5	1	Supervises train control maintenance tasks	82,056	Manager
15	Signal and Communications Tech/ Maintainer	22	6	Performs train control maintenance tasks	71,948	Manager
16	Power and OCS Manager	1	-	Responsible for all aspects of power systems	130,000	Senior Manager (greater than ten years' experience)
17	Power and OCS Supervisor	1	-	Supervises OCS activities	120,000	Senior Manager (fewer than ten years' experience)
18	Power and OCS Inspector/ Foreman	5	1	Performs OCS inspections and direct maintenance activities	83,200	Senior Manager (fewer than ten years' experience)
19	Power and OCS Tech.	27	4	Performs OCS maintenance activities	74,880	Manager
20	Signal & Comms Engineer	5	-	Responsible for all system functioning	120,000	Senior Manager (fewer than ten years' experience)

Figure 9-3: Salary costs for track and systems maintenance labor

Based on the limited distance of PenC, the track maintenance crew will be shared with CVC based on 30% incremental cost. The 30% incremental cost is based on the 27.5 miles distance of the PenC compared to the approximately 90 miles that each track maintenance crew was allocated on CVC.

9.3.1 Material Costs

The Figure 9-4 indicates the annual materials costs for track and systems maintenance. The listed costs are for materials that in-house staff would purchase to repair or replace items as necessary. These costs were developed based on a comparison to other systems maintained in the US. The costs were rationalized to the assets that will be included in CHSRA and also scaled where necessary.

The cost of tools and maintenance (e.g. calibration) and tool replacement is included in the figures below. TOC assumes that specialized tools will be provided as part of the initial capital purchase.

It is assumed that all material and spares required for the first five years will be included and procured within the initial capital purchase.

Item	Units	CVC Quantities	PenC Quantities	Unit cost (in USD)	Notes
Train control and comm	Comm and signal houses	50	10	500	This includes: ▪ Apparatus of the PTC and ATO switches, transponders, ▪ PIS and PAS ▪ CCTV ▪ WiFi ▪ SCADA ▪ RADIO
Traction power (TPSS)	Power facilities	44	5	1,000	TPSS materials, not included in subcontracted services.
Overhead catenary system (OCS)	Track-miles	350	55	150	OCS materials, wire, hangers, etc.

Item	Units	CVC Quantities	PenC Quantities	Unit cost (in USD)	Notes
Track	Track-miles	350	55	150	Rail, frogs, welds, ties, ballast, clips, etc.

Figure 9-4: Materials costs for track and systems maintenance

Item	Division	Type of cost	Units	CVC Quantity	PenC Quantity	CVC Unit cost (in USD)	PenC Unit cost (in USD)	Notes
Electricity consumption	C&S	Utilities	Signal houses	50	10	12,861	8,984	
Electricity consumption	Power	Utilities	Power facilities	44	5	12,861		
Electricity consumption		Utilities	Radio sites	-	6		6,113	
Wi-Fi connectivity	C&S	Service	Signal and comm houses	50	10	4,000		Connectivity service for passengers
Ultrasonic Rail Testing	Track	Service	Three times a year	3	3	120,000	30,000	Performed by subcontractor
Geometry Testing	Track	Service	Every other month	6	12	-		Performed by subcontractor
Rail Grinding	Track	Service	Track mile	350	55	7,000		Performed by sub-contractor; Once during 4 year period for CVC: (2029) / Once during 2 year period

Item	Division	Type of cost	Units	CVC Quantity	PenC Quantity	CVC Unit cost (in USD)	PenC Unit cost (in USD)	Notes
								for PenC (2029)
Vegetation Control	Track	Service	Track-miles	350	55	500		Vegetation control along the right of way and in the yard

Figure 9-5: Cost of services to be performed by outside vendors

Rail grinding is an essential element of a railroad maintenance program. Over time, the proper (designed) interface between train wheels and the rail is degraded as the result of normal operations. In order to maximize the life and value of these rail assets, precision removal of fatigued metal and restoration of the rail head profile need to be periodically performed depending largely on the geometry of the track and the tonnage of the trains.

During routine track inspections the running rail surface is inspected for wheel/rail interface wear. It is assumed for purposes of this study that maintenance grinding to the rail in the CVC and PenC will need to be performed one time during the four-years. Prior to grinding, detail measurements of the existing rail profile would be taken in order to develop a grind plan. Similarly, measurements would be taken at the end of the project to verify that the rail had been ground to the specific designated profile.

The cost estimate is based on U.S. standards for rail profile grinding and Euro norm standards for the type of grinding stones in a high-speed rail environment. It also assumes that the TOC will have a full five hours of productive work time during the overnight maintenance period, high performance rail grinding equipment and reasonable travel times to access the work locations. Mobilization costs are not included in the cost.

9.3.2 NRV For Track And Systems

It is assumed that all vehicles will be procured as part of the capital investment, therefore no initial cost, leases are included. Also, for the purpose of this study no annualized replacement costs have been included in the cost.

Personnel, vehicles and/or equipment that may be necessary as a result of a force majeure event is not included. Maintenance personnel will work a primary shift only and will use trains to transport themselves and equipment to the extent possible.

The Figure 9-6 indicates the cost of NRV for the Track and Systems unit. This cost includes fuel, maintenance, insurance, and anticipated state fees. Outside vendors will maintain NRV.

Vehicle type	Quantity	Annual fuel consumption (gallons)	Annual maintenance and insurance cost (in USD)
CVC			
Backhoe-HR	1	175	9,103
Bucket loader	1	700	16,464
Bucket truck-OCS	2	2,000	25,250
Flat cars	3	-	6,500
Fuel and lube truck	1	2,000	31,375
Hi-rail inspection truck	2	3,000	11,500
Hydraulic, self-propelled rail lifts	2	250	6,920
Logging Truck-HR	2	750	35,000
Lowboy trailer	1	-	9,032
Pick-up truck-extended cab	7	2,000	19,000
Rail puller	2	-	6,400
Speedswing	1	4,000	19,000
Spot tamper	1	20	30,000
SUV	1	1,333	7,000
Swivel dump-HR*	2	750	29,136
Tractor trailer	1	350	18,250
Utility trucks-mechanic	2	2,000	12,500

Vehicle type	Quantity	Annual fuel consumption (gallons)	Annual maintenance and insurance cost (in USD)
Utility trucks-power	-		
Utility trucks-Signal	6	1,667	26,450
Utility trucks-signal crew	3	1,667	16,550
Van-comm.	4	1,333	17,600
Water tank	2	-	7,000
Welders truck	1	2,000	18,000
PenC			
4X4 HR Crew Cab Truck	1	500	675
Backhoe-HR*	1	700	7,050
Bucket Loader	1	700	10,730
Bucket Truck-OCS	1	1,000	15,125
Hi-Rail Inspection Truck	2	3,000	8,250
Hydraulic, Self-propelled Rail Lifts*	1	1,000	5,960
Logging Truck-HR	1	450	1,125
Lowboy trailer	1	-	9,032
Speedswing	1	600	1,050
Spot Tamper	1	75	2,250
Swivel Dump-HR*	1	450	776
Tractor trailer	1	1,400	18,250
Utility Trucks-Power	1	1,250	8,575
Utility Trucks-Signal	2	1,667	8,575
Van-Comms.	1	1,333	8,150

Figure 9-6: Cost of non-revenue vehicles for the Track and Systems unit

9.4 Uncertainties And Contingencies

The design of the system is not complete and may change from the information that is currently available.

The signal and communication houses and traction power substations for the CVC section were based off a partial track chart. The signal and communication houses and traction power substations were based off the spreadsheet list provided with one traction power substation added for Brisbane.

The optimization of the track layout and systems infrastructure was not part of the scope of this study. It is assumed that the infrastructure will be sufficient to allow maintenance and inspection activities without major impact in train traffic (i.e. track diversions, sidings, and yellow plant maintenance access and stabling).

It is assumed that the quantities in Figure 9- 5 will not impact the pricing significantly, but until these are quantified and the design is known this is a risk to the accuracy of the cost numbers.

The track inspection labor staff has been reduced based on the direction of the CHSRA to assume the FRA will provide a waiver relaxing visual track inspection requirement from three times per week to one per week or once every two weeks.

9.5 Cost Projection

The Figure 9-7 shows the resulting cost projection for maintenance of track and systems in 2018 USD.

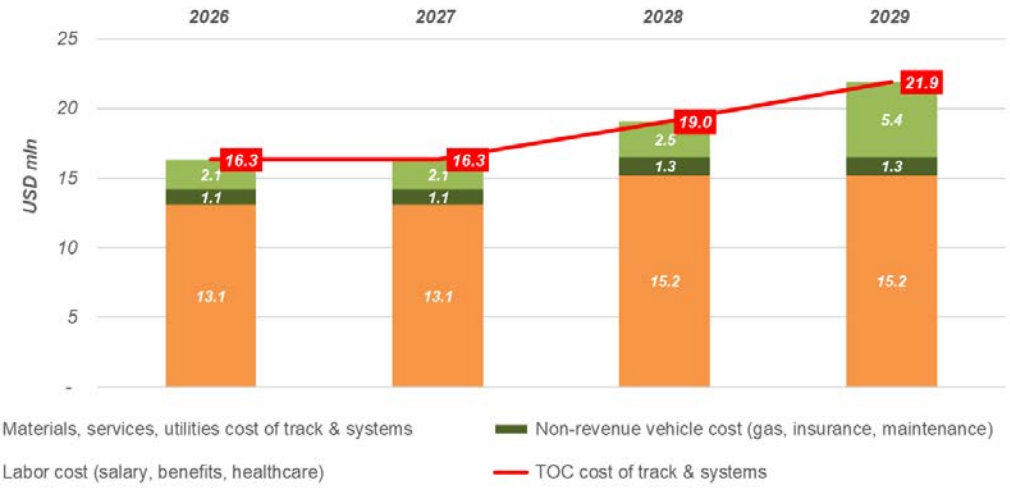


Figure 9-7: Cost projection for maintenance of track and systems

10 Facilities

10.1 Key Assumptions

10.1.1 Scope

The combined facilities maintenance cost items for the CVC and PenC include:

- CVC Stations (all PenC stations assumed to be maintained by Caltrain);
- MOW (Maintenance-of-way) facilities;
- OCC/ TOC administration building.

Specifically, five CVC stations, two CVC MOW facilities, one PenC MOW facility and one OCC/ TOC administration building are included in the estimate.

The CVC stations will consist of side platforms, an overhead access walkway, four elevators per station, canopies, lighting, approximately 180 parking spaces per station, benches, signage, and other station appurtenances.

The MOW facilities will consist of office space for MOW staff, locker rooms for employees to change, and storage space including HVAC (Heating Ventilation and Air Conditioning) systems, lighting and other necessary systems.

The OCC/ TOC administration building will include the OCC and area for the administrative and executive staff including typical systems found in an office environment.

The maintenance plan for the facilities is to utilize a small internal staff and rely on outside contractors to perform specific, specialized tasks. The following facility-specific maintenance and repair tasks will be subcontracted:

- Janitorial services;
- HVAC;
- Fire extinguisher servicing;
- Fire alarm monitoring/servicing;
- Elevators, only in the CVC segment; and

- Pest control.

Staffing for facilities management and maintenance is highlighted in green and is represented in the Figure 10-1.

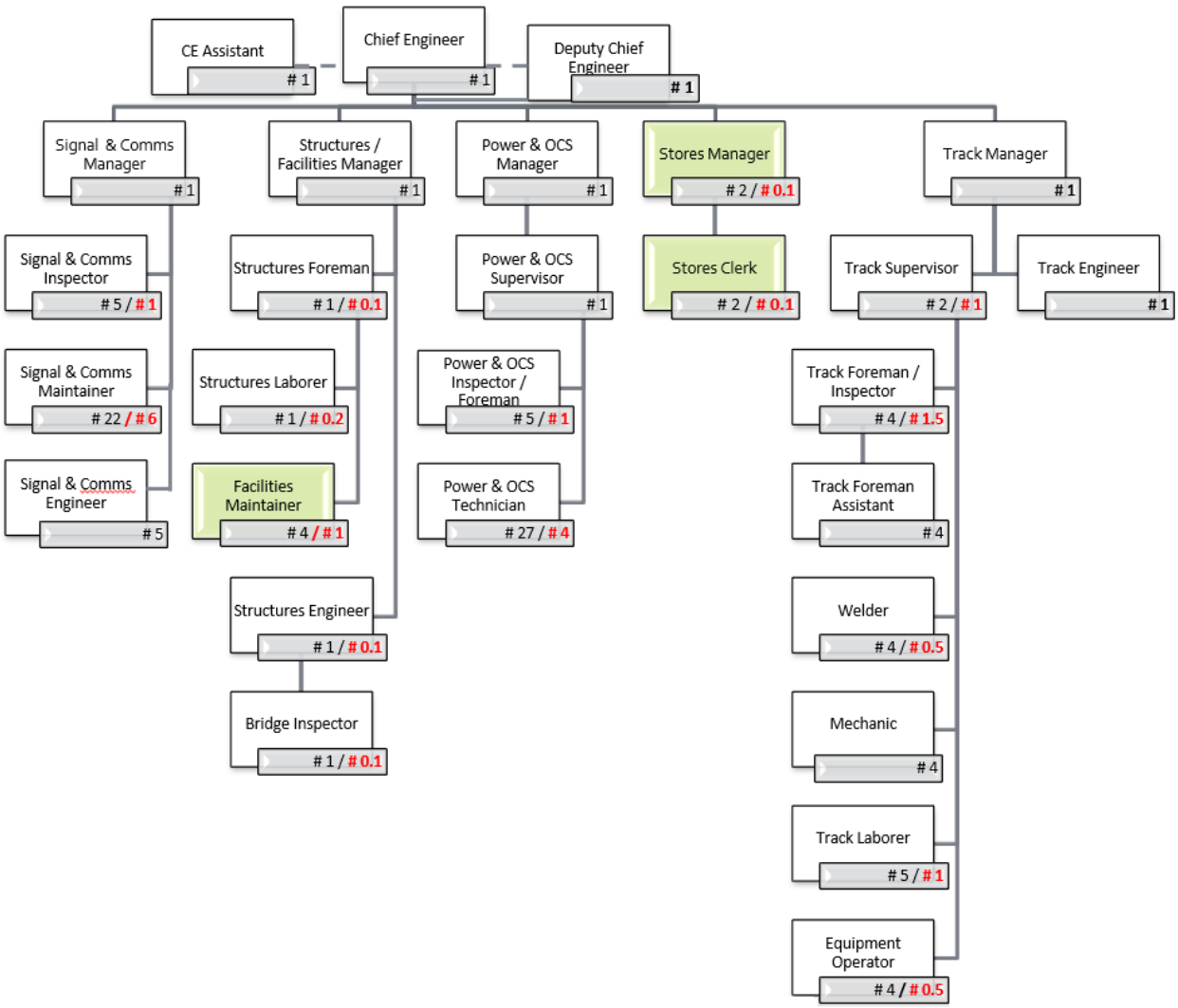


Figure 10-1: Organizational structure of facilities department (CVC in black / PenC incremental in red)

10.2 Cost Drivers

The cost drivers are the number of CVC stations, station appurtenances, physical layouts, and the number of parking spaces. The MOW facilities cost drivers are the size and layout of the building.

The parking lot striping and paving should not be required under normal maintenance conditions in the first years of operations.

10.3 Unit Costs

The Figure 10-2 highlights salary costs for facilities management and maintenance staff.

# No	Position	CVC FTE	PenC FTE	Short task description	Annual Salary (in USD)	Pay Grade Allocation
1	Stores Manager	2	0.1	Manage procurement and inventory	85,000	Manager
2	Stores Clerk	2	0.1	Process inventory, warehouse activities	62,296	Analyst
3	Structures / Facilities Manager	Included in civil structures	-	Oversight of Structures and Facilities Department (repeat of position listed in civil structures)	130,000	Senior Manager (greater than ten years' experience)
4	Facilities Maintainer	4	1	Perform minor maintenance activities and oversee subcontractors	71,457	Manager

Figure 10-2: Facilities management/ maintenance staffing salary costs

The Figure 10-3 indicates the unit costs for facilities management and maintenance. The costs listed below are for materials that in-house staff would purchase to repair or replace items as necessary.

Type	Division	Type of Cost	Units	CVC Quantity	PenC Quantity	Unit cost (in USD)	Cost components
Building maintenance materials	CVC Stations	Materials	CVC Stations	5	-	10,600	Cost of benches, signs, bike racks, canopy parts, tactile, platform edging, railings, etc.
Building maintenance materials	OCC/ TOC Admin Building	Materials	OCC/ TOC Admin Building	1	-	2,600	Cost of doors, wall repairs, picture hangers, ceiling tiles, windows, etc.
Building maintenance materials	MOW	Materials	MOW facility	2	1	5,000	Cost of doors, wall repairs, windows, etc.

Figure 10-3: Material costs facilities

The Figure 10-4 indicates the cost of services to be performed by outside vendors.

Item	Division	Type of Cost	Units	CVC Quantity	PenC Quantity	Unit costs (in USD)	Cost components
Elevator services/ maintenance	CVC Stations	Service	Elevators	20	-	8,500	Four elevators per station at five stations
Building services	CVC Stations	Service	Stations	5	-	85,000	Lighting repairs, janitorial services, landscaping, etc.
Building. services	OCC/ TOC Admin building	Service	OCC / TOC Admin building	1	-	102,000	Lighting repairs, janitorial services, landscaping, etc.

Item	Division	Type of Cost	Units	CVC Quantity	PenC Quantity	Unit costs (in USD)	Cost components
Building services	MOW	Service	MOW Facility	2	1	27,750	Lighting repairs, janitorial services, landscaping, etc.

Figure 10-4: Outside vendor service costs

NRVs are assumed to be shared with the track and systems department. The Figure 10-5 indicates the cost of utilities to be performed by outside vendors.

Item	Type of Facility	CVC Quantity	PenC Quantity	Unit cost (in USD)
Electricity consumption	CVC Stations	5	-	25,000
Water consumption	CVC Stations			400
Electricity consumption	OCC/ TOC Admin building	1	-	104,670
Water consumption	OCC/ TOC Admin building			25,000
Gas consumption	OCC/ TOC Admin building			10,000
Electricity consumption	MOW Facility	2	1	23,260
Water consumption	MOW Facility			2,500
Gas consumption	MOW Facility			2,500

Figure 10-5: Utilities costs for outside vendors

Vehicle type	Quantity	Annual fuel consumption (gallons)	Annual maintenance and insurance cost (in USD)
CVC			
Pick-up truck-extended cab	1	2,000	7,000
SUV	2	1,333	7,000

Figure 10-6: NRVs for facility management / maintenance

NRVs to be used for the maintenance of civil structures on the PenC segment will be shared with the Track and Systems Department and have been described in Chapter 9.

10.4 Uncertainties And Contingencies

The design of the system is not complete and may change from the information that is currently available.

10.5 Cost Projection

The Figure 10-7 shows the resulting cost projection for maintenance of facilities in 2018 USD.

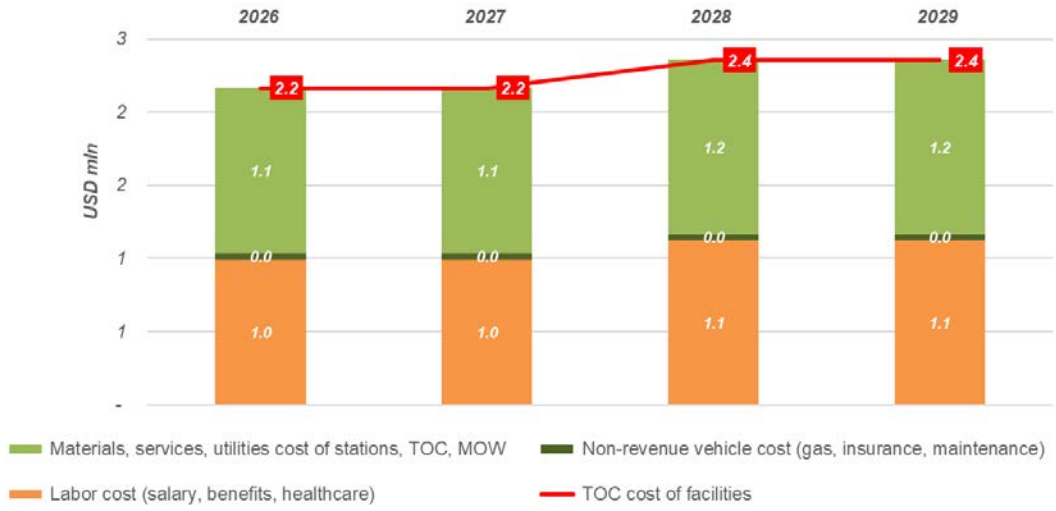


Figure 10-7: Cost projection for management / maintenance of facilities

11 Fare Collection

11.1 Key Assumptions

11.1.1 Introduction

It should be highlighted that for purposes of this study and in order to estimate costs for fare collection systems, traditional solutions of TVMs (Ticket Vending Machines) are presented in addition to mobile applications. However, future concepts to be considered will also include a wider range of payment options, including contactless smart cards and emerging technologies such as biometrics.

11.1.1.1 Overall Fare Collection Approach

In accordance with the revenue policy agreed upon with the CHSRA for both CVC and PenC corridors, this study assumes the following basic revenue collection approach:

- Open station access, meaning there are no physical barriers, gates, or turnstiles blocking passengers and local residents from accessing the station concourse;
- For platform access:
    - On the CVC corridor, gate lines requiring ticket validation prior to accessing platforms;
    - On the PenC corridor, open platform access meaning there are no barriers, gates or turnstiles blocking access to the station platforms; (same comment as above)
- On-board ticket inspection carried out by conductors as the only means to validate passengers have paid the proper fare.

Additional aspects of the revenue collection concept in terms of (1) enforcement approach, (2) fare media, (3) ticket sales/retailing, and (4) ticketing back-office are further detailed below.

ETO assumes that a fixed-price maintenance agreement with provider of the fare collection system equipment is established. This maintenance agreement will cover all maintenance, parts, and services necessary to keep automatic fare collection equipment operational. The contract will include all parts, labor, security audits, required security upgrades, software bug fixes, software compatibility upgrades, and travel needed to keep the equipment (ticket vending machines, data acquisition system, security, servers, data services) running.

11.1.1.2 Enforcement Approach

On the CVC corridor, gate barriers controlling access to platforms, and on-board ticket inspectors, allow the TOC to validate that passengers have paid the right fare or purchased the proper travel product (e.g. a monthly subscription), and have properly paid for their transportation.

Gate barriers will have anti-pass back (no re-entry) features for validated tickets. To allow the possibility to implement distance-based fares in the future, or to coordinate station parking with rail usage, both entry and exit barriers will be required.

On the PenC corridor, because platforms are shared with Caltrain, who do not have controlled platforms these platforms will be open prior to boarding and exiting. On-board ticket inspectors will enable the TOC to validate that passengers have paid the correct fare or possess the correct travel product (e.g. a monthly subscription or transfer) and have properly remitted payment for the transportation they are receiving. Anti-pass back (no re-entry) features possible with the tickets will not be employed. Distanced based fares and tiered fares will be possible with the QR-Code tickets.

