

California High-Speed Rail Authority

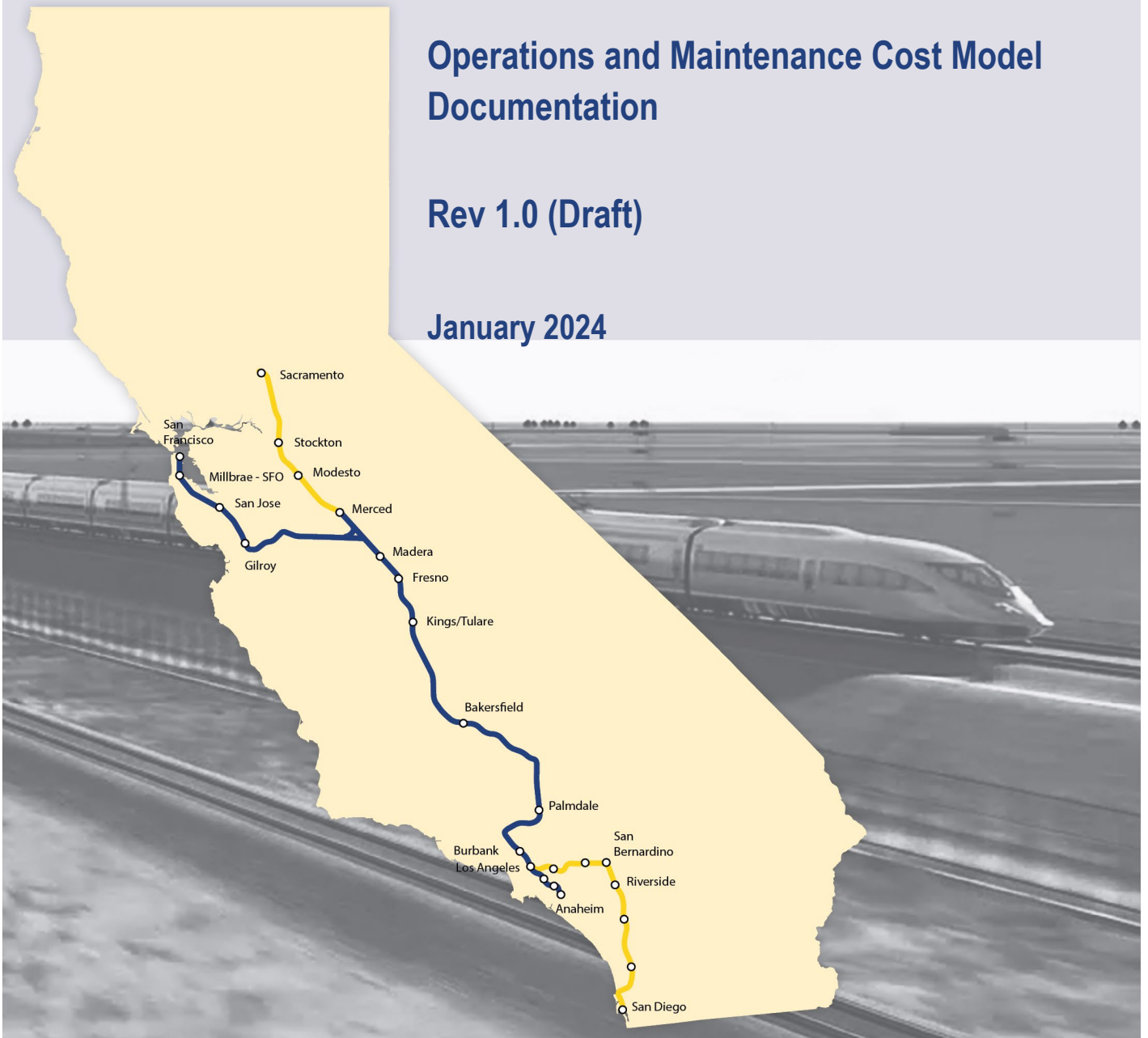
2024 Business Plan

Technical Supporting Document

Operations and Maintenance Cost Model
Documentation

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CALIFORNIA
High-Speed Rail Authority

Prepared by



for the Authority

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TO: Bill Casey

FROM: Mathias Prakesch

SUBJECT: Approval of 2024 Business Plan Operations & Maintenance Cost Model Documentation