If a passenger has boarded a train but is unable to present a valid ticket or display a valid bar code on a mobile device, a train conductor functioning as on-board inspector will take corrective action:

- The passenger is presented with the option to pay the fare, increased with a penalty;
- If unable or unwilling to pay the increased fare, the passenger will be required to leave the train at the next station. The way in which this requirement is to be enforced will be detailed later in close collaboration with the relevant county and law enforcement agencies.
- The TOC has the option to ban passengers from using the service upon repeated violation of fare.
- A Conductor or Assistant Conductor will perform inspector responsibilities.

The Inspectors' hand-held devices will use communications, both wireless and Local Area Network (LAN), both of which are provided and maintained by others. The handheld has computer to verify the validity of fare media (tickets) and serve as a Point-of-Sale (POS) device for selling tickets to passengers on board the vehicle. The hand-held features include communication to a bank clearinghouse/back-office system, a bankcard reader, ticket/receipt printer, user interface buttons,

and visual display. The hand-held POS application must be Payment Card Industry Data Security Standard (PCI/DSS) compliant to protect passenger bankcard financial information.

The AFC Team maintenance personnel will work a primary shift only and will use trains for transport themselves and equipment to the extent possible.

11.1.1.3 Fare Media

For conceptualizing the operational revenue collection on both the CVC and PenC corridors, ETO has assumed the following:

Ticketing via printed tickets (either via online retail or sold from ticket vending machines in stations) will account for 25% of revenue collected;

Ticketing via smart devices (e.g. cell phones) will account for 75% of revenue collected.

The ticket will use a two-dimensional barcode to store information in a uniform, machine-readable format. Information stored in a QR code can be encrypted to provide an additional level of security. QR coded tickets may have other features, like holograms, to make copying by computers difficult.

11.1.1.4 Ticket Retailing Via TVMs

Tickets will be sold via Ticket Vending Machines (TVMs) in the unpaid area of stations. Tickets sold by the TVMs will be printed at the time of purchase with a QR Code. The tickets vended by the TVM will be credit card size card stock with pre-printed CHSRA information. TVMs will only accept credit card and debit card purchases. For the PenC corridor the TVMs are located at the four Caltrain stations served by CHSR.

It has been assumed that each of the stations served will have a minimum of three TVMs per station. These TVMs will be located in close proximity to each other and will be accessible by all CHSR train travelers regardless of travel direction.

Printed tickets will not be produced and/or sold by third party retailers outside of station ticket vending machines and hand-held units. Ticket stock in TVMs is assumed to have 10% waste.

The TVMs will sell tickets with QR Codes to passengers that cannot or do not wish to use the mobile app or the Internet web page on their home computers to purchase boarding fare. The TVM will have

a bank card reader and associated Personal Identification Number (PIN) pad, a ticket vending mechanism, security alarms, user interface buttons (for fare selection), visual display, braille, audio messages, and communications to a bank clearinghouse/back-office system and maintenance provider.

The tables below show the possible Fare Products and Rider Classes. Table 1 also shows where the tickets might be purchased. Decisions on these alternatives will be made during the development of the Automatic Fare Collection System purchase specification.

Fare Product	TVM purchase	Mobile Device	Internet	Conductor Station Agent	Retailer
Full fare same day	√	√	√	√	No
Passes, all types	Possible (TBD)	√	√	√	No
First class (upgrade)	√	√	√	√	No
Discount (all types)	Possible (TBD)	√	√	√	No

Figure 11-1: Ticket purchase options

Fare Class	Immediate Same Day	Future Date	Weekly Pass	Monthly Pass
Full fare/Adult	√	√	√	√
Youth	√	√	√	√
Senior	√	√	√	√
Disability	√	√	√	√
Possible others	√	√	√	√
Student	√	√	√	√

Figure 11-2: Type of passes

TVMs will have a five-year design life; however, any TVM replacements for wear and tear during the first five years will be the responsibility of supplier. There will be a real time supervisory monitoring system for the TVMs. The original supplier of the units under a maintenance contract will provide the TVM maintenance and will manage the TVM encryption devices required by Payment Card Industry (PCI) Data Card Security Standard (DSS). TVMs will use communications such as Wide Area Network (WAN) and LAN maintained by others.

11.1.1.5 Ticket Retailing Via Mobile

Fare products are also available via mobile ticketing. Fare payment with the mobile device App is assumed to be developed specifically for CSHR as a part of the initial capital procurement. During at least the first four years and therefore for the purpose of this study, the CVC and PenC system will not have an electronic ticketing interface with the ticketing systems of other transit agencies.

A software application designed for use on smartphones to purchase, manage and display fare products (tickets). The app will require communications to a bank clearinghouse and a back-office system; employing security features to prevent fraud, and allows inspection of fare products by a Fare Inspector or Conductor using the Hand-held unit to verify fare payment. The app must protect passenger payment information by complying with PCI/DSS.

11.1.1.6 Ticket Retailing Via Website

An online website designed for use on smartphones to purchase, manage, print tickets will be connected to an online payment gateway and employ a back-end server system, implementing advanced security features to prevent fraud.

The printed tickets will allow a fare inspector to inspect fare products using a hand-held unit to verify fare payment. The website for online fare purchase must be PCI/ DSS compliant to protect passenger financial information.

11.1.1.7 Ticketing Back-Office

One FTE will be responsible for a back-office accounting of money and tickets. The accounting analysis will include TVMs, online sales, hand-held purchases, and hand-held proof of payment to assist in identifying fraud. The revenue collection team responsibilities will include managing the

contractor responsible for maintaining the real-time supervisory monitoring system software, cable entry to the TVM, and maintenance of the hand-held ticket validating devices.

The real-time supervisory system will be monitored by personnel in the OCC that are not a part of the revenue collection team. The off-site TVM provider will be responsible for the computer hardware that hosts the real-time supervisory monitoring system. The provider of the smart phone application will be responsible for maintaining and upgrading the app to maintain compatibility, correct errors, and incorporate fare policy changes.

An online system of computers and software will record transactions and events related to the fare collection systems. The back-office data acquisition system will also monitor the fare collection equipment in real time, permitting the status of the whole system to be assessed continuously.

The system will comprise an integrated customer account management and transaction processing function which will eventually accommodate at least:

- Account-based mobile or other NFC (Near Field communicator)-token ticketing;
- Integrated ticketing, clearing, and settlement with other transit operators and mobility service providers.

All processes and relevant equipment components (e.g. TVMs) will comply with the PCI/ DSS. PCI/ DSS is an information security standard designed to protect credit card and debit card information from exposure and to keep it confidential. Compliance requires adherence to best practices for the handling of account numbers and account details, as well as rigorous audit trails for system software modifications by administrators. Auditors specifically trained and certified to audit compliance with the PCI/ DSS standards must audit the compliance of all devices and systems employing the use of bankcards.

11.2 Cost Drivers

In accordance with the above described operational concept for revenue collection for the CVC and PenC operations, the main cost drivers are listed in the table below.

Stations	CVC Quantity	PenC Quantity
TVMs - Maintenance contract, online fees, monitoring (all outsourced to equipment manufacturer) TVMs accept **no** cash—credit and debit cards only. Lump sum is the total amount—three per station	15	12
Fare gates or barriers - Maintenance contract for repair and preventative maintenance of fare gate equipment (outsourced to equipment supplier). Lump sum is the total amount for 30 fare gates—six per station	30	0
Handheld validators/ POS terminals (depot maintenance and replacement costs)	40	65
Software maintenance of mobile/web/handheld ticketing applications	1	1
Software maintenance of fare gate validation application	1	

Figure 11-3: Cost drivers for fare collection

Fare inspector and station agent costs are not included. The former's responsibilities are assumed to be carried out by on-board conductors (part of operations staffing and cost); the latter responsibilities are considered a marketing expense.

11.3 Unit Cost

For each cost driver identified above, unit costs are as follows:

Stations	Unit cost (in USD)
TVMs - Maintenance contract, online fees, monitoring (all outsourced to equipment manufacturer) TVMs accept ***no*** cash—credit and debit cards only. Lump sum is the total amount for 15 TVMs—three per station	2,867
Fare gates or barriers - Maintenance contract for repair and preventative maintenance of fare gate equipment (outsourced to equipment supplier). Lump sum is the total amount—six per station	833

Stations	Unit cost (in USD)
Handheld validators/ POS terminals (depot maintenance and replacement costs)	500
Software maintenance of mobile/web/handheld ticketing applications	38,000
Software maintenance of fare gate validation application	30,000

Figure 11-4: Unit costs fare collection

11.4 Uncertainties And Contingencies

The workload may not permit conductors to fulfill on-board inspection functions.

11.5 Cost Projection

The Figure 11-5 shows the resulting cost projection for fare collection in 2018 USD.

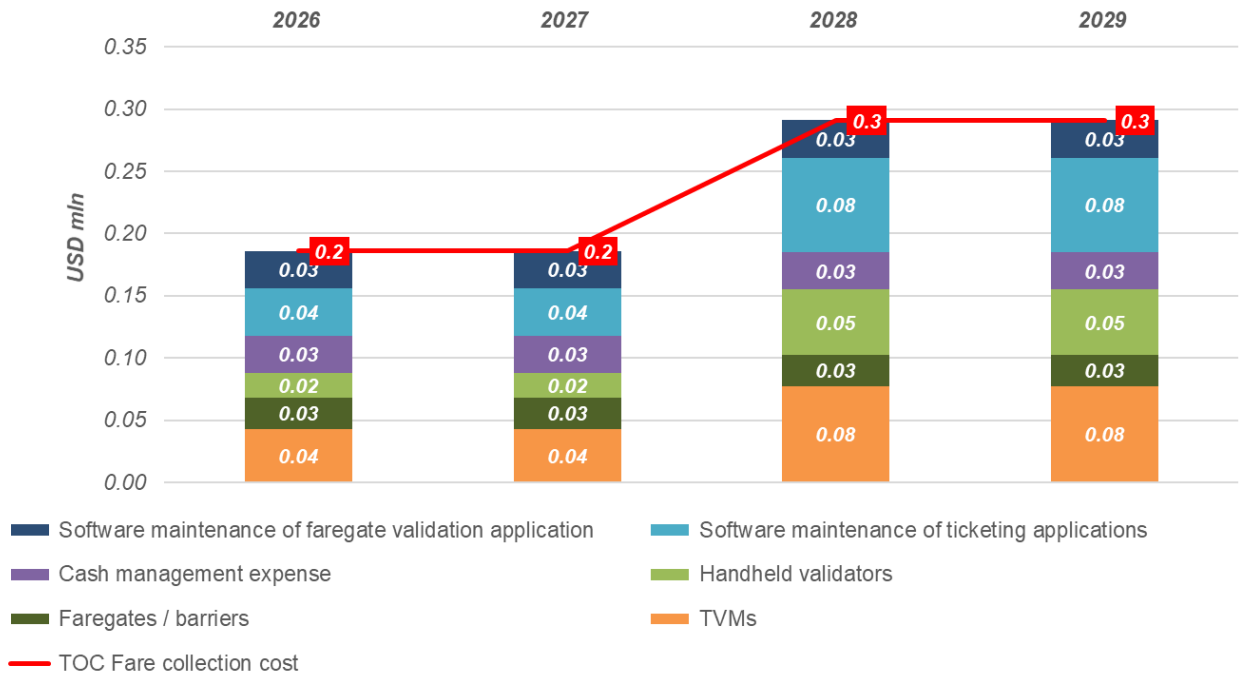


Figure 11-5: Cost projection for fare collection

12 Marketing And Branding

12.1 Key Assumptions

12.1.1 M&B Development

M&B (Marketing and Branding) is an essential early element for the overall marketing and branding success. It will set the stage by building excitement, anticipation, interest, and intent to try. Positive branding will help define and convey the experience of travelling by HSR, imbuing the future experience with positive emotion.

M&B will be designed based on research to communicate the practical passenger benefits of HSR travel across California simply and clearly, capturing the imaginations of our target audiences, stakeholders, and potential sponsors, and establishing California as the leader in innovative transportation across the US.

12.1.2 The Importance Of M&B Planning

The TOC will need to create an advertising and public relations campaign providing detailed strategies for creating a positive, memorable brand identity and recommended marketing strategies and tactics to launch the CVC and PenC services. The plan will define the elements as well as the resources, schedules and costs, both internal and external, to implement the plan. Marketing will strategically concentrate on the factors most likely to build interest and anticipation and to encourage the public to change longstanding travel and mobility habits.

The TOC's early approach is assumed to be: subcontract with an accomplished California-based marketing firm and conduct market research to help identify the most effective messaging and visuals as we create a compelling brand identity for CHSR. It will define the key elements for the brand in close cooperation with the Authority, including an inspiring product name that triggers positive emotions, is related to local roots, and resonates with different cultures across California. This product name will be enhanced by an eye-catching brand logo and an innovative design to communicate the brand identity, and will be applied to all forms of communication. The TOC and the M&B firm will test a variety of options among target audiences to ensure creation of a truly inspiring brand.

The TOC will subsequently need to develop an aggressive marketing and public information campaign to build interest and educate people about CHSR. They will include fully integrated media strategies that reach individual audience segments through paid, earned and social media with targeted messages that resonate with their lifestyle, interests and needs. Aspirational messaging will build intent to ride while educating about “nuts and bolts” issues such as parking at stations, connecting services, fares, how to purchase tickets and train schedules. Marketing will also promote key benefits of the new service, including travel time, personal productivity, competitive fares and state-of-the-art booking solutions. The program will ensure that the timing of marketing campaigns will be fully aligned with the operational launch schedule and progress.

It is assumed that the staffing structure, contracts and costs for M&B including marketing and customer service are based on the assumption of a customer-centric operation.

The recommendations provided within this chapter include both the foundational structure for the marketing and customer service functions established for the TOC in the Central Valley, as well as the expanded functions and budget needed to support the additional Peninsula Corridor route.

Key to the success of the M&B plan is the assumption that the TOC will include a distribution platform that will feed into a customer account / CRM platform for the TOC to collect passenger data and create customer accounts for the purpose of providing optimized customer service, account-based ticketing, and one-to-one customer marketing and passenger communications, as well as integrating a loyalty program.

The following types of functions are assumed to be performed by the TOC, with additional staffing and budget needed for the Peninsula Corridor:

- Marketing and communications;
- Customer service, in-person at a station and via phone through a Customer Call Center as described in the organization chart and list of assumptions;
- Management of customer accounts and profiles by an enterprise CRM system;
- Fare pricing, promotions, sales, analytics and related e-commerce integration with website, mobile app, etc.

12.2 Cost Drivers

In accordance with the above described marketing and branding concept, M&B costs comprise recurrent cost components related to:

- Advertising agency service contract;
- Customer call center;
- Loyalty program;
- PR/ crisis communications firm service contract;
- Web and mobile integration and analytics support, as well as CRM licensing agreements. This interfaces with the revenue collection function.

There is assumed to be upfront fixed costs related to realization of customer account management/ CRM platform, website, and customer facing app are excluded. These are assumed to have been put in place and paid for on commencement of revenue service.

It is assumed that each of the contracts in place at the TOC will be impacted by the separate service route, the Peninsula, as well as the increased ridership provided by this route. With no service overlap of the CVC and Peninsula, some of these contract pieces may need to function separately.

The major cost drivers for calculation of the commercial marketing and customer service functions and contracts include:

- Market size—media market size influences the spend and budget
    - For the full-service advertising agency contract for the CVC corridor, it is assumed that the initial campaign launch has already occurred during the pre-operations time period, but there is a first-year investment to support a larger awareness campaign. It is also assumed that the media markets would include those within the Merced and Bakersfield scenario, in addition to markets served by feeder bus (LA) and the existing San Joaquins connection (Oakland/ Sacramento). Both the LA and Oakland media markets are larger than the Central Valley markets, and therefore cost more to place advertisements. The first-year investment spend of USD 1.75 million plus USD 250,000 in production is based on comparable state route annual marketing budgets

for San Joaquins (USD 1.5 million), Capitol Corridor (USD 1.7 million), and Surfliner (USD 2 million). It is assumed that the budget for the following years would be reduced from USD 2 million to USD 1.5 million.

  - For the full-service advertising agency contract for the PenC corridor, it is assumed that there is a 1st year investment spend of USD 2.5M plus USD 325,000 in production. Assumption is media markets would include: Primary: those within San Francisco/Oakland/San Jose Designated Market Area (DMA). Secondary: markets served by CVC with ACE or bus connection, and feeder buses (Stockton/ Merced / Sacramento, and Monterey). Assumption is all collateral printing needs fall under this contract.

- Call center based on estimated ridership
  - Outsourced Call Center contracts are generally negotiated based on labor and call times. They are set up similar to an agency structure in which staff have more than one client but are also staffed to be available for emergencies. The Call Center will include live operators available during all hours of operation to assist passengers with ticketing, trip planning, refunds, and schedule questions. The contract would also include reactive social media support. For the CVC corridor It is assumed a ridership of 1,671,000 annual riders would require a monthly service contract of USD 750,000. For the PenC corridor it is assumed a monthly service contract of USD 750,000 is set in place at the TOC. And an additional USD 250,000 annually will be needed to support the Peninsula route (this may be adjusted for ridership). By comparison, Capitol Corridor annual ridership is 1.7M and their Call Center contract is USD 1,074,000 annually.
- Hours of operation—Determines need for station coverage
  - The hours of operation will influence the total need for station coverage. It is currently assumed that a Station Assistant will be present at all times at each station during operation. The Station Assistants help passengers in the field with boarding, ticketing, ADA, groups, etc. In order to calculate the Station Assistant FTE the following has been assumed:

- 20 hours of daily coverage for a 19 - hour operations service operating seven days a week;
- A 40-hour work week;
- 20 hours times 7 days /week equals 140 hours per station, per week, for a total of 560 hours per station per month;
- It is assumed there will be 3.5 FTEs per station, however to cover breaks we are assuming 4 FTEs per station.
- For the 5 stations on the CVC corridor we are therefore assuming a total of 20 station assistants. With 4 stations on the PenC corridor we are assuming 16 total station assistants, 4 FTE x 4= 16 for the first year of service. For the second year we are assuming that people will be more familiar with the service and therefore we would provide station assistants during peak hours only and assume 12 total station assistants (in year 2 and beyond, a contract could also be negotiated with Caltrain at stations that may already be staffed by their personnel to reduce staffing costs to the TOC).

12.3 Unit Costs

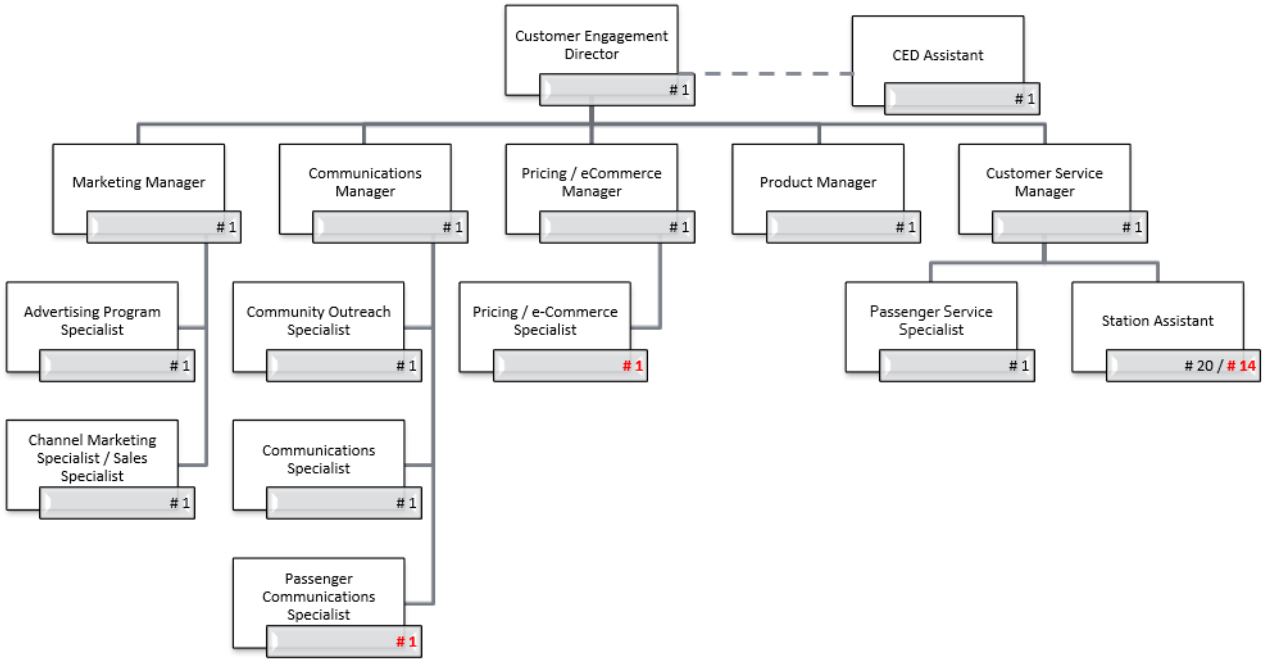


Figure 12-1: Marketing and branding department (CVC in black / PenC incremental in red)

# No	Position	CVC FTE	PenC FTE	Short task description	Annual salary (in USD)	Pay grade allocated
1	Customer Engagement Director	1	-	Oversees department of five managers, eight specialists, station assistants, one assistant and one analyst	130,000	Senior Manager (greater than ten years' experience)

# No	Position	CVC FTE	PenC FTE	Short task description	Annual salary (in USD)	Pay grade allocated
2	Customer Engagement Director Assistant	1	-	Support the Director in an admin function and also provide admin support to the rest of the department	55,600	Assistant
3	Manager: Marketing	1	-	Sets policy with all other departments	110,000	Senior Manager (fewer than ten years' experience)
4	Manager: Communications	1	-	Serves as the PIO (public information officer) for the service. Manages all of the media relations, social media messaging and passenger messages. Oversees the contracts for the PR/Crisis Comm and the shared graphic designer contract with Marketing	90,000	Manager
5	Manager: Pricing/ eCommerce	1	-	Supports director and entire department	102,300	Manager

# No	Position	CVC FTE	PenC FTE	Short task description	Annual salary (in USD)	Pay grade allocated
6	Manager: Product	1	-	Oversees the advertising agency, market research and loyalty program support, and on-call graphic design contracts	113,000	Manager
7	Manager: Customer Service	1	-	Oversees the advertising program, channel marketing and sales, promotions, and research for the service	90,000	Manager
8	Specialist: Advertising/Marketing Program	1	-	Administers the advertising plan and budget and serves as the day-to-day contact with the advertising agency. Reports to the Marketing Manager.	55,000	Analyst
9	Specialist: Channel Marketing/Sales	1	-	Serves as the public information officer for the service	55,000	Analyst

# No	Position	CVC FTE	PenC FTE	Short task description	Annual salary (in USD)	Pay grade allocated
10	Specialist: Communications	1	-	Manages all of the media relations, social media messaging, and passenger messages	55,000	Analyst
11	Specialist: Community Outreach	1	-	Oversees the contracts for public relations/crisis communications agency (on-call 24 hours) and the shared graphic design contract with Marketing	55,000	Analyst
12	Specialist: Passenger Service	1	-	Oversees a pool of Station Assistants in the field. Reports to the Customer Service Manager.	55,000	Analyst
13	Station Assistant	20	14	Tasks are to assist the passengers in the field at stations with boarding, ticketing, ADA, groups, etc. Station assistants do *not* sell tickets or handle cash in any way.	29,277	Assistant

# No	Position	CVC FTE	PenC FTE	Short task description	Annual salary (in USD)	Pay grade allocated
14	Specialist: Passenger Communications *(PenC additional)*	-	1	Responsible for channel passenger communications, onboard signage, timetables, and service announcements for multiple routes (CVC and PenC).		
15	Specialist: Pricing/e-Commerce	-	1	Supports the Pricing/e-Commerce Manager in implementing the fare policy and sales/promotions for multiple routes (CVC and PenC).		

Figure 12-2: Marketing and branding staffing costs

Contract type	Quantity	CVC Total Annual Cost (in USD)	PenC Total Annual Cost (in USD)	Remarks
Full service advertising agency	1	2,000,000	2,825,000	CVC: ▪ Assumes a first-year investment spend of USD 1.75 million + USD 250,000 in production ▪ Assumed media markets include those within Merced and Bakersfield in addition to markets served by feeder

Contract type	Quantity	CVC Total Annual Cost (in USD)	PenC Total Annual Cost (in USD)	Remarks
				bus (LA) and existing San Joaquins connection (Oakland / Sacramento) ▪ Assumes all collateral printing needs fall under this contract ▪ Budget estimate based on comparable state route marketing budgets for San Joaquins (USD 1.5 million), Capitol Corridor (USD 1.7 million), and Surfliner (USD 2 million) ▪ In follow up years the annual budget is USD 1.5 million. PenC: ▪ Assumption is a 1st year investment spend of USD 2.5 million + USD 325,000 in production. Assumption is media markets would include: Primary: Those within San Francisco/Oakland/San Jose Designated Market Area (DMA). Secondary: markets served by CVC with ACE or bus connection, and feeder buses (Stockton/ Merced / Sacramento, and Monterey). Assumption is all collateral printing needs falls under this contract. In follow up years the annual budget is USD 2.3 million.
Market research consulting firm	1	120,000	100,000	Service is assumed to be provided as needed. Assumption is with a totally separate service, different service area, route and pricing structure, the Peninsula would require a similar cost as the CVC with some economies of scale realized using the same contractor.
Loyalty program support agency	1	180,000	100,000	Assumes a production and retainer cost of USD 15,000 per month. Not determined by number of participants, but by initial build out and number of communications issues per month to passengers
On call graphic designer	1	25,000	30,000	Assumes passenger communications and ad hoc requests from marketing and

Contract type	Quantity	CVC Total Annual Cost (in USD)	PenC Total Annual Cost (in USD)	Remarks
(shared with Communications)				communications (not requiring skill of full service ad agency) are included
Public relations/ crisis communications agency (on call 24hours)	1	75,000	20,000	CVC: ▪ Assumes a USD 5,000 monthly retainer for ongoing clip service, support during larger PR programs, and on-call crisis communications support; ▪ Assumes proactive PR and media monitoring contract (USD 10,000 annually); ▪ Assumes any serious crisis would need additional funds; PenC: ▪ Assumes an additional USD10,000 one month prior to launch and month of service launch (total USD10,000 each month) for full product launch.
Call center (includes social media support contract/reactive)	1	750,000	250,000	CVC: ▪ Assumes negotiated contract based on labour and call times. PenC: ▪ Assumes staffing support would increase to support increased ridership. Assumption is program is built out, cost is incremental for additional users/passengers dependent upon number. Ridership impacts the total cost.
Customer relationship management system/DB (CRM)	1	100,000	50,000	CVC: ▪ Assumes licensing fee based on number of users and would include both call center and in-house license usage; PenC: ▪ Assumes staffing support would increase to support increased ridership. Assumption is program is built out to accommodate PenC prior to launch of service. Ridership impacts the total cost

Contract type	Quantity	CVC Total Annual Cost (in USD)	PenC Total Annual Cost (in USD)	Remarks
Website/App	1	100,000	100,000	CVC: ▪ Assumes as-needed programming, support and analytics; ▪ Assumes that both website and app are fully developed, therefore cost does not include design/development budget. PenC: ▪ Assumes approximately the same cost as the CVC as most elements will be based on a completely different route, operation, and pricing structure requiring its own support and maintenance costs. Some economies of scale may be realized by utilizing same vendor and blending some functionalities with CVC service.

Figure 12-3: Marketing and branding unit costs, service contracts

12.4 Uncertainties And Contingencies

It is assumed that the number of stations would only impact the total number of Station Assistants needed, and not the rest of the marketing and customer service staff.

12.5 Cost Projection

The Figure 12-4 shows the resulting cost projection for marketing and branding in 2018 USD.

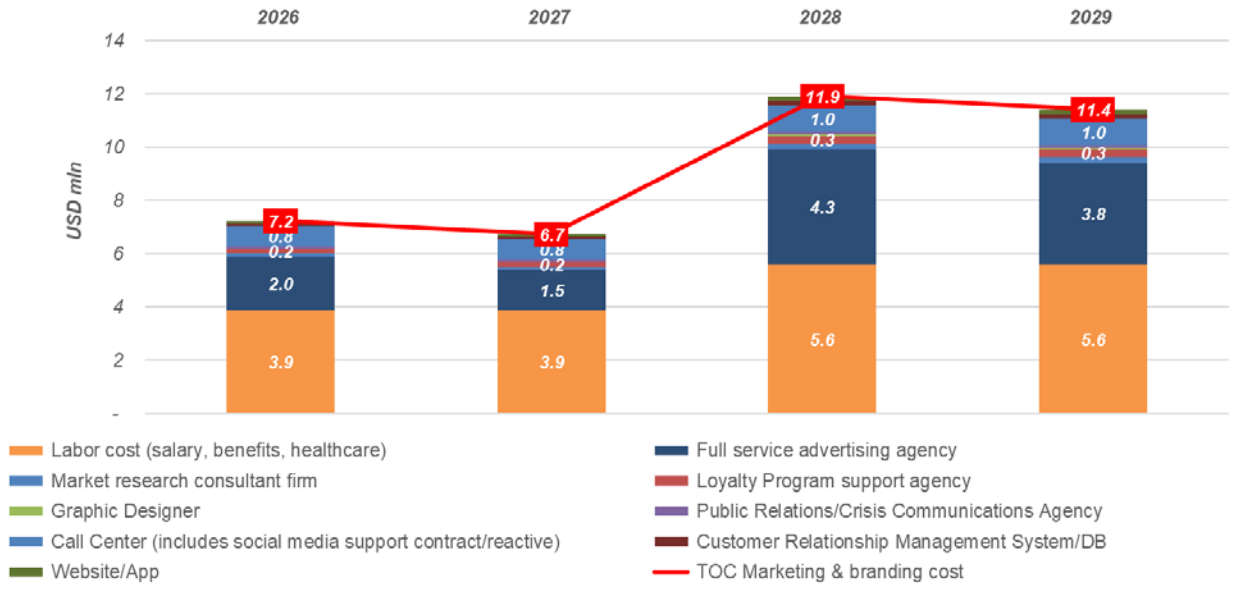


Figure 12-4: Cost projection for marketing and branding

13 Corporate Services And Management

13.1 Key Assumptions

13.1.1 Introduction

Other corporate functions necessary for the TOC's successful operation include the departments of Finance and Accounting, HR (Human Resources), IT (Information Technology), and GRC (Governance, Risk and Compliance).

13.1.2 Finance And Accounting

The finance and accounting team will be responsible for the functions of accounting, procurement and contracting, and warranty. The main responsibility of this team will be firstly, to ensure proper financial reporting so the TOC remains in compliance with the law and secondly, to improve financial results. This team will also create budgets and forecasts, analyze performance, and develop strategies to improve profitability.

13.1.3 Cost drivers

The cost drivers of the finance and accounting department are staffing labor, which includes a CFO (Chief Financial Operator).

13.1.3.1 Unit Costs

Unit costs per FTE are shown below.

# No	Position	CVC FTE	PenC FTE	Short task description	Annual Salary (in USD)	Pay grade allocated
1	CFO	1	-	Leads all strategic and tactical matters as they relate to accounting, treasury functions, forecasting, performance controlling, procurement and contract management	300,000	Senior Director

# No	Position	CVC FTE	PenC FTE	Short task description	Annual Salary (in USD)	Pay grade allocated
2	CFO Assistant	1	-	Supports the CFO in administrative function	60,000	Assistant
3	Corporate Controller	1	-	Leads financial reporting	150,000	Senior Manager (greater than ten years' experience)
4	Finance & Accounting Manager	1	-	Responsible for ensuring GAAP accounting	100,000	Manager
5	AP & AR	2	1	Responsible for accounts payable and accounts receivable	80,000	Analyst
6	Performance Controller	1	-	Leads analysis on company's performance and provides guidance on areas for improvement	150,000	Senior Manager (greater than ten years' experience)
7	Planning & Forecasting	1	1	Leads budgeting and forecasting activities on monthly, quarterly and annual basis	80,000	Analyst
8	Treasury	1	-	Responsible to develop and manage strategies, operations and policies related to cash management, borrowing and payment processing	150,000	Senior Manager (greater than ten years' experience)
9	Fare Revenue Manager	1	1	Responsible for revenue reporting from farebox	100,000	Manager

# No	Position	CVC FTE	PenC FTE	Short task description	Annual Salary (in USD)	Pay grade allocated
10	Procurement and Contract Manager	1	1	Responsible for developing and executing procurement strategies and actively managing risks and opportunities on contracts	150,000	Senior Manager (greater than ten years' experience)
11	Buyer	3	2	Tactical responsibility for executing purchase orders	80,000	Analyst
12	Contract Officer	2	1	Responsible for supporting legal with contracts review and supporting execution of active contracts	100,000	Manager
13	Warranty Officer	2	1	Responsible for developing and executing warranty programs	100,000	Manager

Figure 13-1: Finance & Accounting staff roles and responsibilities

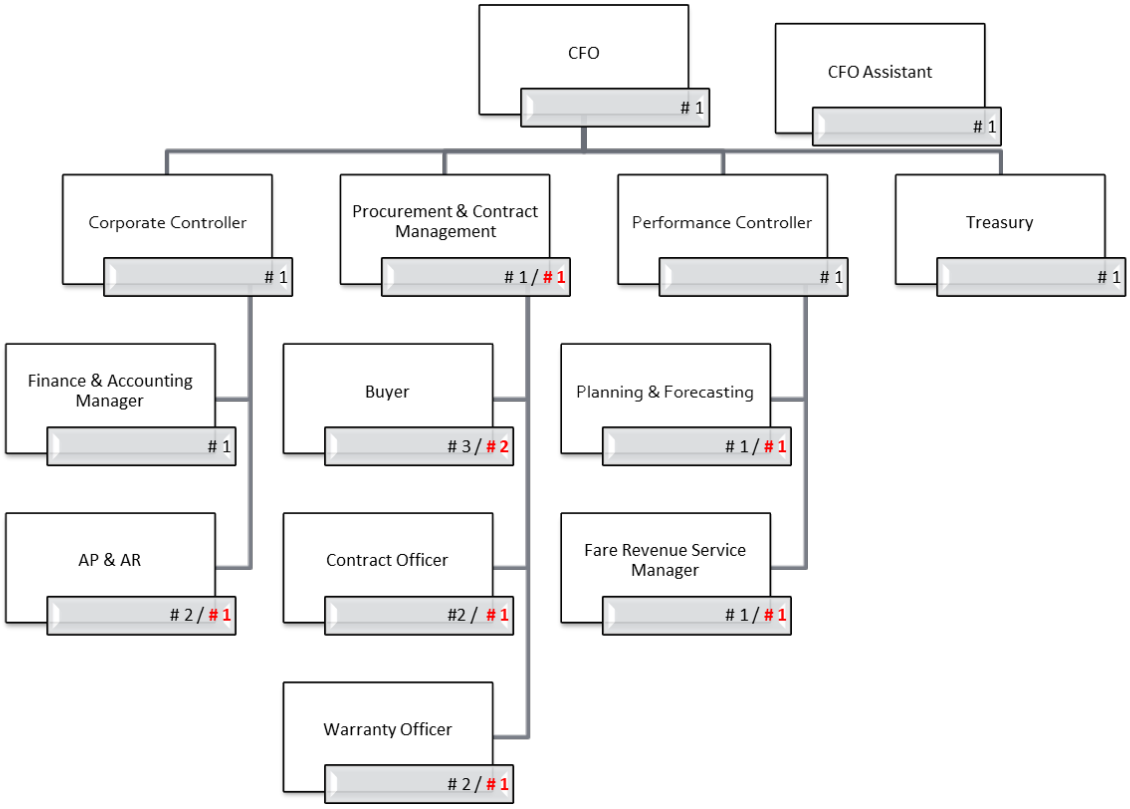


Figure 13-2: Organizational structure of Finance and Accounting department (CVC in black / PenC incremental in red)

13.1.4 Human Resources

The HR department's primary functions will be to assist with attracting and retaining employees. Employees of the TOC will be oriented towards:

- Organizational policies of the TOC system;
- Customer service;
- Safety and security;
- Employee conduct and human resource policies;
- Drug and alcohol testing program.

Another major part of HR responsibility will be to provide training.

To staff and retain qualified personnel adequately at all levels of the organization, proper training will be provided. The training program will be comprised of a number of discreet modules covering specific subjects pertinent to management, operations and facilities maintenance.

The training program for train crews, and for operations supervisors, will include:

- Railroad safety;
- Accidents/incidents response;
- Railroad operating practices;
- Train driving hours;
- Safety at work;
- New techniques / vehicles / component trainings.

It will specifically address, as required, operator certification training, specifically:

- 49 CFR Part 240
    - The purpose of this part is to ensure that only qualified persons operate a locomotive or train;
    - This part prescribes minimum Federal safety standards for the eligibility, training, testing, certification and monitoring of all locomotive engineers to whom it applies. This part does not restrict a railroad from adopting and enforcing additional or more stringent requirements not inconsistent with this part;
    - The qualifications for locomotive engineers prescribed in this part are pertinent to any person who operates a locomotive, unless that person is specifically excluded by a provision of this part, regardless of the fact that a person may have a job classification title other than that of locomotive engineer.
- 49 CFR Part 242
    - The purpose of this part is to ensure that only those persons who meet minimum Federal safety standards serve as conductors, to reduce the rate and number of accidents and incidents and to improve railroad safety;

- This part prescribes minimum Federal safety standards for the eligibility, training, testing, certification and monitoring of all conductors to whom it applies. This part does not restrict a railroad from adopting and enforcing additional or more stringent requirements consistent with this part;
- The conductor certification requirements prescribed in this part apply to any person who meets the definition of conductor contained in §242.7, regardless of the fact that the person may have a job classification title other than that of conductor.

- Operating Rules for operations employees (49 CFR Part 217.11)
  - To ensure that each railroad employee whose activities are governed by the railroad's operating rules understands those rules, each railroad to which this part applies shall periodically instruct each such employee on the meaning and application of the railroad's operating rules in accordance with a written program retained at its system headquarters and at the division headquarters for each division where the employee is instructed.
- Drugs & Alcohol training for supervisors (49 CFR Part 219.11 (g)
  - Any regulated employee who is subject to performing regulated service for a railroad is deemed to have consented to testing as required in subparts B, C, D, E, F, G, and K of this part.
- Emergency preparedness training (49 CFR Part 239.101)
  - Employee training and qualification—(i) On-board personnel. The railroad's emergency preparedness plan shall address individual employee responsibilities and provide for initial training, as well as periodic training at least once every two calendar years thereafter, on the applicable plan provisions. As a minimum, the initial and periodic training shall include:
    - Rail equipment familiarization;
    - Situational awareness;
    - Passenger evacuation;
    - Coordination of functions; and

- "Hands-on" instruction concerning the location, function, and operation of on-board emergency equipment.

- Radio communications (49 CFR Part 220)
  - This part prescribes minimum requirements governing the use of wireless communications in connection with railroad operations. In addition, this part sets forth prohibitions, restrictions, and requirements that apply to the use of personal and railroad-supplied cellular telephones and other electronic devices. So long as these minimum requirements are met, railroads may adopt additional or more stringent requirements.
- Railroad accidents and incidents (49 CFR Part 225)
  - The purpose of this part is to provide the Federal Railroad Administration with accurate information concerning the hazards and risks that exist on the Nation's railroads. FRA needs this information to effectively carry out its regulatory responsibilities under 49 U.S.C. chapters 201-213. FRA also uses this information for determining comparative trends of railroad safety and to develop hazard elimination and risk reduction programs that focus on preventing railroad injuries and accidents. Any State may require railroads to submit to it copies of accident/incident and injury/illness reports filed with FRA under this part, for accidents/incidents and injuries/illnesses which occur in that State.
- General Code of Operating Rules Transportation
  - These rules have been adopted by many passenger and freight railroads in the western half of the United States, including Caltrain and ACE here in California and would be relevant for the TOC to adopt as well.

TOC will establish a recertification program in accordance with 49 CFR Part 240 and Part 242. Training for facilities maintainers will include roadway worker protection, blue flag protection, radio communications, and accident/incident response.

As it relates to training of the operations workforce, TOC will provide trainings for all newly recruited staff and provide periodic refresher/ recertification training thereafter in order to ensure that all

employees have the necessary skills and competencies to execute safe, reliable and customer-oriented operation and maintenance procedures and services.

Training costs are included for job specific positions as described above and additionally for all employees with focus on railway fundamentals training, including rules and regulations, operating HSR network, safety, accident/incident response, radio communications, leadership, human resources, and finance and accounting.

13.1.4.1 Cost Drivers

The cost drivers for developing and administering the HR programs and plans will be staffing labor, which includes an overall HR Manager, HR Assistant, Coordinator, Recruiter and Learning & Development.

13.1.4.2 Unit Costs

Unit costs per FTE are shown below.

# No	Position	CVC FTE	PenC FTE	Short task description	Annual Salary (in USD)	Pay grade allocated
1	HR Manager	1	-	Responsible for administration of company polices, employee benefits, training, hiring and retention	120,000	Senior Manager (fewer than ten years' experience)
2	Recruiter	3	1	Responsible for hiring new employees that meet company's needs	80,000	Analyst
3	Coordinator	3	1	Responsible for execution of day to day HR activities	80,000	Analyst
4	HR Assistant	2	1	Provides administrative support to HR dept	60,000	Assistant

# No	Position	CVC FTE	PenC FTE	Short task description	Annual Salary (in USD)	Pay grade allocated
5	Learning & Development Officer	1	1	Responsible for training and career development programs for employees	100,000	Manager

Figure 13-3: HR staff roles and responsibilities

13.1.5 IT

Under corporate services, the following minimum network characteristics are to be considered:

- It is assumed that all the costs for network implementation, required hardware and software, and systems will be in place before the start of revenue service;
- All costs associated with the initial IT asset purchases are not included in this study. The values represented here are only for maintenance and operations of the IT infrastructure;
- Security will be implemented using:
    - Encryption;
    - Risk assessments;
    - Vulnerability assessment;
    - Incident and change management;
    - Employee training;
    - Performing audits;
    - Keeping applications up to date;
    - Preventing unauthorized access;
    - Establishing role-based access;
    - Implementing firewall and viruses scanning techniques.

The following minimum characteristics will be considered for the design and implementation of data centers with core, distribution and access layers:

- It is assumed that all data center services are contracted through cloud service;

- An on-premises data center is considered but only for those minimum services that cannot be subcontracted. It is assumed that the space for the data center will be provided with no cost to the operator and will be located in the operations control center in Fresno;
- All critical systems will be implemented considering high availability with failover options to reduce the need of additional staff to attend the critical failures;
- It is assumed that a backup control center will be available and ready for operations before the start of the revenue service in 2026 to mitigate against disaster;
- It is assumed that the system will run on cloud services using Microsoft Web Services.

It is assumed that all end user equipment such as desktops, printers, laptops, etc. is already supplied before the start of revenue service. No budget has been included for any initial capital investments. The values in the budget represent only the operations and maintenance costs.

13.1.6 Cost Drivers

The cost drivers for IT will be composed of staffing labor, contract services and hardware.

# No	Service contract	CVC Annual Cost (in USD)	PenC Annual Cost (in USD)
1	Computer service contracts	51,500	24,600
2	Servers & network hardware	207,637	173,319
3	Telephone & Internet	247,500	169,440
4	Internet Connectivity (TOC, HMF, LMF)	20,000	-
5	Desktop User Software	80,179	40,560
6	Automatic Passenger Counting	7,164	-

# No	Service contract	CVC Annual Cost (in USD)	PenC Annual Cost (in USD)
7	Reporting Database & Reports	20,000	20,000
8	HASTUS Scheduling Software	80,000	80,000
9	Safety Management	54,800	54,800
10	ADP (Payroll, HR)	124,800	58,401
11	Azure Solution	110,000	60,000
12	Accounting (GP in cloud)	23,760	23,760
13	Customer Response System (Year 1)	39,000 (Year 1: 49,000)	-
14	Asset Maintenance Management Software	417,000	126,000

Figure13-4: IT contract services

13.1.6.1 Unit Costs

Table 13-5 highlights IT staff roles and responsibilities, as well as annual salary per FTE.

# No	Position	CVC FTE	PenC FTE	Short task description	Annual Salary (in USD)	Pay grade allocated
1	IT Manager	1	-	Accomplishes information technology staff results by communicating job expectations; planning, monitoring, and appraising job results; coaching employees; initiating, coordinating, and enforcing systems, policies, and procedures	175,000	Director
2	Database Developer Lead	1	-	Serves as technical team lead for database software development projects	145,000	Senior Manager (greater than ten years experience)
3	Database Administrator (DBA)	1	-	Uses specialized software to store and organize data. The role may include capacity planning, installation, configuration, database design, migration, performance monitoring, security, troubleshooting, backup, and data recovery	120,000	Senior Manager (fewer than ten years experience)
4	IT Infrastructure Architect/Lead	1	-	Helps design and implement information systems to support the CVC enterprise infrastructure	150,000	Senior Manager (greater than ten years experience)
5	Senior System Engineer	1	-	Ensures the stability, integrity, and efficient operation of the in-house information systems that support core organizational functions. This is achieved by monitoring, maintaining, supporting, and	135,000	Senior Manager (fewer than ten years experience)

# No	Position	CVC FTE	PenC FTE	Short task description	Annual Salary (in USD)	Pay grade allocated
				optimizing all networked software and associated operating systems		
6	Junior System Engineer	1	1	Helps in monitoring, maintaining, supporting, and optimizing all network software and associated operating systems	90,000	Manager
7	Senior Network Engineer	1	-	Helps design and plan the deployment, maintenance, development, upgrade, and support of the network system	135,000	Senior Manager (fewer than ten years experience)
8	Junior Network Engineer	1	-	Helps in monitoring, maintaining, supporting, and optimizing all network systems	90,000	Manager
9	IT Support	6	2	Provides support services both on-site and remotely	65,000	Assistant
10	Senior Application Architect	1	-	Works with third-party application developer to create user information solutions by developing, implementing, and maintaining Internet/intranet applications	145,000	Senior Manager (greater than ten years experience)
11	Application Analyst	1	-	Consults with management and helps develop software to fit clients' needs. Provides accurate, quality analysis of new program applications, conducts testing, locates potential problems, and solves them efficiently	80,000	Manager
12	IT Security Manager	1	-	Responsible for protecting the CVC's computers, networks and data against threats, such as security breaches, computer viruses or attacks by cyber-criminals	150,000	Senior Manager (greater than ten years experience)

# No	Position	CVC FTE	PenC FTE	Short task description	Annual Salary (in USD)	Pay grade allocated
13	IT Security Analyst	1	-	Helps plan and carry out security measures to protect an organization's computer networks and systems	90,000	Manager
14	IT Security Engineer	1	-	Implements solutions to protect CVC's network against threat such as viruses and attacks, IT Security Engineer will also help to keep the network infrastructure up to date and perform auditing on routine	125,000	Senior Manager (fewer than ten years experience)

Figure13-5: IT staff roles and responsibilities

13.1.7 Management, Governance, Risk And Compliance

The TOC is assumed to have an integrated approach towards GRC to support operational efficiency. This reduces duplication of activities and efforts, thereby helping to control costs. Most importantly, focusing on GRC will help the TOC cope with compliance requirements, as well as with external laws and regulations.