DESCRIPTION OF ENCLOSED DOCUMENT(S): 2024 Business Plan Operations & Maintenance Cost Model Documentation

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ACRONYMS AND ABBREVIATIONS

Abbreviation	Description
AFC	Automated Fare Collection
ATO	Automatic Train Operation
CARB	California Air Resources Board
CCTV	Closed-Circuit Television
CDL	Commercial Driver License
CDO	Chief Digitization Officer
CEO	Chief Executive Officer
CEQA	California Environmental Quality Act
CHRO	Chief Human Resources Officer
CPM	Cost per thousand impressions
CRM	Customer relationship management
ETO	Early Train Operator
FRA	Federal Railroad Administration
FTE	Full-time employee
GSA	General Services Administration
GSM-R	Global System for Mobile Communications-Railway
GWh	Gigawatt hour
HMF	Heavy Maintenance Facility
HVAC	Heating, ventilation and air conditioning
IGP	Industrial General Permit
IIPP	Injury and Illness Prevention Plan
kWh	Kilowatt hour
LGV	Lignes à Grande Vitesse
LMF	Light Maintenance Facility
MOE	Maintenance of Equipment
MOI	Maintenance of Infrastructure
MOW	Maintenance of Way
NEPA	National Environmental Policy Act
O&M	Operations and Maintenance
OBP	Office of Planning Budgeting
OCC	Operations Control Center
OCS	Overhead Catenary System
OTT	Over the top
PFAL	Project Finance Advisory Ltd.
PG&E	Pacific Gas & Electric
PTC	Positive Train Control
ROW	Right of Way
RWQCB	Regional Water Quality Control Board
SUV	Sport Utility Vehicle
SWPPP	Storm Water Pollution Prevention Plan

Abbreviation	Description
TOC	Train Operating Company
tphpd	Trains per hour per direction
TVM	Ticket Vending Machine
ZEB	Zero-Emission Bus

1 INTRODUCTION AND EXECUTIVE SUMMARY

The California High-Speed Rail Authority (Authority) is responsible for planning, designing, building and operation of the first high-speed rail system in the nation. By the California Public Utilities Code section 185033 as amended by Assembly Bill (AB) 528, this technical memorandum supports the content of the Business Plan requirement. California high-speed rail will connect the mega-regions of the state, contribute to economic development and a cleaner environment, create jobs and preserve agricultural and protected lands. The system will run from San Francisco to the Los Angeles basin in under three hours at speeds capable of over 200 miles per hour after Phase 1 is completed. The system will eventually extend to Sacramento and San Diego, totaling 800 miles with up to 24 stations.

This Technical Supporting Document outlines the assumptions and inputs for the California High-Speed Rail System Operations and Maintenance Cost Model. The model is designed to help test the system's ability to meet the requirements of Proposition 1A to operate without a subsidy. The model is based on the current level of available system detail and assumptions surrounding the system operations.

Since 2019, under the Authority 17-20 contract, the Early Train Operator (ETO) has been responsible for reviewing and updating the Operations and Maintenance Cost Model and Technical Supporting Document for the Business Plan. The ETO brings their international high-speed rail experience in operations and maintenance planning, development and delivery.

Since the release of the 2018 Business Plan, the direction of the California High-Speed Rail Project has changed. Given the funding constraints and current political challenges, California Governor Gavin Newsom made the executive decision to focus on opening an interim service in the Central Valley, to initiate high-speed service in California as soon as possible. This provides Californians with mobility and economic and environmental benefits in the least amount of time.

This building-block approach is a way to “live within our means,” as explained already in the 2019 Project Update Report. According to the 2023 Project Update Report, it is the goal to become the early service between Merced and Bakersfield in the Central Valley, operational by the end of 2030. This service would be followed by the Silicon Valley to Central Valley service, and Phase 1 service from San Francisco to Anaheim thereafter.