Governance activities will assist in facilitating accurate, timely information deemed critical to management so they can make decisions. Together with active risk management and compliance with internal and external requirements, management can prioritize actions, implement consistent strategies, and assess potential costs with associated mitigation plans.

In addition to GRC, this section captures the management team, which includes the CEO and some of the CEO's direct reports, such as the Corporate Services Director and Legal Director.

13.1.7.1 Cost Drivers

The cost drivers are staffing labor.

13.1.7.2 Unit Costs

The figure 13-6 below lists respective positions with its short descriptions of tasks, as well as the cost per FTE.

# No	Positions	CVC FTE	PenC FTE	Short task description	Annual Salary (in USD)	Pay grade allocated
1	CEO	1	-	Creates, plans, implements strategic direction, and leads the organization	350,000	Senior Director
2	CEO Assistant	1	-	Provides administrative support to the CEO	60,000	Assistant
3	Corporate Service Director	1	-	Responsible for the functions of HR, IT, GRC, and Insurance	175,000	Director
4	Governance, Risk and Compliance Manager	1	-	Responsible for oversight of company risks and ensures internal and external compliance	120,000	Senior Manager (fewer than ten years' experience)
5	Internal Compliance	1	-	Responsible for ensuring internal compliance to company polices and regulations	100,000	Manager
6	External Compliance	1	-	Responsible for ensuring external compliance to governing state bodies	100,000	Manager
7	Insurance Manager	1	-	Responsible for administering and maintaining company's insurance programs	150,000	Senior Manager (greater than ten years' experience
8	Insurance Manager Assistant	1	-	Supports insurance manager	60,000	Assistant

# No	Positions	CVC FTE	PenC FTE	Short task description	Annual Salary (in USD)	Pay grade allocated
9	Legal Director	1	-	Responsible for advising TOC executives and employees regarding changes to the law affecting the company, ensuring the company is always in compliance with the law, and overseeing any lawsuits	200,000	Senior Director
10	Legal Assistant	2	-	Provides administrative support to Legal Director	100,000	Manager

Figure13-6: Management, governance, risk and compliance staff roles and responsibilities

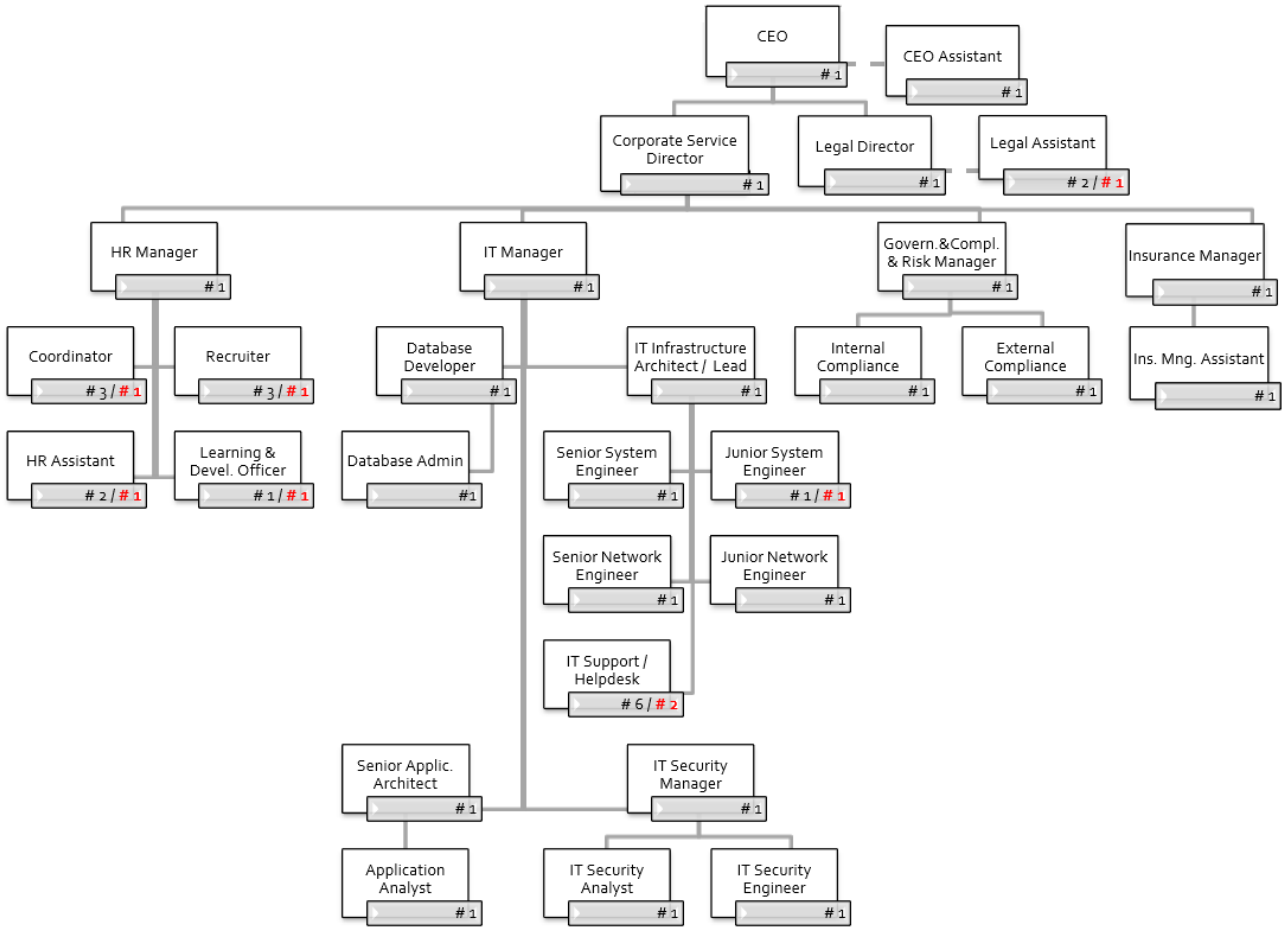


Figure 13-7: Organizational structure of management and corporate services department (CVC in black / PenC incremental in red)

13.2 Insurance

13.2.1 Property Insurance

Property insurance is assumed to be provided by the CSHRA because they will own the assets, such as the rolling stock, stations, TOC administrative building, and the tracks and infrastructure. Therefore, no premiums for property insurance are included in the study.

13.2.2 Casualty Insurance / Railroad Liability Insurance

The railroad liability policy provides third-party bodily injury and third-party property damage coverage, including passenger liability while in the train and on the platform. Defense coverage erodes the self-insured retention and is included in the limit of insurance. The policy limit is an annual aggregate and can be reinstated at 125% of the annual premium. The policy does not provide any employee injury coverage (workers' compensation). For purposes of this study, it has been assumed to provide coverage up to the federal cap of USD 300 million for passenger liability and USD 50 million to cover other 3rd party liability, for a total of USD 350 million. The casualty program would most likely include a primary program (first layer) an umbrella policy (second layer) and the excess liability policies to the required limit. A cost of USD 1.5 million self-insured retention has been included to reflect the annual premium.

13.2.3 Cyber Insurance

Cyber insurance is often excluded from a general liability policy. Therefore, for purposes of this study the cost for cyber insurance is included. The purpose is to protect sensitive customer information, such as credit card numbers and account numbers that will be transmitted on a daily basis from passengers. The types of activities that would be covered by cyber insurance include, notification to customers about data breach, restoring personal identities to affected customers, recovering compromised data, and repairing damaged information technology systems. The cost of USD 1 million self-insured retention had been included to reflect the annual premium with an annual limit of USD 25 million.

13.2.4 Insurance Cost Drivers

The cost drivers for insurance will be the self-insured retention amounts for casualty / railroad liability insurance and cyber insurance.

Total costs for insurance self-insured retention are shown below.

# No	Type of insurance	Self-Insured Retention (in USD mln)	Annual Limit (in USD mln)
1	Casualty insurance / Railroad liability insurance	1.5	350.0
2	Cyber insurance	1.0	25.0
3	TOC deductible	1.5	N/A

Figure 13-8: Annual insurance costs

13.3 Uncertainties And Contingencies

For purposes of this study, only very high-level estimates were provided for insurance coverages and a more detailed review of the requirements would need to be undertaken to understand all the potential activities and risks, which could affect the coverage needed and associated premiums.

13.4 Cost Projection

The resulting cost projection for management, corporate services, trainings, insurance and other costs (uniforms, safety gear and office supplies) is shown in Figure 13-9, in 2018 USD.

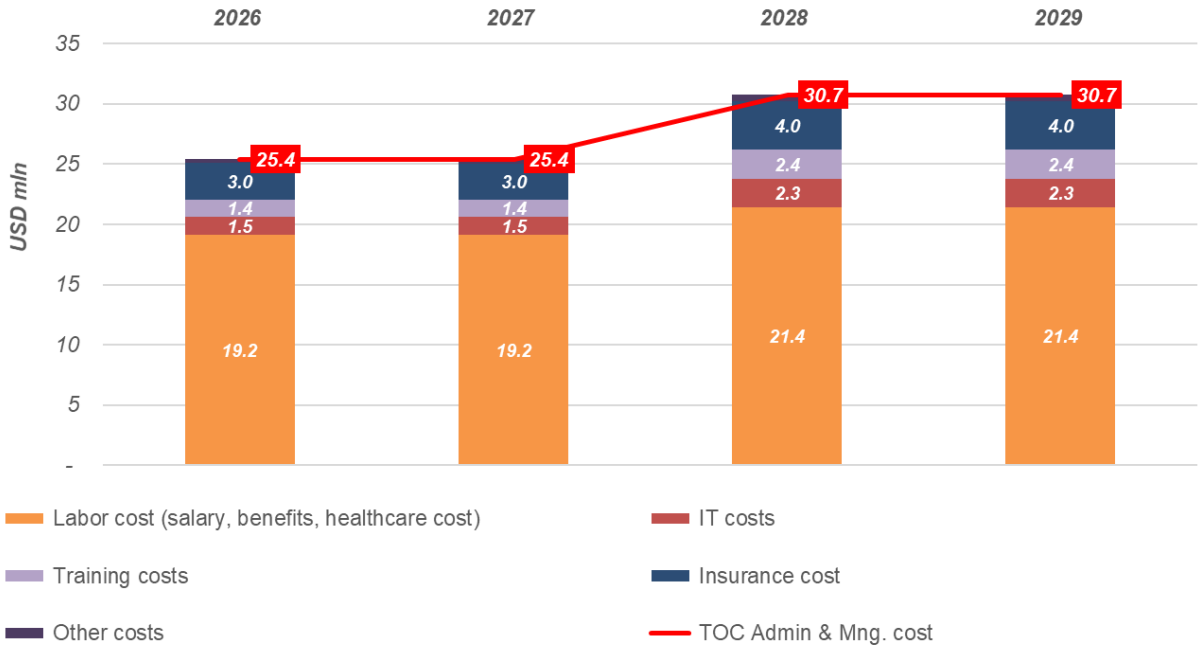


Figure 13-9: Cost projection for management, corporate services, trainings, insurance and other costs

14 Environmental, Health And Safety

14.1 Key Assumptions

14.1.1 Introduction

14.1.1.1 Environmental

California has rigorous laws, regulations and state agencies that will provide environmental compliance oversight for the CHSRA. The CPUC (California Public Utilities Commission), the California EPA (Environmental Protection Agency), the California Occupational, Health and Safety Administration, the California Air Resources Board, State Water Resources Control Board, and the California Energy Commission will each play important roles in areas such as safety, health, noise, electromagnetic interference, emergency response, vegetation control, air and water quality, spill prevention and control, and sustainability.

Each of these regulations requires the TOC to develop plans and procedures, conduct inspections, obtain permits, track data, and provide reports, as mandated by the respective agencies. For example:

- The CPUC requires immediate and monthly reports regarding accidents;
- The Regional Water Quality Control Board and the State Water Resources Control Board permit conditions require periodic storm water sampling and inspections;
- The Certified Unified Program Agency requires plans and other documentation, updated annually, for spill prevention, containment, and counter measures;
- Cal EPA requires reports, inspections, plans, and other documentation related to hazardous waste.

It is assumed that the headcount necessary to staff the environmental department consists of four personnel, including an Environmental Officer, an Environmental Technician, an Administrative Assistant, and a Certified Pesticide Applicator. The salaries for these positions were gleaned from the mean average United States Bureau of Labor Statistics, for the State of California in the year 2017. In addition to the headcount, ETO anticipates the need for permit costs.

Assuming that all required plans are developed prior to the start of operations, the Environmental Department will be responsible for performing and/or implementing the following items:

- Aboveground petroleum storage tanks

  Obtain permits, implement plans, develop training modules, document inspections, and certify the SPCC (Spill Prevention, Control, and Countermeasure) plan. At the HMF, it is assumed there will be one aboveground petroleum storage tank of less than 10,000 gallons to provide fuel for vehicles supporting train operations and maintenance.

- Regional Water Quality Control Board

  Ensure compliance with regulations governing equipment service documentation, training, wastewater, facility water, SWPPP (Storm Water Pollution Prevention Plan), IGP (Interior Gateway Protocol), and the NPDES (National Pollutant Discharge Elimination System) permit. It is assumed that a private QSD will develop the SWPPP prior to operations. The Environmental Technician will provide regular inspections, as required by the IGP and SWPPP.

- San Joaquins Valley Air Pollution Control District

  Obtain permits, schedule inspections, and certify portable equipment for CVC. It is assumed that all heavy equipment, such as cranes, will be Tier 3 or above. The Environmental Officer will work closely with the Vehicle Maintenance Officer to ensure that all vehicles are maintained in accordance with conditions of the permits.

- Bay Area Air Quality Management District and Monterey Bay Air Resources District

  Obtain permits, schedule inspections, and certify portable equipment for PenC. It is assumed that all heavy equipment, such as cranes, will be Tier 3 or above. The Environmental Officer will work closely with the Vehicle Maintenance Officer to ensure that all vehicles are maintained in accordance with conditions of the permits.

- CEQA (California Environmental Quality Act) and NEPA (National Environmental Policy Act)

  Develop and perform employee training, implement the weed control plan. The Environmental Officer will act as Weed Management Officer during the operations period. The goal is to identify and eradicate noxious weeds in the alignment.

- Hazardous Materials

  Obtain permits, write performance reports, train personnel, inspect, and prepare shipping manifests. In addition, the community right-to-know in EPCRA SARA (Emergency Planning and Community Right-to-Know Act, Superfund Amendments and Reauthorization Act) Title III requires an emergency response report and a hazardous materials business plan, both developed by the Environmental Officer.

- San Francisco Public Utilities Commission

  Ensure compliance with permits and plans pertaining to wastewater within PenC.

- Sustainability

  Implement plans as required by the FRA and the State of California; provide monthly and annual reports on sustainability.

The major points for calculating costs associated with environmental tasks are requirements for obtaining environmental permits, and labor for implementing plans and ensuring compliance with various environmental permits.

The State of California and FRA require numerous environmental permits to operate and maintain high-speed trainsets. It is assumed that the Environmental Officer will be responsible for researching the necessary permits and directing staff to fill out permit applications as necessary.

Environmental labor is needed to develop environmental plans and ensure that the plans are implemented as required, develop training procedures for employees working in various departments, report on sustainability items, and direct environmental personnel.

It is assumed that air pressure vessels inspection requirements are considered within the environmental scope of work.

14.1.1.2 Health And Safety

The following are considered in the field of health and safety:

- IIPP (Injury and Illness Prevention Plan)

The H&S (Health and Safety) Officer will be responsible for developing and implementing an effective IIPP. Required IIPP elements include:

- Responsibility;
- Compliance;
- Communication;
- Hazard assessment;
- Accident/exposure investigation;
- Hazard correction;
- Training and instruction;
- Record keeping.

An effective IIPP must fully involve all employees, supervisors and management, identify specific workplace hazards, correct said hazards in an appropriate and timely manner, and provide effective training. The plan must be reviewed annually.

- Heat illness prevention

  The H&S Officer will be responsible for developing and implementing a heat illness prevention plan that applies to all outdoor places of employment. The plan includes emergency response procedures, and must be reviewed annually.

- EPP (Emergency Preparedness Plan)

  The Health and Safety Officer will be responsible for developing and implementing an EPP and making a training program available online for all emergency responders. The plan includes:

  - Initial and on-board notification to the control center;
  - Informing passengers and indicating corrective countermeasures. The control center notifies emergency responders, adjacent rail modes of transportation, and appropriate railroad officials;
  - The EPP must be distributed at least once every three years or when plans change.

- Fire Safety

  The Health and Safety Officer develops and implements written procedures for the inspection, testing, and maintenance of all fire safety systems and equipment. The plan must be reviewed annually.

14.1.1.3 Emergency Action Plan

The Health and Safety Officer will be responsible for developing and implementing the plan. Required emergency action plan elements include procedures for:

- Emergency evacuation;
- Employees who remain to operate critical plant operations before they evacuate;
- Accounting for all employees;
- Employees performing rescue or medical duties;
- The preferred means of reporting fires and other emergencies;
- Names, or regular job titles and contact information for persons/departments who must be contacted for further information about duties under the plan.

An alarm system that complies with Article 165 must be established. The plan must be reviewed annually or when plans change.

14.1.1.4 Valley Fever

- The H&S Officer will be responsible for implementing Valley Fever control measures in coordination with the county public health officer. Plan requirements include:
  - Training for recognizing symptoms of illness and minimizing exposure;
  - Providing washing facilities;
  - Providing vehicles with enclosed, air-conditioned cabs;
  - Making respiratory protection masks with particulate filters available to workers.

14.1.1.5 Radiofrequency Radiation Exposure limits And Electric System

The H&S Officer will be responsible for reporting maximum permissible levels for whole and partial body exposure to electromagnetic energy, documentation of safety standards, and training personnel for proper operation, maintenance, repair, and inspections of electrical systems.

The major points for calculating costs associated with health and safety tasks are labor costs for the development and implementation of plans and ensuring compliance with health and safety codes.

14.1.1.6 Healthy And Safety Labor

The H&S Officer will be responsible for developing:

- Health and safety plans and for ensuring that the plans are implemented as required;
- Training procedures for employees working in various departments;
- Directing health and safety personnel.

14.2 Cost Drivers

The cost drivers are labor (highlighted below), permit costs and 3rd party environmental costs.

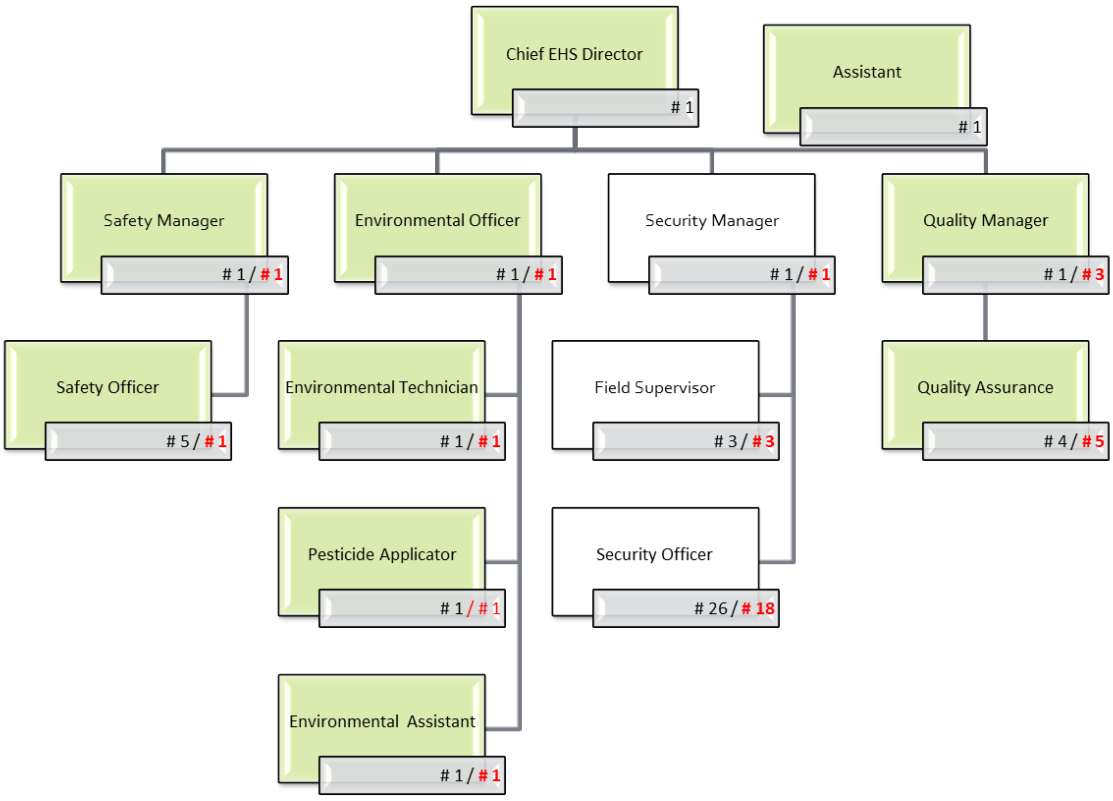


Figure 14-1: Organizational structure of EHS department (CVC in black / PenC incremental in red)

14.3 Unit Costs

The below summarizes unit costs for CVC and PenC.

Health and safety consumables for CVC	Total in USD
Respiratory protection masks (Valley Fever)	10.79 per box of 20

Figure 14-2: Health and safety consumables for CVC

CVC	2,900
PenC	2,900

Figure 14-3: Annual environmental subcontract costs

Environmental permit costs	Total in USD
CVC	83,751
PenC	19,832

Figure 14-4: Annual environmental permit costs

Health and safety permit costs	Total in USD
CVC	12,150
PenC	12,150

Figure 14-5: Annual health and safety permit costs

Health and safety subcontractor costs	Total in USD
CVC	21,000
PenC	21,000

Figure 14-6: Annual health & safety subcontractor costs

Water usage costs	Total in USD
CVC	28,455
PenC	18,984

Figure 14-7: Annual water usage costs

# No	Position	CVC FTE	PenC FTE	Short task description	Annual salary (in USD)	Pay grade allocation
1	Chief EHS Director	1	-	Responsible for developing and leading environmental, health, safety, security and	175,000	Director

# No	Position	CVC FTE	PenC FTE	Short task description	Annual salary (in USD)	Pay grade allocation
				quality programs/policies		
2	Chief EHS Director Assistant	1	-	Provides admin support to EHS Director	60,000	Assistant
3	Safety Manager	1	1	Responsible for executing safety programs/policies	150,000	Senior Manager (greater than ten years' experience)
4	Safety Officer	5	1	Responsible for developing safety programs for employees	80,000	Analyst
5	Quality Manager	1	1	Develops quality standards	150,000	Senior Manager (greater than ten years' experience)
6	Quality Assurance	4	4	Executes quality standards	100,000	Manager
7	Environmental Officer	1	1	Responsible for developing environments programs and ensuring external compliance	120,000	Senior Manager (fewer than ten years' experience)
8	Environmental Technician	1	1	Supports Environmental Officer	60,000	Assistant
9	Pesticide Applicator	1	1	Performs pesticide application	60,000	Assistant
10	Environmental Assistant	1	1	Provide admin support to Environmental Officer	60,000	Assistant

Figure 14-8: EHS staff

14.4 Uncertainties And Contingencies

It is expected that there will be numerous environmental permits required by the State of California and the FRA to operate and maintain high-speed trainsets. It has yet to be seen the full requirements needed for environmental permits and therefore, not all the permit costs reflected in this study may be 100% reflective of all the future environmental permit costs.

In the event that additional plans are required for the TOC to comply with health and safety regulations, an increase in costs may result. Numerous plans will be prepared in advance of train operations. These plans must address required site and project specific measures accurately for the plans to comply with all conditions and measures and prevent cost overruns associated with preparing compliant versions.

14.5 Cost Projection

The Figure 14-9 shows the resulting cost projection for environmental, health and safety in 2018 USD.

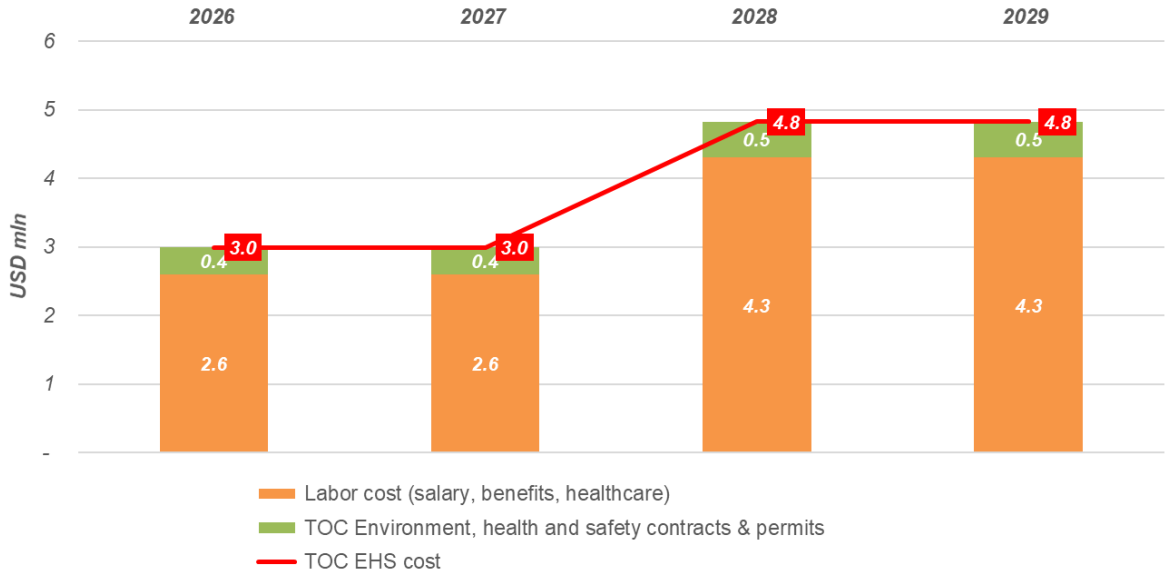


Figure 14-9: Cost projection for EHS

15 Security

15.1 Key Assumptions

15.1.1 Introduction

It should be highlighted that the Authority is currently evaluating a policing plan with the CHP. For purposes of this study and in order to estimate security costs, the basis for the cost estimates reflect the establishment of MOUs (Memorandums of Understanding) with local and county police departments along the CVC corridor in addition to local law enforcement assumed to provide supplemental security to the TOC.

The CVC operating segment consists of five stations with Merced as the northernmost station and Bakersfield as the southernmost station needing security services. The PenC operating segment consist of four stations with 4th & King as the northernmost station and Gilroy as the southernmost station needing security services. Security information presented in this case study is aligned with current rail transit security standards referenced by the APTA (American Public Transportation Association), DHS (Department of Homeland Security), and Federal Transit Administration security standards:

- The system security structure is based on establishing MOUs (Memorandums of Understanding) with local and county police departments along the CVC corridor. This rail system security model is currently used along the PenC (Caltrain) and for other California commuter rail systems;
- For both CVC and PenC corridors, the Security Operations Center (SOC) will house all CCTV monitors and intrusion detection alarms to monitor security at stations and other key assets, including the maintenance facility;
- Local law enforcement assumed to provide supplemental security support to the TOC contracted county police deputy sheriffs along the service corridor through the counties served. These support services include coordination of incident response as required and sharing local crime statistics and threat concerns;

- TOC contracted local county deputy sheriffs and rail-system-trained law enforcement staff will have jurisdiction for all onboard and right of way incidents along the rail corridor.

For the CVC corridor, stations and parking facilities within the system will be managed by a combination of electronic security and security/ police patrols.

Signal communication shelters along the right of way have potential vandalism and theft exposures, so intrusion detection will be provided for both corridors. Trespassing along the right of way and grade crossings may also present exposures.

15.2 Security Organizational Structure

The overall security structure is based on a number of MOUs. The MOUs will describe and define the roles and responsibilities between the TOC and local county police departments along the corridor. The Security Manager would be the overseeing authority between the contracted County deputy sheriff departments and TOC and must coordinate the application of system security requirements with each affected county jurisdiction along the rail service alignment. The security for the PenC Corridor segment would build upon that which is already in place for the CVC corridor and would also rely on a number of executed MOU's with County Sheriffs and local law enforcement departments.

The CVC staffing would consist of a Security Manager, in charge of daily security operations and coordination, and the SOC. Three Security Operation Field Supervisors will be required to cover the north and south ends of the CVC operating segment, based on the planned scheduled hours of service, and report activity to SOC. PenC operations will require an additional four Security Operation Field Supervisors.

On the CVC corridor, the TOC security staffing would be provided through establishing contracts with the Bakersfield and Fresno County Police. In addition to the local and county police, private contracted security personnel (26 total) would be required to provide security at stations and the maintenance facility, and to staff the SOC to monitor electronic security. On the PenC corridor, additional private contracted security personnel (21 total, of which 3 supervisors and 18 guards) would be required to provide security at stations and the new Light Maintenance Facility at Brisbane.

15.2.1 Proposed Security Staffing Model

TOC will rely heavily on collaborative police-community problem solving activities, which incorporate problem identification, problem analysis, and problem resolution to deploy police effectively in areas where they are needed most. All police departments who currently serve local CVC and PenC communities where the HSR will run will face similar challenges in measuring the impact of a new rail operation.

For the PenC corridor, the San Mateo County Sheriff's department policing territory from 4th & King to Gilroy, will be chosen to form a Strategic Rail Operation Unit (SROU) to respond to rail related incidents along the corridor. The SROU would be dedicated to the security needs of HSR and would be trained on HSR security related rail system characteristics, operational interface, and roadway worker protection safety. Currently, this model is in place for the Caltrain operation as the San Mateo County Sheriffs (Transit Police) are contracted out to Caltrain.

For purposes of this study, it is assumed that the TOC will enter into cooperation agreements with each county to support first responder and security needs to financially support each sheriff's department, a cost of USD 150,000 for each county has been calculated.

15.3 Cost Drivers

The cost drivers will be security staffing. Staffing costs for the CVC and PenC will include security guards at the stations, HMF, LMF and TOC/ OCC.

The security guards' duties include:

- Routine station inspections;
- Communicating with the SOC for all emergencies;
- Monitoring CCTV cameras in the SOC;
- Protecting CHSRA property;
- Assisting customers as needed in stations;
- Security patrols as needed.

In addition to security staffing costs, there will be maintenance costs for security hardware and service contracts (cooperation agreements with each county).

15.4 Maintenance Costs

15.4.1 Security Systems

It is anticipated that the annual maintenance costs for both the vehicles for security personnel and the electronic security systems will be included in the security contract. Based on that, the following assumptions were made:

On the CVC corridor, each station will have a total of eight CCTV cameras (four covering the platform edges, two covering the TVMs and two covering the fare array area (turnstiles).

Each station will have four intrusion detection contacts. Each station area assumes a parking lot with four CCTV cameras covering parking lot areas. The heavy maintenance facility will have ten CCTV cameras and ten intrusion detection contacts. Signal houses and miscellaneous facilities will have a total of ten intrusion detection contacts.

In addition, on the PenC corridor, each station will have a total of twenty CCTV cameras (sixteen covering the platform edges and four covering parking lots). The Brisbane LMF will have 10 CCTV cameras and 10 intrusion detection contacts. As on the CVC corridor, signal houses and miscellaneous facilities will have a total of ten intrusion detection contacts.

The costs associated with maintenance of these systems are estimated to be approximately USD 900 per device per year.

15.4.2 Vehicles

Vehicle maintenance is added to the cost of providing security. It is assumed that the county sheriffs will use their own current vehicles. The maintenance and fuel cost for TOC vehicles assumed to be included in the security budget. The private security vehicles are assumed to be included in their contract to provide security services, so there would not be any additional annual maintenance costs outside of their annual contract.

15.4.3 Unit Costs

The cost drivers of labor are highlighted below in green.

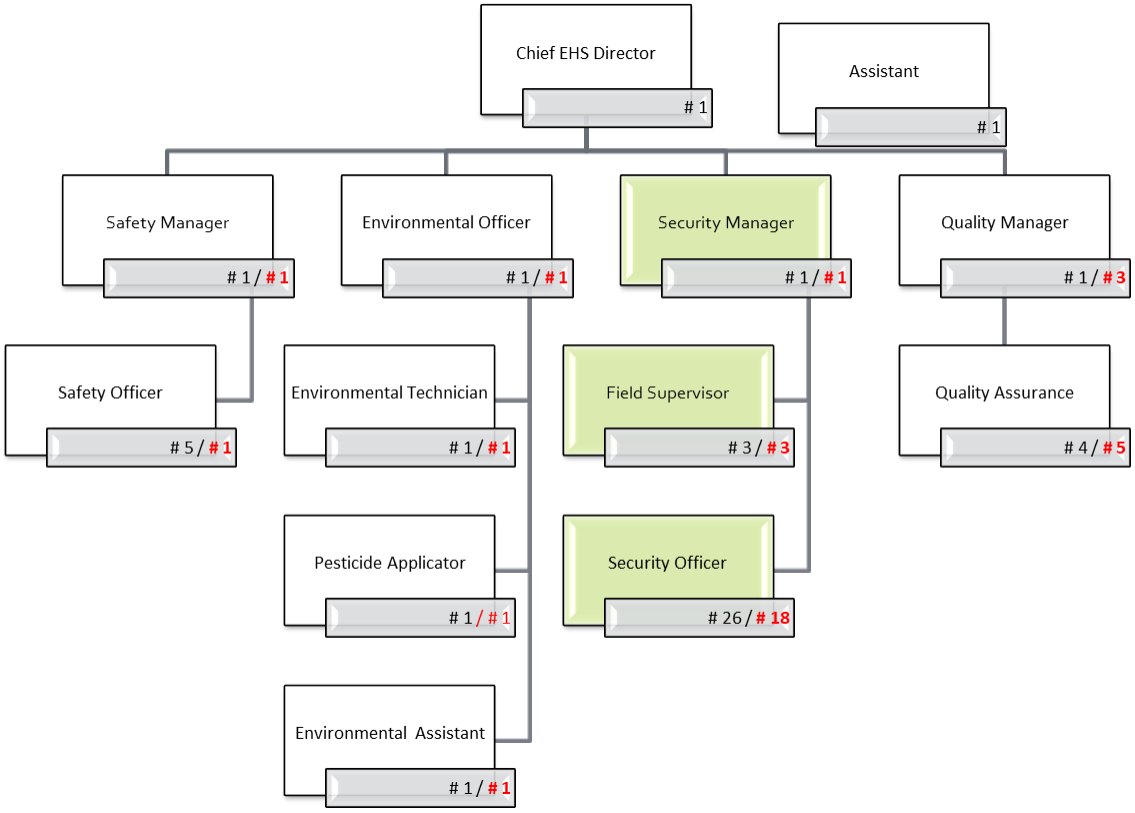


Figure 15-1: Organizational structure of security division (CVC in black / PenC incremental in red)

The costs in tables below are assumed for security.

# No	Position	FTE CVC	FTE PenC	Short task description	Annual Salary (in USD)	Pay grade allocated
1	Security Manager	1		In charge of daily security operations and coordination	150,000	Senior Manager (greater than ten years' experience)

# No	Position	FTE CVC	FTE PenC	Short task description	Annual Salary (in USD)	Pay grade allocated
2	Field Supervisor	3	3	To cover the north and south ends of the operating segments, based on the planned scheduled hours of service, and report activity to SOC.	80,000	Analyst
3	Security Officer	26	18	Stationed at HMF (CVC corridor), LMF (PenC corridor), stations and TOC building to monitor cameras and ensure security at the premises	60,000	Assistant

Figure 15-2: Security staff

# No	Type of security vehicle	Number of vehicles CVC	Number of vehicles PenC	Annual maintenance cost (USD per vehicle)
1	SUV	2	5	10,000

Figure 15-3: Security vehicles

# No	Type of security equipment	Quantity of security equipment CVC	Quantity of security equipment PenC	Annual maintenance cost (USD per device)
1	Electronic security device	110	110	900

Figure 15-4: Security equipment overview

# No	Type of contract	Number of contracts CVC	Number of contracts PenC	Annual maintenance cost (USD per contract)
1	First responders contract (county level)	5	3	150,000

Figure 15-5: First responder contracts

15.4.4 Uncertainties And Contingencies

To provide adequate security for the system, a TVA (Threat and Vulnerability Assessment) must be performed to determine the security needs at each station and along the right of way. This will involve local police under a cooperative agreement, as defined above, who can provide crime statistics for their jurisdiction as well as estimated ridership numbers. Contingent on the TVA information, additional security design (e.g., cameras, lighting, fencing, intrusion detection) and / or procedural mitigation measures (e.g., increased patrols) may be required to address potential threats.

The interconnected, varied, and expansive scope of the HSR system creates unique security challenges that are best addressed through stakeholder communication, coordination, and collaboration. To best assist surface transportation owners and operators with their security needs, the TOC will focus its efforts on system assessments, voluntary interconnecting operator compliance with industry standards, collaborative law enforcement and security operations, accurate and timely exchange of intelligence information, regulatory oversight, and technological expertise.

Threats and vulnerabilities identified by the TVA at stations and outlying points must be mitigated to provide a safe, secure environment for the riding public, employees, and emergency response personnel.

15.5 Cost Projection

The Figure 15-6 shows the resulting cost projection for security in 2018 USD.

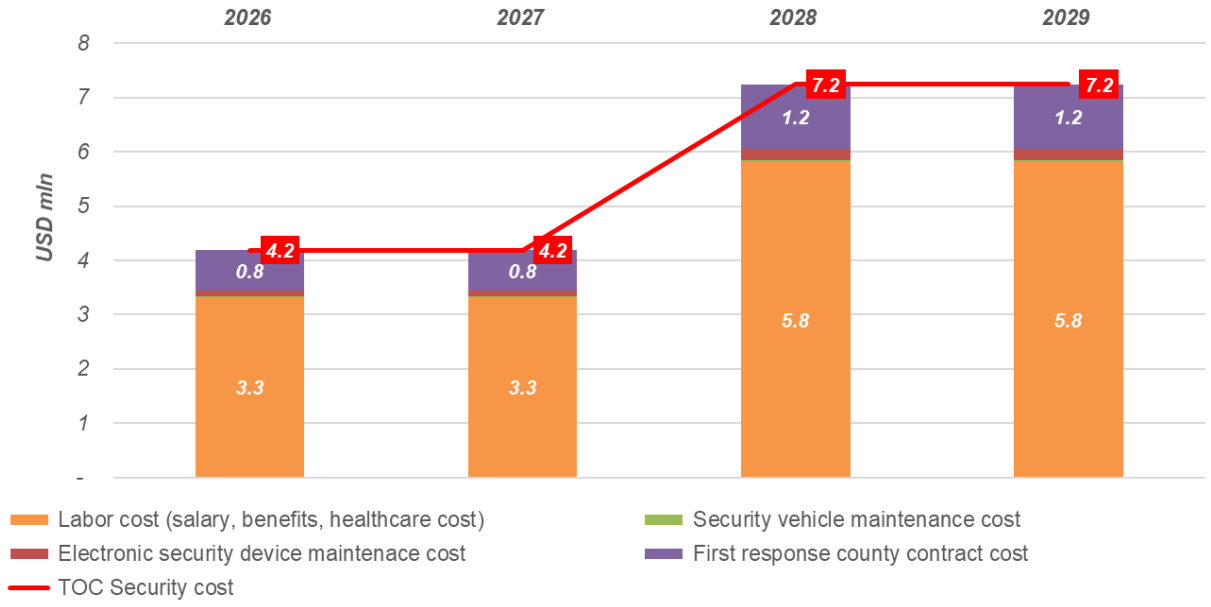


Figure 15-6: Cost projection for security

16 General Contingency Provision

16.1 Risk And Uncertainties Inside And Outside TOC Scope

A general contingency provision is included on top of all TOC costs projected in this study, but only related to a subset of risks and uncertainties affecting those TOC costs.

For the purpose of including this provision, a distinction is made between contingencies related to risks and uncertainties.

- Within the TOC's scope and span of control, and therefore typically considered a TOC business risk;
- Outside the TOC's scope and span of control, which are driven by, for example, government or authority action or inaction, regional economic development or lack thereof, force majeure events, etc.

The general contingency provision is only included for risks and uncertainties within the TOC's scope and span of control.

It is therefore certain that there are risks and uncertainties which (1) may drive up costs (or, inversely, result in TOC costs coming in below projections in this study) but (2) are not reflected in the general contingency provision applied in this study.

16.2 Level Of Contingency Provision

The general contingency provision included in this study is based on a general assessment of:

- The preliminary and indicative nature of operational concepts and cost projections, as developed for and included in this study;
- The within-TOC-scope risks and uncertainties that must be accounted for.

On this basis, the general contingency provision used is 10%.

17 CVC Ridership and Fare Revenue

17.1 Ridership Model Background

The CHSRA's official ridership forecasts for the 2018 Business Plan were produced using the Business Plan Model Version 3 (BPM-V3). This model was developed to forecast ridership on a system stretching from San Francisco to Los Angeles. Although numerous external parties have reviewed the statewide ridership forecasts produced by the BPM-V3, its focus on a larger HSR system limits its representation of the smaller operating segment envisioned by the CVC. In conclusion, it was identified that the ridership values in the smaller Central Valley HSR section are not adequately represented in any of the ridership models available to the Authority, which were designed to represent valley to valley and Phase 1 service.

For purposes of this study, the ETO reviewed three independent ridership forecasts (Merced-Bakersfield):

- Forecast derived for the CVC stand-alone corridor using inputs from the Cambridge 2018 Business Plan ridership forecasts (used only as a reference point);
- Analysed and escalated the actual 2017 San Joaquins ridership provided by CalSTA to 2026 in order to arrive at a ridership forecast (used only as a reference point);
- California State Transportation Agency Ridership forecast model was calibrated using the actual 2017 San Joaquins ridership. Future connections planned for availability in 2026 were included and assumed the high-speed corridor in the Central Valley as part of the San Joaquins network (results used for purposes of this study).

Note: The above three sources provide high-level forecasts of ridership and revenue. The results should not be relied upon solely for decision-making. The San Joaquins 2017 ridership values, the Cambridge ridership forecast, and the California State models were used during the last years to represent and estimate the Central valley corridor passenger's behaviours. The ETO does not own any of these models and does not have any control on the reliability of the data and the outputs from the models.

17.2 Ridership Forecast Derived From Current CHSRA Model

The ETO took the following steps to derive a CVC ridership forecast:

- Use of Cambridge Systematics' O/D (Origin Destination) trip table matrix (4,683 zones) and other inputs;
- Construction of a model using VISUM travel demand modelling software to aggregate and filter the zones in the relevant CVC sections.
- These values in Figure 17-1 does not reflect any improvements in the corridors north of Merced and as well does not represent a highly integrated service with San Joaquins and ACE.

The results from the aggregation and filter of the ridership data are shown in Figure 17-1.

From / To	Merced	Madera	Fresno	Tulare	Bakersfield	Total
Merced	0	0	330	80	70	**480**
Madera	0	0	50	60	60	**170**
Fresno	330	50	0	70	710	**1,160**
Tulare	80	60	70	0	320	**530**
Bakersfield	70	60	710	320	0	**1,160**
Day Total	**480**	**170**	**1,160**	**530**	**1,160**	**3,500**
Year Total						**1.3 mln**

Figure 17-1: Average daily traffic demand (HSR, trips/day) in the Central Valley (Year 2040)

17.3 Actual 2017 Merced-Bakersfield Ridership

In consultation with CHSRA, CalSTA, and Caltrans, the available information (including the comprehensive list of stations pair data in the San Joaquins corridor) was used to derive the actual ridership in the study section. Compared to the two other sources, this is not a forecast.

The numbers below represent the actual number of passengers whose travel was initiated or terminated in the Central Valley section between Merced and Bakersfield. These numbers are used as a plausibility check against the numbers from the forecasts.

The following activities were performed:

- Used the actual stations' passenger boarding pairs (origin/destination) in the San Joaquins corridor provided by CalSTA as an input;
- The data used for all calculations was from 1 Jan to 31 Dec 2017;
- Southbound traffic: All boardings starting north of Merced and ending in the section between Merced and Bakersfield were included in the ridership;
- Northbound traffic: All boardings starting between Merced and Bakersfield regardless of the destination were included in the ridership.

The resulting 2017 numbers of passengers in the Central Valley section are shown below.

From / To	Merced	Madera	Fresno	Hanford (Kings Tulare)	Corcoran	Wasco	Bakersfield	Total
Oakland Jack London		490	7,317	1,582	199	153	7,003	16,744
Oakland Coliseum Airport		-	1	-	-	-	-	1
Emeryville		1,072	13,758	3,618	476	320	9,311	28,555
Richmond		577	7,027	1,411	166	130	3,021	12,332
Martinez		1,039	10,749	3,539	405	240	17,996	33,968
Antioch		298	2,395	660	205	145	4,048	7,751
Stockton-San Joaquin St.		2,169	22,082	7,494	794	823	37,932	71,294
Sacramento		1,548	14,682	6,073	709	592	15,655	39,259
Lodi		55	567	459	28	45	1,325	2,479
Stockton-Downtown		319	2,960	1,327	128	113	5,728	10,575
Modesto		568	5,873	2,360	161	233	17,874	27,069
Denair (Turlock)		257	1,600	758	103	98	5,565	8,381
Merced	0	787	6,252	2,226	160	336	18,711	28,472
Madera		0	514	1,260	44	75	3,003	4,896
Fresno			0	36,447	842	1,071	49,285	87,645
Hanford (Kings Tulare)				0	6,073	499	21,165	27,737
Corcoran					0	52	2,939	2,991
Wasco						0	15,627	15,627
Bakersfield							0	0
Total	0	9,179	95,777	69,214	10,493	4,925	236,188	**425,776**

Figure 17-2: Ridership - San Joaquins 2017 (Jan-Dec) southbound

To / From	Merced	Madera	Fresno	Hanford (Kings Tulare)	Corcoran	Wasco	Bakersfield	Total
Oakland Jack London		509	6,803	1,539	173	148	6,236	15,408
Oakland Coliseum Airport		-	-	-	-	-	-	0
Emeryville		964	13,016	3,472	418	283	9,243	27,396
Richmond		593	7,022	1,376	172	112	2,998	12,273
Martinez		1,083	11,206	3,687	425	245	17,362	34,008
Antioch		321	2,493	919	71	154	4,206	8,164
Stockton-San Joaquin St.		2,483	26,942	9,271	966	929	41,573	82,164
Sacramento		1,151	12,027	5,093	746	454	11,703	31,174
Lodi		37	412	353	26	40	745	1,613
Stockton Downtown		232	2,615	1,136	91	100	4,966	9,140
Modesto		567	6,013	2,346	156	226	17,168	26,476
Denair (Turlock)		181	1,598	800	96	88	5,568	8,331
Merced	0	534	6,130	2,010	147	303	17,008	26,132
Madera		0	1,113	1,320	44	83	3,090	5,650
Fresno			0	35,551	702	956	48,345	85,554
Hanford (Kings Tulare)				0	6,392	486	20,091	26,969
Corcoran					0	58	3,170	3,228
Wasco						0	16,671	16,671
Bakersfield							0	0
Total	0	8,655	97,390	68,873	10,625	4,665	230,143	**420,351**
Total 2017 passangers Northbound + Southbound								**846, 127**

Figure 17-3: Ridership San Joaquins 2017 (Jan-Dec) northbound

17.4 Calibration Of Existing State Rail Plan Ridership Forecast Model

In consultation with CalSTA, the following process was conducted using the existing model from the State Rail Plan project:

- Applied the existing Ridership Forecast Model for the San Joaquins Corridor as input for calibration (Figure 17-2 and 17-3);
- Assumed the HSR Central Valley section as part of the San Joaquins Corridor;
- Included in the model the future available connections and improvements in the northern and southern Central Valley by 2026;
- Used the existing policy fare for the San Joaquins corridor;
- Executed the model with the new considerations.

Values were estimated for the ridership forecast in the specific section between Merced and Bakersfield (future HSR Section). The results of the calibrated model framework from the State Rail Plan project are shown below. Total ridership is forecasted at 1,671,000 with associated fare revenues of USD 30.5 million.

From / To	Merced	Madera	Fresno	Tulare	Bakersfield	Total
Merced	0	21,200	220,000	57,600	236,000	**534,800**
Madera	21,200	0	1,600	2,200	8,200	**33,200**
Fresno	220,000	1,600	0	87,100	144,000	**452,700**
Tulare	57,600	2,200	87,100	0	57,600	**204,500**
Bakersfield	236,000	8,200	144,000	57,600	0	**445,800**
Total	**0.5 mln**	**0.03 mln**	**0.5 mln**	**0.2 mln**	**0.5 mln**	**1.7 mln**

Figure 17-4: Daily traffic demand (HSR, trips/day) in the Central Valley (Year 2026 'steady state')

From / To	Merced	Madera	Fresno	Tulare	Bakersfield
Merced	0	234,000	3,082,000	979,000	6,147,000
Madera	234,000	0	13,400	26,300	196,000
Fresno	3,082,000	13,400	0	435,000	3,160,000
Tulare	979,000	26,300	435,000	0	980,000
Bakersfield	6,147,000	196,000	3,160,000	980,000	**0**

Figure 17-5: Fare revenue in the Central Valley (Year 2026 'steady state')

17.5 Summary of Ridership Reference Values

The table below summarizes the different ridership values obtained using the above described sources.

Source	Annual Ridership	Comments
Ridership Forecast derived from CHSRA current model	1.4 mln	• Input available was based on the assumption of a longer distance service (for a steady state 2040 scenario) • Does not introduce the new assumptions and improvements of the current San Joaquin and ACE services planned to be available in 2026 provided by CalSTA • Used as a reference check point
Actual San Joaquins Ridership in 2017	0.8 mln	• Includes all trips ending or starting between Merced and Bakersfield in 2017 • Does not consider the new assumptions and improvements of the current San Joaquin and ACE services planned to be available in 2026 provided by CalSTA • Presented only as a reference check point • Does not include Thruway buses
Modification of existing Ridership Forecast model framework from the State Rail Plan project	1.7 mln Value used for the study	Forecast in 2026 adapting the current California State ridership model (steady state after ramp-up), assuming: • The ACE and San Joaquin Corridors improvement planned to be available in 2026 by CalSTA • The HSR section between Merced-Bakersfield will be part of the San Joaquin corridor service instead of using the private railroads infrastructure in this section • Cross platform Transfer in Merced • Includes the improvement of the reduction of total travel time by introducing high speed service • Includes the improvement of reducing the average number of bus transfers

Source	Annual Ridership	Comments
		• Assumes the same fare policy currently used in the corridor (no price increase)

Figure 17-6: Summary of ridership value sources

As highlighted in the Executive Summary to this financial study, a principal assumption is that HSR is made an integral part of the San Joaquins and ACE corridor service (and therewith an enhancement to the travel option currently available in the San Joaquins and ACE corridor). The California State Ridership model is the only source that is able to reflect this assumption. From the alternatives available to date it is, therefore, considered the source with the best estimate for use as assumption in this study and the values from the (adapted) California State Ridership forecast model are adopted as the basis for this study, namely: annual ridership of 1,671,000 passengers on HSR Merced to Bakersfield only.

Note: During recent years, the State model has been used to represent and estimate the Central valley corridor passengers' behaviors and numbers with respect to the San Joaquin and ACE regional services. As such it was not specifically developed for the HSR service. This model should, therefore, be considered as a reference, with the understanding that its values result from an adaptation specifically done for the purpose of this study.

18 PenC Ridership and Fare Revenue

18.1 Ridership Methodology

The State Rail Plan Ridership Model was calibrated for purposes of the PenC study as well as the data assumptions regarding the supply of rail services for the proposed HSR service in the PenC. The process included a transformation of the data to a 2028 time horizon to reflect the proposed opening year of the initial service. The estimates were scaled to reflect differences between the raw model output and observed ridership counts for a 2017 / 2018 base year situation for Caltrain service.

The following model scenario outputs were provided below in order to allow for an incremental calculation of the impacts due to the various changes to the schedules:

1. 2017 / 2018 Base Year, with 2018 Existing Caltrain Schedule (No-Build). The model is based on 2017 ridership data for model calibration and incremental application of model output, 2018 fares, 2018 schedules;
2. 2028 No-Build, with 2018 Existing Caltrain Schedule;
3. 2028 Electrification, with 2020 Caltrain Electrification Schedule (BASE Scenario 6 + 2 Caltrain Trains Per hour per direction peak);
4. 2028 HSR, with 2020 Caltrain Electrification Schedule + 2028 HSR Service Schedule (separate station-to-station matrices for Caltrain and HSR service); 2 HSR trains are added per hour per direction peak for a total of 6 + 2 + 2

The difference in the ridership values between 3 and 4 represents the impact of starting HSR Early operations and are the values that can be attributed to HSR.

The following schedules were used as inputs:

- 2018 Existing Caltrain Schedule (No-Build);
- 2020 Caltrain Electrification Schedule;
- 2028 HSR Service Schedule provided by the ETO.

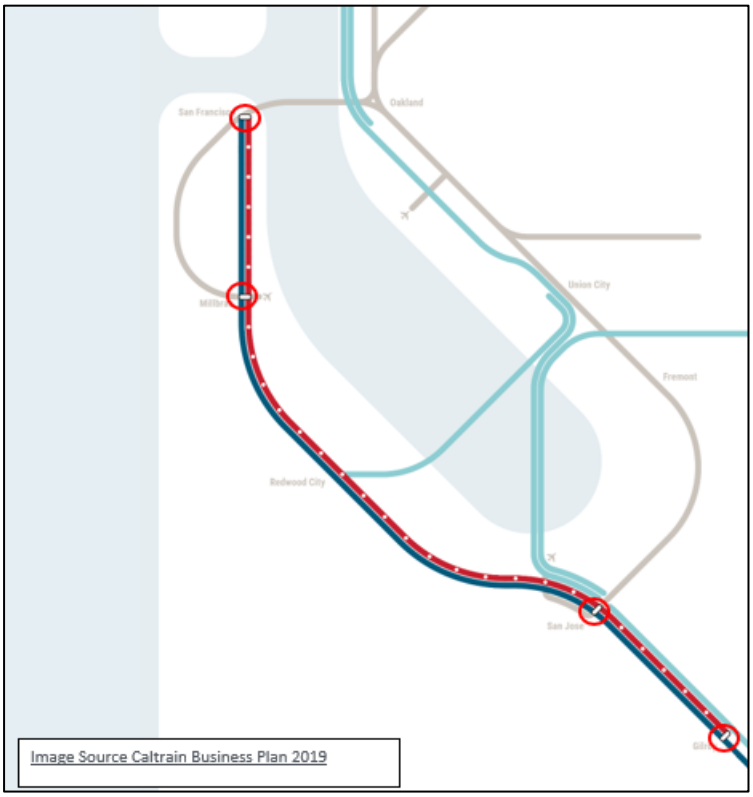


Figure 18-1: Blended Service Caltrain + HSR Servicing 4 stations

18.2 Assumptions

HSR travel time reduction and increased service frequency are only reflected in the impedance matrices for the HSR scenario. No further improvements to the level of service in the PenC are assumed including any changes to the highway impedances.

A general transfer wait time was assumed to be half of the combined headways and the resulting wait times range from about 5 to 7 minutes in San Jose, Millbrae, and San Francisco 4th & King and about 15 minutes in Gilroy.

Caltrain fares are assumed to remain constant as compared to the 2018/2019 fare schedule. The model uses an average fare that is calculated from the various fare card prices and the percentages from the user survey.

HSR fares are calculated based on the 2018/2019 Caltrain fare schedule with the following surcharges:

- PenC Coach class fares shall be calculated at Caltrain fare plus a premium of 10%;
- Business/First class fares shall be calculated at the PenC coach class fare plus a premium of 75%; and
- Assumed an 80% /20% split of coach versus business users. Weighted surcharge is therefore 23% on top of Caltrain cash fare.

18.3 Ridership and Fare Revenue

For the PenC study, the annual ridership of 1,731,000 passengers on HSR from San Francisco 4th & King to Gilroy was used, with corresponding fare revenue of USD 22.9 million (highlighted below)

See below for ridership and revenue estimates. Dollars shown are in 2018 dollars.

Scenario	Service	Annual Ridership	Annual Revenue (in USD)	Increment
2017 No Build	Caltrain	19,333,000	96.2 mln	
2028 No Build	Caltrain	23,410,000	119.6 mln	+ 21% rid . / + 24% rev
2028 Electrification	Caltrain	27,568,000	142.9 mln	+ 18% rid . / + 19% rev
2028 Electrification + HSR	Caltrain	27,348,000	140.9 mln	+ 6% rid . / + 16% rev
	HSR	1,731,000	22.9 mln	
	Caltrain + HSR	29,079,000	163.9 mln	

Figure 18-2: Summary table of ridership and revenues

Figure 18-3: Summary of ridership and revenues

- The results above show that overlaying early HSR operations in the Peninsula corridor servicing only 4 HSR stations (difference between the 2028 Electrification Scenario and the 2028 Electrification + HSR Scenario) will result in an incremental increase of only approximately 6% in ridership (these 4 stations represent less than 12% of the total number of passengers traveling in the Peninsula Corridor);
- Most of the improvements are already captured by the 2028 Electrification Scenario by Caltrain (without HSR);
- The proposed HSR service without the connection to the Central Valley will compete with a well- established commuter rail corridor and except for the Gilroy to San Jose segment, adds incremental service to existing service (Caltrain baby bullet service). Therefore, the capture rate of these markets is limited.

Note: The results from this model should be considered as a reference, with the understanding that its values result from an adaptation specifically done for the purpose of this study.

19 Ancillary Revenues

19.1 Introduction

Potential sources of ancillary revenue have been analyzed. This analysis is highly preliminary, because of a number of factors, including:

5. The available data to conduct the analysis of ancillary revenue opportunities is based on reports prepared by the CHSRA and its sub-consultants for the 2018 Business Plan[12].
6. Although these reports were prepared recently and involved an in-depth examination of ancillary revenue opportunities, they were focused on a larger initial project configuration, specifically the V2V (San José to Bakersfield) and Phase 1 scenario.
7. The focused nature and timeframe of the CVC and PenC analysis did not allow for performance of any independent research and due diligence. As such, certain professional assumptions have been made that, while considered reasonable, must be verified with further data. The ETO has provided some guidance in relation to adapting this prior work to the current CVC and PenC incremental study.
8. The preliminary CVC station designs are categorized as “platforms and canopies”, which therefore, limits the opportunity for stations as a destination revenue source. Parking is limited and assumed to be free, so is therefore, not considered a revenue source.

Accordingly, while early operations on the CVC and PenC corridor is expected to generate some ancillary revenue, the level is still uncertain.

[12] Referenced reports include: (i) Final 2018 Business Plan Ancillary Revenue Technical Documentation, June 1, 2018; (ii) Ancillary Revenue Report, December 22, 2017; and California High-Speed Rail, Preliminary Estimates for Ancillary Revenue Contributions, 2018 Business Plan, January 25, 2018.

19.2 CVC Ancillary Revenues

19.2.1 Categories

The ancillary revenue opportunities examined for the CVC projections were limited to the thirteen ancillary revenue categories down-selected by the CHSRA for inclusion in the Final 2018 Business Plan, as follows:

- Advertising: billboard;
- Advertising: rolling stock and station-level;
- Baggage and associated fees;
- Excess land;
- Parking fees;
- Station-level retail;
- Sponsorship: branding exclusivity;
- Sponsorship: station naming;
- Sponsorship: system naming;
- Telecommunications: longitudinal fiber;
- Telecommunications: towers;
- Web-based advertising;
- Ground leases.

19.2.2 Base Metric Drivers

As in the 2018 Business Plan, the ancillary revenue estimates were prepared using a relevant base metric driver for each ancillary revenue category. These drivers generally relate to a major system feature, as shown in Figure 19-1.

Base metric driver	Applicable ancillary revenue type(s)
Ridership	▪ Advertising (rolling stock and station-level) ▪ Baggage and associated fees
Number of stations	▪ Advertising (billboards) ▪ Sponsorship (station naming) ▪ Telecommunications (towers)

Base metric driver	Applicable ancillary revenue type(s)
	▪ Web-based advertising
Right-of-way miles	▪ Telecommunications (longitudinal fiber)
Parking spaces	▪ Parking fees
Retail space square footage	▪ Retail (station level)
Other (generally fixed per annum dollar amounts profiled over a defined timeframe)	▪ Excess Land (fee simple interest) ▪ Sponsorship (branding exclusivity) ▪ Sponsorship (system naming) ▪ Ground leases

Figure 19-1: Basic metric drivers

The levels assumed for the base metric drivers in the CVC analysis are:

- **Ridership:** The annual ridership figure for the initial year of operations is forecast at 1,671,000 passengers;
- **Number of stations:** Five stations are included: Merced, Madera, Fresno, Kings / Tulare, and Bakersfield. These stations simply consist of platforms and canopies, with pedestrian overpasses, two escalators, and two sets of stairs on each side. They do not include actual buildings at this stage of the project;
- **Right-of-way miles:** A total of 175 ROW miles are assumed to be acquired;
- **Parking spaces:** A total of 900 parking spaces are assumed, split evenly among the five stations;
- **Retail space square footage:** A total of 5,000 square feet of retail space is assumed, split evenly among the five stations. Based on 1,000 square feet per station, this translates into one or two retail facilities per station, such as a coffee shop or a drycleaner. For actual build out, larger stations, such as Fresno, may have larger or more retail activity, smaller stations, such as Madera, may have less.

19.2.3 Timing Parameters

Key timing assumptions for ancillary revenues in the CVC analysis include:

- ROW acquired – 2022
- Real property acquired – 2023
- Operations commencement – January 1, 2026.

As in the 2018 Business Plan, each of the ancillary revenues is profiled to commence (and, in some instances, to occur entirely) during one of three phases in time.

Timing Phase	Applicable Ancillary Revenue Type(s)	Date Range
Pre-operations	▪ Excess land (fee simple interest) ▪ Telecommunications (towers) ▪ Telecommunications (longitudinal fiber)	▪ 2019 to 2023 ▪ 2023 onward ▪ 2022 onward
Mature operations (from the fifth anniversary of operations)	▪ Ground leases	▪ 2031 onward
Operations	▪ The nine remaining ancillary revenue types (See 19.2.1)	▪ January 1, 2026 onward

Figure 19-2: Timing phase, applicable ancillary revenue type(s) and date range

It should be noted that the ancillary revenue cash flow projections for the CVC analysis focus on the first four years of operations, from 1 January, 2026 to 31 December, 2029. As such, ancillary revenues arising during the pre-operations phase have not been considered. Moreover, since certain categories of ancillary revenue arise entirely outside this four-year timeframe (i.e. those from excess land and ground leases), they are not reflected in the projections.

19.2.4 Net Revenue Unit Multipliers

19.2.4.1 Background

In the detailed analysis supporting the 2018 Business Plan, the ETO prepared low, medium, and high benchmark multipliers for each of the ancillary revenue opportunities[13]. These benchmark multipliers were then applied to the relevant base metric driver for each ancillary revenue type, producing low, medium, and high ancillary revenue cases. The medium ancillary revenue case then formed the basis for forecasting ancillary revenues within the 2018 Business Plan. All such ancillary revenues calculations were made on a net revenue basis (i.e. taking into account the operating costs of their pursuit).

19.2.4.2 Unit Multipliers For Ancillary Revenues In The CVC Analysis

The CHSRA's prior ancillary revenue reports were reviewed and discussed with CHSRA team of consultants. Based on this information, the following unit multipliers were applied to generate a "medium" ancillary revenue case for the CVC projections. As was previously the case, these multipliers are for the calculation of ancillary revenues on a net revenue basis. All figures are in USD 2017, unless otherwise stated.

In general, these assumptions reflect the view that ancillary revenues will be lower than those projected for V2V and Phase 1 in the 2018 Business Plan because of:

- Limited service in terms of capacity and frequency;
- The service only serves smaller markets in the Central Valley and does not connect to major population areas in the Bay Area or Los Angeles;
- The median household income in Central Valley counties is materially lower than those in the Bay Area and Los Angeles.

[13] A summary of these ancillary revenue multiplier estimates (low, medium, and high) and key benchmarking assumptions supporting them are set out on page 11 of the report entitled "California High-Speed Rail, Preliminary Estimates for Ancillary Revenue Contributions, 2018 Business Plan", dated 25 January 2018

Ancillary Revenue Category	Medium Multiplier Estimate for CVC in USD	Discussion / Rationale	Prior Low / Medium / High levels in 2018 Business Plan in USD[2]
Advertising: billboard	50,000 per station	Equals prior low estimate. CVC is primarily rural. No network effects.	50,000 / 75,000 / 100,000
Advertising: rolling stock and station-level	0.05 per passenger	Equals prior low estimate. CVC is primarily rural. More basic station design. Less dwell time.	0.05 / 0.075 / 0.10
Baggage and associated fees	NIL per passenger	Assumption for study purposes: No baggage fees.	0 / 1.25 / 2.50
Excess land	N/A	The opportunity is expected to arise prior to the four-year modeling timeframe for CVC.	6,000,000 / 8,000,000 / 12,000,000 per annum for five years (commencing immediately)
Parking fees	NIL per annum, per parking space	Assumption for study purposes: No parking fees.	750 / 1,125 / 1,500
Station-level retail	8.00 per square foot	Equals prior low estimate. Significantly reduced station sizes; more basic space types.	8.00 / 10.40 / 12.40
Sponsorship: branding exclusivity	50,000 per annum	Equals 50% of prior medium estimate. CVC is primarily rural. Lower CVC median household income.	0 / 100,000 / 200,000
Sponsorship: station naming	25,000 per station	Equals 50% of prior medium estimate. CVC is primarily rural. Lower CVC median household income.	0 / 50,000 / 100,000
Sponsorship: system naming	1,000,000 per year	Equals 50% of prior medium estimate. CVC is primarily rural.	0 / 2,000,000 / 4,000,000
Telecommunications: longitudinal fiber	10,000 per ROW mile	Equals prior low estimate. (note: may require legal action, as	10,000 / 25,000 / 40,000

Ancillary Revenue Category	Medium Multiplier Estimate for CVC in USD	Discussion / Rationale	Prior Low / Medium / High levels in 2018 Business Plan in USD[2]
		discussed in the 2018 Business Plan)	
Telecommunications: towers	2,000k per station	Equals prior low estimate	20,000 / 25,000 / 30,000
Web-based advertising	20,000 per station	Equals prior low estimate. CVC is primarily rural. Lower CVC median household income.	20,000 / 40,000 / 60,000
Ground leases	N/A	The opportunity is expected to arise beyond the four-year modeling timeframe for CVC.	1,750,000 / 3,500,000 / 7,000,000 per annum

Figure 19-3: Ancillary revenue category

The ancillary revenues estimated for CVC (Merced-Bakersfield) beginning in 2026 is approximately USD 3.7 million per year to 2029.

19.2.5 Low Carbon Fuel Standard Credits

The TOC may be eligible to generate LCFS[14] (Low Carbon Fuel Standard) credits worth between USD 3.2 million and USD 19.2 million starting in 2026 for the CVC. "Credits" and "Deficits" mean the units of measures used for determining a regulated party's entity's compliance with the average carbon intensity requirements in section 95484. Credits and deficits are denominated in units of metric tons of carbon dioxide equivalent (CO2e) and are calculated pursuant to sections 95486(b)95486.1(a), (c), 95486.2(a)(5) and (b)(5), 95489 and 95490.[15]" For this study, USD 3.2 million worth of LCFS credits has been assumed.

In October 2018, the ARB (California Air Resources Board) approved a rule change for the LCFS program extending to 2030. This provides a solid indication that the market for these credits is strong

[14] The purpose of this regulation is to implement a low carbon fuel standard, which will reduce the full fuel-cycle, carbon intensity of the transportation fuel pool used in California, pursuant to the California Global Warming Solutions Act of 2006 (Health & Safety Code [H&S], section 38500 et seq

[15] https://www.arb.ca.gov/regact/2018/lcfs18/fro.pdf.

and for purposes of this study has been included. Final rules are expected to be in effect on 1 January 2019.

The estimate of credits is based on the following current regulations and LCFS formula:

HSR would generate credits under Fixed-Guideway regulations, using electricity as the fuel pathway (either grid average carbon-intensity, "CI", or clean zero-CI sources).

The formula for generating credits from kWh used for heavy rail propulsion is presented in the text box[16].

Credits = [Diesel CI – (Electricity CI / EER)] * EER * Energy Density / 1,000,000 * kWh

Energy usage: 75,300,000 kWh
LCFS Credits: 106,466
LCFS Credit Price Range: USD 30/credit – USD 180/credit
LCFS Credit Revenue Range: USD 3.2 million – USD 19.2 million

19.3 PenC Ancillary Revenues

19.3.1 Categories

Potential sources of ancillary revenue ("AR") for PenC (San Francisco at 4th & King to Gilroy) have been analyzed. This analysis assumes that the CVC is operational from January 1, 2026, and that the PenC then commences operations two years afterward, at January 1, 2028.

[16] Formula Sources (https://www.arb.ca.gov/regact/2018/lcfs18/fro.pdf):

CI of Diesel in 2026 (85.38 gCO2e/MJ; Table 2)

CI of Diesel in 2028 (82.87 gCO2e/MJ; Table 2)

Energy Density of Electricity (3.6 MJ/kWh; Table 4)

CI of Grid Average Electricity in all years (93.75 gCO2e/MJ; Table 7-1)

CI of Zero-Carbon Electricity (0.0 gCO2e/MJ; Table 7-1)

Energy Economy Ratio of Electricity relative to Diesel (4.6 [dimensionless]; Table 5

LCFS Price Sources:

- https://www.neste.com/corporate-info/investors/market-data/lcfs-credit-price
- https://www.arb.ca.gov/fuels/lcfs/credit/lrtmonthlycreditreports.htm

The ancillary revenue opportunities examined for the PenC projections were limited to the 13 ancillary revenue categories down-selected by the Authority for inclusion in the Final 2018 Business Plan, as with the CVC corridor ancillary revenues analysis.

It should be noted that HSR will be a tenant at most of the PenC stations. Consistent with the approach taken in 2018 Business Plan, it is assumed that incorporating the HSR service will expand the total net ancillary revenues that can be derived from additional passenger volumes at such stations. Accordingly, it is assumed that HSR will be in a position to negotiate and secure a portion of these incremental ancillary revenues. Examples include ancillary revenues for parking, retail and various forms of advertising.

19.3.2 Base Metric Drivers

For PenC the ETO looked at the same set of drivers of ancillary revenues (see 19.2.2). The levels assumed for the base metric drivers in the PenC analysis of ancillary revenues are as follows:

- **Ridership:** The annual ridership figure for the initial year of operations is forecast at 1,731,000 passengers.
- **Number of stations:** Four stations are included – San Francisco 4th & King, Millbrae, San Jose Diridon and Gilroy.
- **Parking spaces:** A total of 2,579 parking spaces are ass**u**med, reflecting inputs from CHSRA, split as follows: San Francisco 4th & King (0), Millbrae (771), San Jose Diridon (948) and Gilroy (860).
- **Retail space square footage:** A total of 21,793 square feet of retail space is assumed, split as follows: San Francisco 4th & King (0), Millbrae (0), San Jose Diridon (13,202) and Gilroy (8,773). As in the prior analyses, these figures include a gross-up for back-of-house and mechanical space.

19.3.3 Timing Parameters

Key timing assumptions for ancillary revenues in the PenC analysis include:

- ROW acquired – 2022;

- Real property acquired – 2023;
- PenC Operations commencement – January 1, 2028.

As in the 2018 Business Plan, each of the ancillary revenues are profiled to commence (and, in some instances, to occur entirely) during one of three phases in time.

Timing Phase	Applicable Ancillary Revenue Type(s)	Date Range
Pre-operations	- Excess Land (Fee Simple Interest) - Telecommunications (Towers) - Telecommunications (Longitudinal Fiber)	- 2019 to 2023 - 2023 onward - 2022 onward
Mature operations (from the 5th anniversary of operations)	- Ground Leases	- 2033 onward
Operations	- The 9 remaining ancillary revenue types (See 19.2.1)	- January 1, 2028 onward

Figure 19-4: Timing phase, applicable ancillary revenue type(s) and date range

It should be noted that the incremental ancillary revenue cash flow projections for the PenC Scenario 1 analysis are focused on the first two years of operations, from January 1, 2028 to December 31, 2029. As such, ancillary revenues arising during the pre-operations phase have not been considered. Moreover, as certain categories of ancillary revenue arise entirely outside this two-year timeframe (i.e. those from Excess Land and Ground Leases), they are not reflected in the projections.

19.3.4 Net Revenue Unit Multipliers

In the detailed analysis supporting the 2018 Business Plan, the Authority and its sub-consultants prepared low, medium and high benchmark multipliers for each of the ancillary revenue opportunities[17]. These benchmark multipliers were then applied to the relevant base metric driver for each ancillary revenue type – producing low, medium and high ancillary revenue cases. The medium ancillary revenue case then formed the basis for forecasting ancillary revenues within the 2018

[17] A summary of these ancillary revenue multiplier estimates (low, medium and high) and key benchmarking assumptions supporting them are set out on page 11 of the report entitled "California High-Speed Rail, Preliminary Estimates for Ancillary Revenue Contributions, 2018 Business Plan", dated January 25, 2018.

Business Plan. All such ancillary revenues calculations were made on a net revenue basis (i.e. taking into account the operating costs of their pursuit).

The Authority's prior ancillary revenue reports were reviewed and discussed. Based on this information, the following unit multipliers were applied in generating a "medium" incremental ancillary revenue case for the PenC projections. As was previously the case, these multipliers are for the calculation of ancillary revenues on a net revenue basis. All figures are in 2017 dollars, unless otherwise stated.

In general, these assumptions reflect the view that ancillary revenues will be lower than those projected for V2Ve and Phase 1 in the 2018 Business Plan because of:

1) Limited service in terms of capacity and frequency,
2) Lack of a through service between the initial CVC and the PenC operating segments – and no connection to the Los Angeles metro area.

Ancillary Revenue Category	Medium Multiplier Estimate for PenC	Discussion / Rationale	Prior Low / Medium / High levels in 2018 Business Plan in USD[2]
Advertising: Billboard	USD 75k per station	Equals prior medium estimate. Representative mix of stations	50k / 75k / 100k
Advertising: Rolling Stock & Station-level	USD 0.075 per passenger	Equals prior medium estimate	0.05 / 0.075 / 0.10
Baggage and Associated Fees	NIL per passenger	Assumption for study purposes: No baggage fees	0 / 1.25 / 2.50
Excess Land	N/A	The opportunity is assessed to arise prior to the 2 year modeling timeframe for PenC. Also, there would be no incremental change over CVC-only case.	6 million / 8 million / 12 million per annum for five years (commencing immediately)
Parking Fees	USD 1,125 per annum, per parking space	Equals prior medium estimate	750 / 1,125 / 1,500
Retail: Station Level	USD 10.40 per square foot	Equals prior medium estimate	8.00 / 10.40 / 12.40

Ancillary Revenue Category	Medium Multiplier Estimate for PenC	Discussion / Rationale	Prior Low / Medium / High levels in 2018 Business Plan in USD[2]
Sponsorship: Branding Exclusivity	USD 25k per annum, incremental from PenC	Total of USD 75k per annum. Equals average of the assumption in the CVC analysis (USD 50k.p.a.) and the prior medium estimate. Increment to CVC-only case is USD 25k per annum	0 / 100k / 200k
Sponsorship: Station Naming	USD 50k per station	Equals prior medium estimate	0 / 50k / 100k
Sponsorship: System Naming	USD 500k per annum, incremental from PenC	Total of USD 1.5 million per annum. Equals average of the assumption in the CVC analysis (USD 1 million p.a.) and the prior medium estimate. Increment to CVC-only cases is USD 500k per annum.	0 / 2 million / 4 million
Telecommunications: Longitudinal Fiber	USD 25k per ROW mile	Equals prior medium estimate. (note: may require legal action, as discussed in the 2018 Business Plan)	10k / 25k / 40k
Telecommunications: Towers	USD 25k per station	Equals prior medium estimate	20k / 25k / 30k
Web-based Advertising	USD 40k per station	Equals prior medium estimate	20k / 40k / 60k
Ground Leases	N/A	The opportunity is assessed to arise beyond the 2 year modeling timeframe for PenC.	1.75 million / 3.5 million / 7 million per annum

Figure 19-5: PenC Ancillary revenue category

The incremental ancillary revenues estimated for PenC beginning in 2028 is approximately USD 6.7 million per year to 2029.

19.3.5 Low Carbon Fuel Standard Credits

Similar as for the CVC corridor (reference paragraph 19.2.5), potential revenues from low carbon credits from HSR operations on the PenC corridor are estimated to be USD 1.5 million per year.

Credits = [Diesel CI – (Electricity CI / EER)] * EER * Energy Density / 1,000,000 * kWh

Energy usage: 37,600,000 kWh
LCFS Credits: 51,600
LCFS Credit Price Range: USD 30/credit – USD 180/credit
LCFS Credit Revenue Range: USD 1.5 million – USD 9.3 million

19.3.6 PenC Ancillary Revenues Projection

Under the assumptions set out in section above, the projected “medium” case incremental ancillary revenues for CVC and PenC in USD 2018 are as follows.

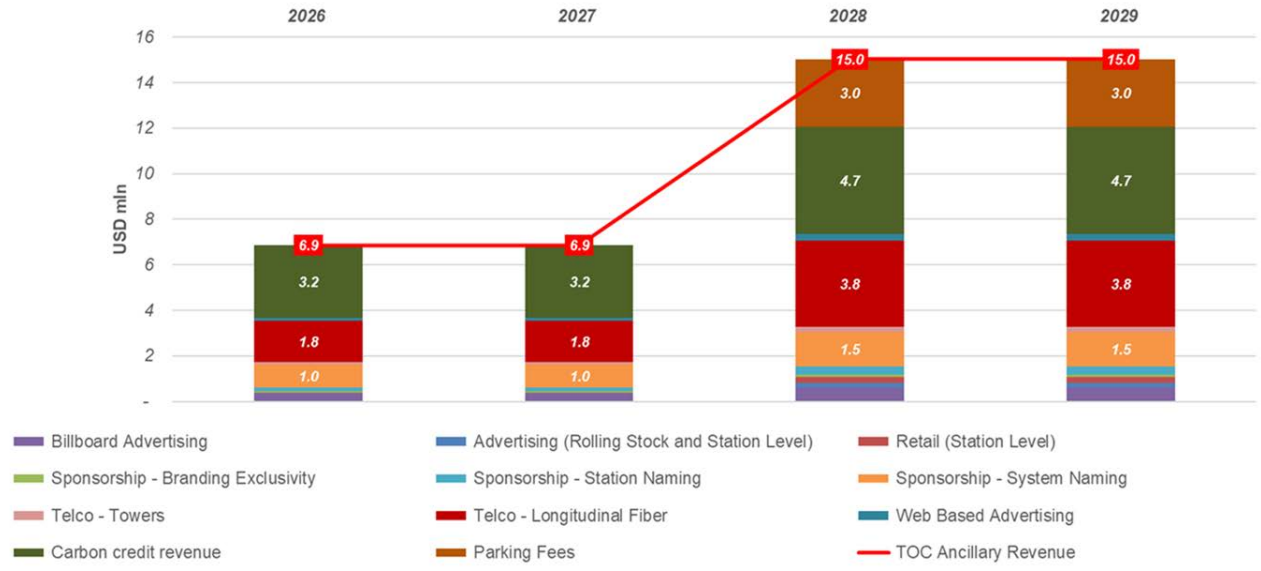


Figure 19-6: Ancillary revenues for CVC and incremental for PenC

20 O&M Projected Financial Balance

20.1 TOC Overall Cost Structure

The resulting overall cost structure of TOC operations for the full period from 2026 until 2029 is shown in Figure 20-1 and reflects CVC O&M costs and PenC incremental O&M costs.

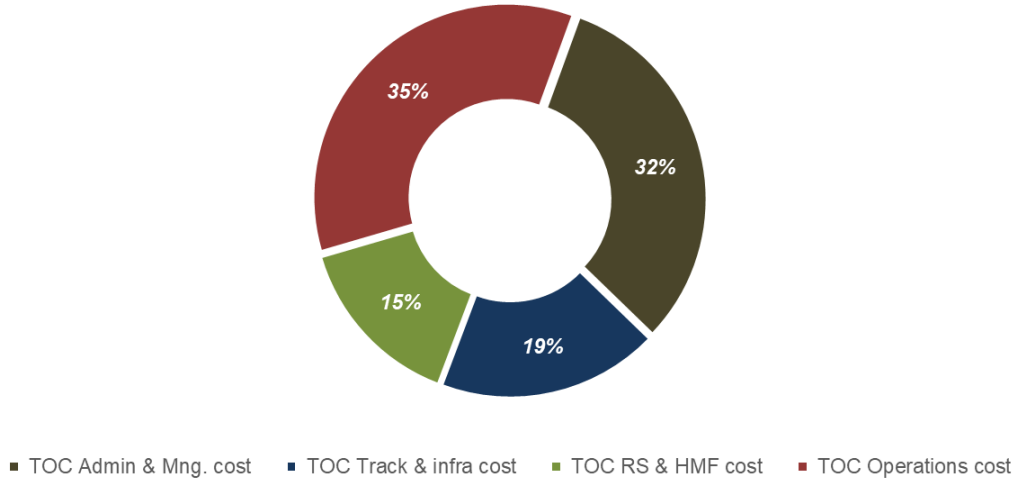


Figure 20-1: Cost structure TOC

21 Conclusions

Assumptions and Methodology

This document is strictly for deliberative purposes. It should be noted that this is the first time since the Business Plan 2018 that a study is undertaken with some level of detail in understanding the benefits that early HSR operations will create. Therefore, the ETO completed an analysis in a stepped approach specifically evaluating the following:

Step 1: Analysis of ridership and revenues on HSR operations between Merced – Bakersfield using the existing San Joaquins fare structure, in order to understand how much ridership can be gained and how much service to provide to carry that ridership. Accordingly, the associated operations and maintenance (O&M) costs are also calculated for this segment including costs for a Train Operating Company (TOC). Additionally, analysis of ridership and revenues (using existing Caltrain fare schedule) on HSR operations between 4th & King and Gilroy was conducted with the associated O&M costs in an incremental view to operations on the Central Valley Corridor. This step did not involve running multiple fare levels or any attempt to maximize revenue, as that effort is intended to be part of the optimization efforts in the future.

Step 2: After understanding the ridership and revenues impact in Step 1, the ETO analyzed the HSR operations across the San Joaquins and ACE corridors and the impact on revenue, ridership and cost from a total integrated corridor view. The purpose is to provide an understanding and identify the benefits that HSR operations will bring, in terms of train miles offered, quality of service, efficiency in cost per train mile and improvement in costs covered by fare revenues. The associated O&M costs include the HSR costs calculated in Step 1, in addition to the San Joaquins and ACE O&M costs, including thruway bus. Revenues are evaluated in total since revenue sharing agreements have not yet been established among the operators. Those revenue sharing arrangements will presumably take into account the costs each incur in order to provide service.

Step 3: There will be further optimizations, which include but are not limited to the following:

- Perform an integrated service planning including San Joaquins, ACE and HSR corridors to optimize the connections and maximize the service offerings to the passengers traveling between Sacramento, Oakland and San Jose in the Bay area;

- Design a highly synchronized integrated service timetable for a seamless journey;
- Optimization and integration of ticketing and fare policy in the combined corridor;
- Establish the priorities, required improvements, additional infrastructure, budget and commitments required north of Merced including CalSTA, ACE and San Joaquins;
- Optimization of the required track and systems infrastructure;
- Evaluate further opportunities to optimize bus connections;
- Definition of the required fleet in the integrated corridor;
- Update the service concept;
- Update the ridership and revenue forecasts based on the revised inputs from the operations planning process; and
- The updated ridership forecast and the definitions in the operations planning step will then be used to optimize the required rolling stock fleet and train layout specifications and stations requirements.

The optimization and refinement process in Step 3 are expected to begin in the coming months and are, therefore, not covered in this study.

The study is neither a proposal nor an offer to perform such services and has been carried out from a pure operations and maintenance (O&M) perspective, without regard for the implications related to:

- Infrastructure capital costs, completion dates,[18] etc.;
- Compliance with the CHSRA business plan;
- Compliance with Prop1A;
- Commercial arrangements.

[18] At the date of performing this study the master schedule (including the procurement and construction dates) was in the process of being updated by CHSRA. It will be reviewed by the ETO for plausibility once it is available.

Financial projections included in this document are therefore to be seen as high-level and indicative projections of costs and revenues related to operations on the CVC corridor and subsequently related to incremental operations on the PenC corridor (i.e. *additional* to CVC operations).

The information contained in this report and appendix as they relate to O&M costs and revenues were obtained from the following sources, which includes 3rd party information based on their assumptions:

- HSR costs estimates were calculated by the ETO for CVC and PenC incremental; whereas
- ACE and San Joaquins costs were calculated and provided by San Joaquin Regional Rail Commission (SJRRC) staff for CVC, in the total corridor view;
- Ridership and revenue forecasts were generated from the State Rail Plan Model as the basis and calibrated for purposes of this study. Inputs to the ridership model were provided jointly by the ETO, CalSTA and SJRRC staff (for CVC). As a side note, it was identified that the ridership values in the smaller Central Valley HSR section are not adequately represented in any of the ridership models available to the Authority, which were designed to represent valley to valley and Phase 1 service;
- Further, in consultation with CHSRA and CalSTA, it is assumed the HSR infrastructure assets and HSR train service in the CVC are integrated as part of the regional service of ACE and San Joaquin. This assumption implies that all competing trains from the ACE and San Joaquins corridors will stop in the northmost station of the HSR (Merced) and the passengers will be transferred to the high-speed service.

The financial balance reviewed in the study concerns the projected difference between estimated O&M costs and revenues, analyzed on the basis of the following key assumptions:

- This study provides a high-level review of the financial balance related to early HSR services on the CVC corridor for the time period 1 January, 2026 to 31 December, 2029. The PenC corridor financial balance is projected for the time period 1 January, 2028 to 31 December, 2029. This timeframe is solely used for purposes of this study and is under evaluation by the Authority for implementation.
- All dollar amounts in this study are provided and calculated in 2018 USD, unless stated otherwise.

- This study reviews the operations and maintenance costs of operating the HSR service. For purposes of this study, a 10% profit margin and a 10% contingency margin are included into these cost projections.
- It is also assumed that CHSRA incurs all capital expenditures and that all the necessary assets, systems, equipment, infrastructure, facilities, etc. are already in place prior to "day 1" of operations and revenue service.
- It is assumed that the HSR service is provided by a designated TOC. This TOC will have several pre-existing maintenance contractors assigned to it which, for the purpose of this study, are considered to function as internal departments of the TOC. The TOC, for purposes of this study, represents a stand-alone company and costs calculated for TOC overhead can be further optimized depending on future commercial arrangements.
- Only for purposes of this study, the presence of an HMF between Fresno and Kings/Tulare is assumed (without rental/ lease costs or capital cost depreciation, but costs to maintain are included, e.g. janitorial services, etc.). The final location for the HMF is still to be determined by the Authority.
- This study furthermore looks at a 'steady' state projection of costs and revenues, following a presumed ramp-up period. It is assumed that the service ramp-up effects on cost/ efficiency will be covered during the trial operations period.

This study reviews ridership fare revenue on the basis of the following fare assumptions:

- For CVC, the HSR fares are based on current San Joaquin fare structure. For PenC, the HSR fares are calculated based on the 2018/2019 Caltrain fare schedule with the following surcharges:
    - For study purposes PenC Coach class fares shall be calculated at Caltrain fare plus a premium of 10%.
    - Business/First class fares shall be calculated at the PenC coach class fare plus a premium of 75%.
    - Assumed an 80% /20% split of coach versus business users. Weighted surcharge is therefore 23% on top of Caltrain cash fare.

- The fare assumptions should be re-evaluated at a later time for consideration of yield management and premium services to optimize revenues.

The study furthermore reviews and validates revenue estimates for the most plausible ancillary revenue streams resulting from the operation of the HSR service in both corridors.

Central Valley

The financial balance of HSR services in the Central Valley corridor is reviewed in two steps:

- *First*, HSR service from Merced to Bakersfield from a stand-alone financial perspective, considering revenue and costs in this alignment section, which is covered in the main body of the report. The O&M amounts can also be seen in Figure ES3. The build-up of revenues and costs for this stand-alone financial balance of an early Merced-Bakersfield HSR service is as follows (figures below shown in 2026, Year 1).
  - Operating income of USD 37.4 million is composed of USD 6.9 million in ancillary revenue (primarily composed of carbon credits income, fiber cable data capacity and system naming rights) and USD 30.5 million in fare revenue (based on projected annual ridership of 1.7 million passengers and fare levels equal to today's San Joaquin fares);
  - TOC operations cost of USD 24.5 million is predominantly composed of USD 13.9 million in staffing costs (for 105 FTE), USD 9.5 million in electricity costs mostly for traction power, as well as USD 1.0 million for OCC costs;
  - Rolling stock (RS) and Heavy Maintenance Facility (HMF) cost of USD 12.6 million predominantly includes USD 7.8 million in labor costs (for 67 FTE) and USD 2.4 million in Heavy Maintenance Facility (HMF) related costs alongside USD 2.3 million for rolling stock cleaning costs assuming four operational trainsets (on top of which one trainset is for maintenance and one trainset is for operational reserve);
  - Track & Infrastructure cost of USD 19.7 million is composed of USD 1.2 million for civil structures maintenance, USD 2.2 million for facilities maintenance, and USD 16.3 million for track and systems maintenance (USD 1.1 million for non-revenue vehicles, USD 13.1 million for labor costs and USD 2.1 million for materials and utility costs);

- Administration and management cost of USD 30.2 million is composed of USD 0.2 million for fare collection, USD 7.2 million for marketing and branding costs, USD 15.6 million for TOC corporate services and management costs (mostly driven by USD 3.0 million for insurance, USD 1.4 million for training, USD 1.5 million for IT, and USD 9.4 million in labor), USD 3.0 million for environmental/health & safety costs and USD 4.2 million for security.
- Contingency is calculated at 10% for a cost of USD 8.7 million.
- Profit Margin is calculated at 10% for an amount of USD 9.6 million.

- *Second*, HSR service from Merced to Bakersfield, connections from Merced to Sacramento in the North and connections to the Bay Area through Oakland and San Jose, as an integrated financial perspective for HSR, San Joaquins and ACE corridors in 2026 (this is covered in detail in Appendix 1 to the report) to see the wider impact and positive benefits.

The review of the logic, underlying assumptions and projected financial balance in these two steps for operation of early HSR services in the Central Valley Corridor leads to the following *principal conclusions*:

1. Central Valley Early HSR Service Creates Significant Value

- Introduction of an early operations HSR service in the Central Valley will produce significant value and benefits to communities, public transport passengers and operators as well as to the State of California.

  Benefits may include:

  - Optimal use of State assets as dependency on the current private freight railroad infrastructure is reduced. The freight railroad infrastructure currently has limited capacity for additional passenger services;
  - Using dedicated high-speed infrastructure allows for higher frequencies of public transport services to be offered;
  - Achievement of higher frequencies in turn helps to improve critical connectivity available to local communities and allows the HSR operator to test and adjust the optimal rail service offered to the communities, while at the same time allowing for familiarization by and instruction to local communities;

- It will also contribute to economic development and ease of access to economic opportunities throughout the Central Valley;

  Similar to Germany, California has thriving urban areas as well as communities that have less access to opportunities. It is worth noting an actual reference case out of many others, where the impact of integrating the communities with less opportunities with high-speed rail network can have a truly substantial impact. Montabaur was a disadvantaged community in Germany back in 1999. During this time, there was a 13.8 million Euros CAPEX made as an investment for a 3 platform high-speed rail station. The total construction costs (including new parking slots, industrial area and Highway connection to the City) were 23.6 million Euros. Since the construction and final operation in August 2002 this connectivity opportunity attracted 205 million Euros investment by private entities in the community. A 3.2 million sq. ft big new neighborhood of the city of Montabaur developed between the city and new High-Speed Rail station. The result of this is a creation of 2,200 new permanent jobs, 80 new companies on site in Montabaur and over 2,500 passengers per day riding high speed rail. The passenger number increased since the opening in 2002 by over +130%. Now Montabaur is a thriving community. According to DB's experience, DB is confident that similar positive impacts will happen to the communities in the Central Valley from the introduction of high- speed services creating positive long term and permanent changes.

- Furthermore, HSR service introduction lowers the cost per train mile and reduces CO2 emissions from public transportation across the wider Central Valley corridor;
- Introduction of HSR service also results in shorter travel times for the passengers, enhancing the attractiveness of public transport and resulting in higher ridership as well as in a higher percentage of operations and maintenance costs recovered from fare collection across the wider the corridor;
- Finally, early HSR operations in the Central Valley may reduce the ramp-up time of Valley to Valley (V2V) HSR services once the required infrastructure has been completed.

Description	Quantitative view on benefits		Qualitative view on benefits
	With HSR (ACE, San Joaquins, HSR)	***Without HSR (ACE and San Joaquins)***	***Impact***
Train Miles Offered	1,932,225	990,838	More than double the service offer to the community, with more train frequencies
Description	**Quantitative view on benefits**		**Qualitative view on benefits**
	With HSR (ACE, San Joaquins, HSR)	***Without HSR (ACE and San Joaquins)***	***Impact***
Travel time in the corridor	Reduction of more than 90 min in the overall travel time		Better quality of service for the passengers
Average Cost per Train Mile	USD 110.61	USD 118.04	More efficient cost per mile
Percentage of costs covered by Fare (includes thruway bus)	73%	41%	32% improvement in cost recovery

Figure ES2: Benefits of HSR to Central Valley public transportation

2. Early HSR Service May Improve the Financial Balance of the Total Combined Regional Corridor

- The study shows in the second step that integrating the early HSR service into the regional corridor may improve San Joaquins and ACE's combined existing farebox recovery ratio. It is best practice in railway financial planning to measure the impacts to the total combined regional corridor (instead of one part of the alignment). The details are highlighted as follows:

- HSR early services analysis of the total corridor, including San Joaquins, ACE and HSR shows the value of HSR services from the passengers' travel perspective and financial point of view. Based on the assumption that the TOC can provide HSR train services as a service provider to the SJJPA, the following advantages can be noted:
  - Increase in farebox recovery ratio for the combined corridor up to an estimated 73%;
  - While in parallel, enhancing the train service offered in the total Central Valley Corridor (doubling of train miles).

Therefore, with a view to the preparation of early HSR train operations in the Central Valley, it is recommended to undertake a more detailed study of costs, ridership and revenue potential, as well as commercial/legal structuring for a Merced to Bakersfield HSR service that is integrated into the wider travel chain of the combined San Joaquins, ACE and HSR corridors. Such a follow-up study would also need to explore more carefully technical implications as well as HSR infrastructure CAPEX implications (the current study focuses first and foremost on the financial aspects of operations only).

The following table shows the improvement on the financial balance of the total corridor (ACE, San Joaquin, HSR).

Total 2026 with HSR (in 2018 USD mln) (ACE, San Joaquin, HSR) up to Merced			**Total 2026 without HSR (in 2018 USD mln) (ACE, San Joaquin)**		
Costs	Revenue	Difference	Costs	Revenue	Difference
228.4	165.8	(62.6)	140.3	57.5	(82.8)

Figure ES3: Corridor-level financial balance with/without HSR

3. Early HSR Services to Bakersfield As The Southernmost Station

- Poplar as the southernmost station of a future HSR service presents additional challenges from the operations perspective:
  - Assuming that the HSR corridor will replace the existing private freight railroad as an integral part of the wider corridor, it is noted that an HSR service that stops in Poplar

will leave Bakersfield without any rail service. Therefore, all passengers at Bakersfield will only have bus connectivity.

- Ridership on a Merced to Poplar HSR service would be significantly below a Merced to Bakersfield operating segment.
- The cost addition related to operating down to Bakersfield instead of Poplar is minimal compared to the loss of ridership resulting from the exclusion of HSR service from Bakersfield.
- From the ridership and the financial balance perspective of public transport operations across the wider corridor, the preferred segment to be further developed, constructed and operated is to Bakersfield.

4. Madera

- The performance of a station is measured by the following two main components:
  - Direct access and direct egress, which reflects the passengers who access the system in this particular station; and
  - Seamless connectivity, which reflects the impact in the passengers who are using the station as a transfer point between connecting services. The behaviour of the passengers, when selecting the mode of transportation is highly sensitive to the transfer times and ease of connections.
- The Merced scenario compared to Madera offers:
  - Better cost efficiency per train mile due to a longer high-speed section;
  - Best option for seamless connectivity. After analyzing the State Rail Plan, Merced offers the best location for an intermodal station between ACE, HSR and San Joaquins;
  - Higher ridership due to Merced's catchment area compared to Madera (direct access / egress); and
  - The main drivers for the increase in Merced ridership compared to the scenario of Madera primarily results from reduced transfer penalties at Merced with the connecting services.

Peninsula

The financial balance of revenues and costs of HSR services in the Peninsula corridor is reviewed for HSR services from San Francisco 4th & King to Gilroy as a service that is operated *incrementally* (additionally) to CVC. The O&M amounts can also be seen in Figure ES3, and for the purposes below a comparison is made between Year 2028 (1st year of PenC assumed operations) and Year 2027 (2nd year of CVC operations) to arrive at the PenC incremental amounts. The build-up of revenues and costs for this incremental PenC service is as follows:

- Operating income of USD 31.4 million is composed of USD 8.2 million in ancillary revenue (primarily composed of carbon credits income, fiber cable data capacity, parking and system naming rights) and USD 22.9 million in fare revenue (based on projected annual ridership of 1.7 million passengers), as well as track access charges paid by Caltrain to HSR in the amount of USD 0.3 million per annum;
- TOC operations cost of USD 33.9 million is predominantly composed of USD 20.2 million in staffing costs (for incremental 168 FTE), USD 4.8 million in electricity costs mostly for traction power, USD 8.8 million in track access charges paid by HSR to Caltrain, and USD 0.1 million in additional costs for vehicles;
- Rolling stock (RS) and Light Maintenance Facility (LMF) cost of USD 9.7 million predominantly includes USD 3.7 million in labor costs (for incremental 31 FTE) and USD 1.1 million in LMF related costs alongside USD 4.8 million for rolling stock cleaning costs assuming six operational trainsets (on top of which one trainset is for maintenance and one trainset is for operational reserve);
- Track & Infrastructure cost of USD 3.0 million is composed of USD 0.1 million for civil structures maintenance, USD 2.7 million for track and systems maintenance (USD 0.4 million for materials, services, utility costs, USD 0.2 million for non-revenue vehicle costs, and USD 2.1 for labor costs), USD 0.2 million for facilities maintenance;
- Administration and management cost of USD 15.5 million is composed of USD 0.1 million for fare collection, USD 5.2 million for marketing and branding costs, USD 1.8 million for environmental/health & safety costs and USD 3.1 million for security, USD 1.0 million for staff training, USD 0.8 million for IT, USD 0.2 million for office supplies

and uniforms / safety gear, USD 1.0 million in insurance costs and TOC management and administration salaries of USD 2.3 million.

- Contingency is calculated at 10% for a cost of USD 6.2 million.
- Profit Margin is calculated at 10% for an amount of USD 6.9 million.

The review of the logic, underlying assumptions and projected incremental financial balance for the PenC scenario leads to the following principal conclusion:

1. Operating an Early HSR Service on the Peninsula Corridor Overlaying the Caltrain Service Does Not Create A Substantial Impact

- The study shows that the operations and maintenance costs significantly exceed the forecasted revenues for this segment, San Francisco 4th & King – Gilroy. The PenC incremental O&M costs is approximately USD 75.2 million (including contingency and profit margin) and the incremental revenues (including ancillary revenues) is approximately USD 31.4 million.
- The study shows that overlaying early HSR operations in the Peninsula corridor servicing only 4 HSR stations (difference between the 2028 Electrification Scenario and the 2028 Electrification + HSR Scenario) will result in an incremental increase of only approximately 6% in ridership.
- Most of the improvements are already captured by the 2028 Electrification Scenario by Caltrain (without HSR).
- HSR service attending only these 4 stations cannot produce a significant impact in the Peninsula corridor before the tunnel section connects the Central Valley (these 4 stations represent less than 12% of the total number of passengers traveling in the Peninsula Corridor).
- The proposed HSR service without the connection to the Central Valley will compete with a well- established commuter rail corridor and except for the Gilroy to San Jose segment, adds incremental service to existing service (Caltrain baby bullet service). Therefore, the capture rate of these markets is limited.

The Figure ES3 below shows the total O&M costs for CVC (Merced – Bakersfield) reflected in 2026 – 2029. The total O&M increase in 2028 is driven by the start of PenC operations and calculated as

incremental costs to CVC. The O&M incremental costs for PenC are reflected in 2028 and 2029 in addition to the CVC O&M costs reflected in those years.

Figure ES4: O&M Costs for CVC and PenC incremental

Appendix 1 Integrated CVC Corridor Analysis

Background

In this appendix, Step 2 (as defined in 1.2.1) is conducted, which analyzes the wider impacts of HSR early operations on public transportation in the Central Valley, across the San Joaquins and ACE corridors.

In this step, there is close consultation with CalSTA, where the wider qualitative and quantitative impacts of starting early services are identified from the perspectives of:

- Passengers and communities in the Central Valley;
- The State of California Public transportation (represented by CalSTA);
- The California High Speed Rail Service; and
- The San Joaquins and ACE Services.

Identification of quantitative impacts involves a 2026 projection of the total costs and revenues of operating public transportation services in the corridors. In doing so, two views are taken:

- A view that does not include an HSR service early operations and its costs and revenues (in which case public transport continues to use the current freight corridors); and
- A view that does include HSR service and its costs and revenues (in which case the HSR section replaces part of the current freight corridors and service thereon).

Key Assumptions

The following assumptions are made to analyze the corridor:

- All assumptions as described in the study report are applicable as it relates to the HSR O&M costs (see Ch3-19);
- Unless indicated otherwise, costs shown are in 2018 USD.

Cost Projection For The Corridor

The 2026 projection of operating and maintenance costs for the ACE and San Joaquins corridors is based on a review of their 2017 actuals. Furthermore:

- In the view without HSR service in 2026, the cost projection is based on enhanced service levels, bus connections and the number of daily trips. This considers the limitations of the freight railroads infrastructure.
- In the view with HSR service in 2026, the number of trips in the San Joaquins and ACE corridors are further increased, taking advantage of the additional capacity of the dedicated high-speed passenger corridor.

The cost projections and their underlying service assumptions are shown in more detail in the Figure below.

Service / Station pairs	Roundtrips		O&M Cost Estimate (2018 USD)		Changes to O&M Costs (TIRCP without HSR vs. with HSR)
	without HSR	with HSR	without HSR	with HSR	
ACE					
Ceres ↔ Natomas	3	5	USD 41.3 million	USD 47.9 million	Additional cost of 2 round trips
Ceres ↔ San Jose	1	1			No change
Stockton ↔ San Jose	2	2			No change
Natomas ↔ San Jose	1	1			No change
Natomas ↔ Stockton	1	1			No change

Service / Station pairs	Roundtrips		O&M Cost Estimate (2018 USD)		Changes to O&M Costs (TIRCP without HSR vs. with HSR)
	without HSR	with HSR	without HSR	with HSR	
Merced ↔ Ceres	1 rail 3 bus	NB:4 1rail,3bus SB:6 1 rail,5 bus			Additional cost of rail or bus between Ceres and Merced, as applicable (based on schedule)
Train Miles	206,453	292,645			
San Joaquins					
Bakersfield ↔ Sacto. Valley	1	0	USD 99.0 million	USD 70.9 million	Reduced cost of 1 round trip
Fresno ↔ Sacto. Valley	1	0			Reduced cost of 1 round trip
Bakersfield ↔ Oakland	3	3			Subtraction of Merced ↔ Bakersfield segments (replaced by HSR)
Fresno ↔ Oakland	1	1			Subtraction of Merced ↔ Fresno segments (replaced by HSR)
Bakersfield ↔ Natomas	1	6			Additional cost of 4 round trips, excluding costs for Merced – Bakersfield/Fresno segment (replaced by HSR)
Fresno ↔ Natomas	1				
Stockton ↔ Oakland	1	1			No change

Service / Station pairs	Roundtrips		O&M Cost Estimate (2018 USD)		Changes to O&M Costs (TIRCP without HSR vs. with HSR)
	without HSR	with HSR	without HSR	with HSR	
Additional Bus Service South of Merced			0	USD 4.1 million	
Train Miles	784,385	489,830			Total daily trains increased but the distance is shorter
HSR					
Merced ↔ Bakersfield	0	19	0	USD 105.3 million	19 HSR roundtrips between Merced and Bakersfield
Train Miles	0	1,149,750			

Figure A1-1: Cost projections and the underlying service assumptions

Ridership And Fare Revenue Projection For The Corridor

Furthermore, a 2026 projection of ridership and revenues on the San Joaquins and ACE corridors, with and without HSR service is provided, which have been derived from the ridership and revenue projections estimated by CalSTA ridership model. These projections include all estimated trips on the San Joaquin, ACE and HSR services as well as connecting Thruway Bus services in Bakersfield.

The Figure below demonstrates the ridership and revenues, as per 2017. According to this estimate, the annual revenue for the combined corridors adds up to USD 45.2 million.

Totals	Daily Ridership	Daily Revenue (in USD)	Annual Ridership	Annual Revenue (in USD)
HSR	-	-	-	-

Totals	Daily Ridership	Daily Revenue (in USD)	Annual Ridership	Annual Revenue (in USD)
San Joaquins	3,407	75,031	1,102,000	24,280,000
ACE	5,918	39,272	1,503,000	9,975,000
Thruway BFD	1,027	10,499	375,000	3,398,000
Other Thruway	-	-	-	7,515,000
Total				**45,168,000**

Figure A1-2: Revenue projections, as per ridership in 2017 (in 2018 USD)

The following Figure shows the 2026 projection of ridership and revenues, including expected growth with and without HSR service.

	Ridership Projections in 2026 Without HSR		Ridership Projections in 2026 With HSR	
Totals	**Annual Ridership**	**Annual Revenue (in USD)**	**Annual Ridership**	**Annual Revenue (in USD)**
HSR	-	-	1,671,000	Revenues in this scenario were evaluated in total since revenue sharing agreements have not yet been established among the operators. Those revenue sharing arrangements would presumably take into account the costs each incur in order to provide service.
San Joaquins	1,689,000	31,708,000	3,327,000	
ACE	2,376,000	12,528,000	4,306,000	
Thruway BFD	324,000	4,271,000	570,000	
Other Thruway	-	8,970,000	-	

	Ridership Projections in 2026 Without HSR		Ridership Projections in 2026 With HSR	
Totals	**Annual Ridership**	**Annual Revenue (in USD)**	**Annual Ridership**	**Annual Revenue (in USD)**
Total		**57,477,000**		**158,918,000**

Figure A1-3: Revenue and ridership projections in 2026, with and without HSR (in 2018 USD)

In Figure A1-3 shown above, annual revenues for the total combined corridor of San Joaquins, ACE and HSR add up to USD 158.9 million per annum.

Note: The above shown values reflect a steady state service (i.e. full potential following a ramp-up period). Figure A1-3:

- *These matrices include all estimated trips on HSR, San Joaquins and ACE services as well as connecting Thruway Bus services in Bakersfield.*
- *Other Thruway Bus ridership is currently not reported and included in rail ridership numbers as linked trips.*
- *Under No Build conditions the annualization factor that is used to expand average weekday demand to annual demand is assumed to be 254 based on actual ridership information. With HSR service in place, an annualization factor of 323.6 for ACE ridership is assumed similar to the observed San Joaquins service is applied. This reflects changes to ridership markets including weekends and non-commute markets with the HSR service in operation.*

The main drivers for the larger 2026 ridership in the scenario *with* HSR service are the following:

- A substantially improved price-quality proposition for travel across the corridor as a result of:
  - A reduction of travel time in the combined corridor due to the introduction of HSR service between Merced and Bakersfield;

- No fare increase; current San Joaquin fare structure is used. This assumption should be re-evaluated at a later time for consideration of yield management and premium services to optimize revenues.

Reduced transfer times and improved ease of transfer due to the introduction of a presumed Merced intermodal station which brings together ACE, San Joaquins and HSR services in almost seamless (cross-platform) transfers.

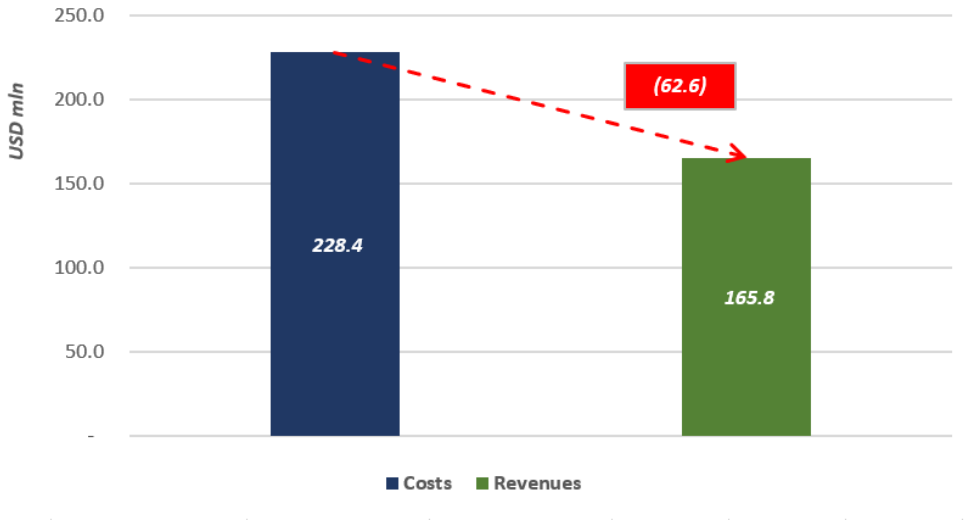
O&M Projected financial balance of the corridor

Total 2026 with HSR (in 2018 USD mln) up to Merced			**Total 2026 without HSR (in 2018 USD mln)**		
Costs	Revenue	Difference	Costs	Revenue	Difference
228.4	165.8[19]	(62.6)	140.3	57.5	(82.8)

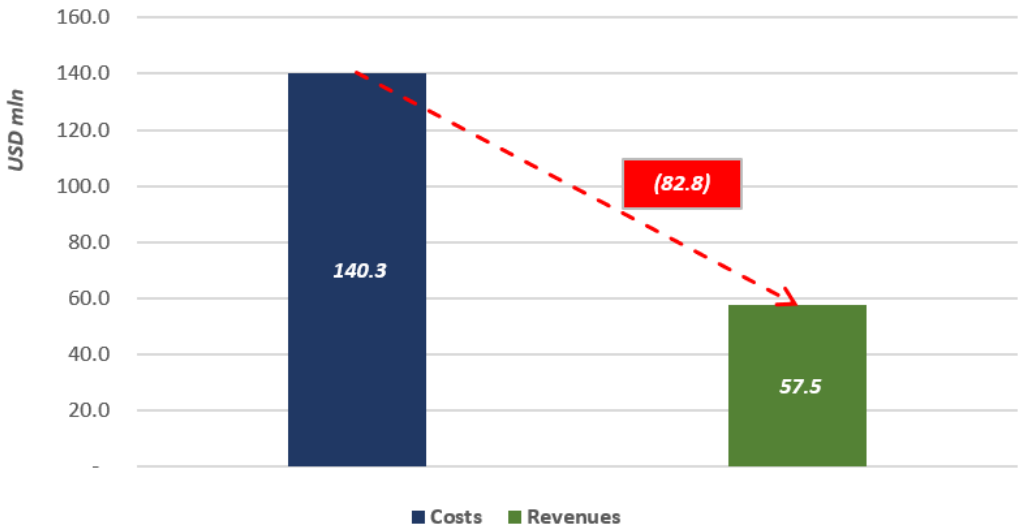
Figure ES2: Corridor-level financial balance with/without HSR

The above is presented in Figure A1-4 below, where the two graphs presents the balance in case of service provision with HSR and without HSR.

[19] This figure includes USD 6.9 million ancillary revenues. Reference Chapter 19, Figure 19-6.



Total 2026 with HSR (in 2018 USD mln) up to Merced



Total 2026 without HSR (in 2018 USD mln)

Figure A1-4: Financial balance of the corridor in 2026

The above graphs in Figure A1-4 demonstrates that the financial scenario is better with HSR than without HSR. Total costs with HSR are 1.6 times higher than without HSR in 2026. However, the revenues with HSR are 2.9 times higher than without HSR, resulting in a smaller difference of USD 62.6 million compared to USD 82.8 million. This means that from the point of view of California's state

budget, introducing early HSR services in Central Valley (Merced-Bakersfield) creates positive benefits shown across the San Joaquins and ACE corridors; twice the level of service is provided to the communities in the integrated corridor.

Step 3 as described in the Executive Summary is expected to begin in the coming months where there will be an optimization and refinement process, which include but are not limited to the following:

- Perform an integrated service planning including San Joaquins, ACE and HSR corridors to optimize the connections and maximize the service offerings to the passengers traveling between Sacramento, Oakland and San Jose in the Bay area;
- Design a highly synchronized integrated service timetable for a seamless journey;
- Optimization and integration of ticketing and fare policy in the combined corridor;
- Establish the priorities, required improvements, additional infrastructure, budget and commitments required north of Merced including CalSTA, ACE and San Joaquins;
- Optimization of the required track and systems infrastructure;
- Evaluate further opportunities to optimize bus connections;
- Definition of the required fleet in the integrated corridor;
- Update the service concept;
- Update the ridership and revenue forecasts based on the revised inputs from the operations planning process; and
- The updated ridership forecast and the definitions in the operations planning step will then be used to optimize the required rolling stock fleet and train layout specifications and stations requirements.