1.1 Clarifications on the Operations and Maintenance Cost Model Scope

For high-speed rail operations, three stages or “building blocks” are identified:

1. Central Valley early service—Merced to Bakersfield (operations and maintenance costs covered in the ETO Central Valley Segment System Management & Operations Interim Financial Plan)
2. Silicon Valley to Central Valley—San Francisco to Bakersfield (covered in this document)
3. Phase 1—San Francisco to Anaheim (covered in this document)

For the 2024 Business Plan, the ETO performed a full review of the operations and maintenance cost model methodology, assumptions, cost line items and inputs for each of the sections. In addition, the team has made several enhancements to the financial model that was used to forecast costs based on DB's experience in high-speed rail operations.

While a few cost items were refined in the model, further development in relation to service planning was significant. Even if the assumed service was unchanged, numerous optimizations were made. For the 2024 Business Plan, the high-speed rail service planning process uses the Viriato software tool to construct stringlines, calculate train trip times with pad and support the construction of conflict-free service concepts in areas of the high-speed rail operation with mixed-service operation (Peninsula and South of Burbank). The resultant high-speed rail service plan includes consideration of the train slotting and more

detailed assumptions resulting in updated trip times and revised non-revenue modes that will be reflected in the operations and maintenance cost calculation as well.

These updates resulted in revised costs that both increase and decrease the cost of operations and maintenance (O&M) in their respective categories and lead to a positive outlook for the system, similar to the 2022 Business Plan.

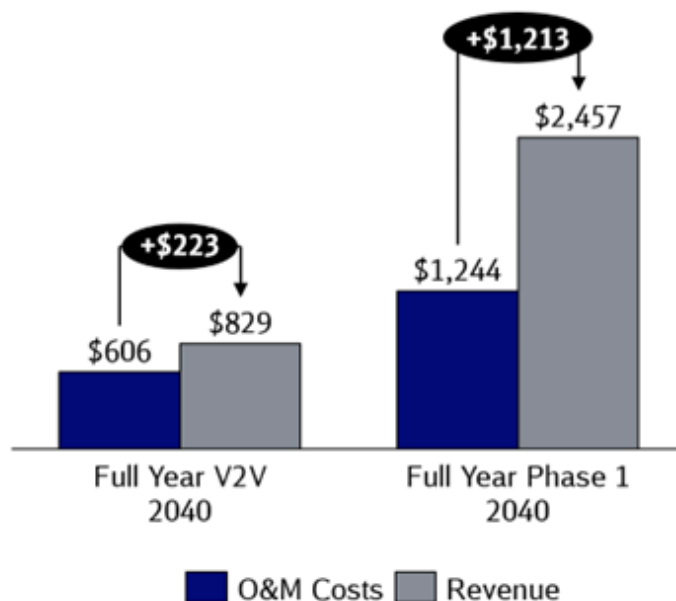
The O&M model forecasts the operations for Silicon Valley to Central Valley in 2040:

- An associated operations and maintenance cost of \$606 million; and
- A net revenue of \$829 million.

This leads to a system net positive cashflow of \$223 million in Year 2040 of operations (without the consideration of ancillary revenues).

The following figure shows the cashflow (operations expenditures vs. revenue) for selected stages.

Figure 1 Operations and Maintenance Costs vs. Net Revenue (in June 2023 dollars)



Note: Numbers may not add up due to rounding.

1.2 Further Refinements and Next Steps

The current O&M model reflects a service plan for a full-leg wye south of Merced. This includes the following high-speed rail service sections in the Silicon Valley to Central Valley stage:

- San Francisco – Merced – Bakersfield (one train per hour per direction (tphpd) all day)
- Merced – Bakersfield (one train per every-two-hours per direction all day)

The results from our O&M cost model led to a net positive cashflow of \$223 million (2023 dollars) running the full-leg wye scenario in year 2040 of Silicon Valley to Central Valley operations (see Figure 1).

The ETO, in consultation with the Authority, will continue to refine the study and make additional refinements to the financial model, including fare policy, track access fees and additional information available in the near future from the procurement process of the track, systems and rolling stock.

Following the release of the 2020 Business Plan, a consolidated model was developed that includes the three building blocks of implementation, namely the Central Valley segment, Silicon Valley to Central Valley and Phase 1. During the consolidation process, two existing models—one used for regular Business Plan updates and a second that covered the Central Valley segment studies—were combined into one model. The new consolidated financial model allows modeling of the different building blocks individually and provides flexibility in modeling the cost items.

Consistent to previous models, the consolidated model includes the following categories of O&M costs: train operations, dispatching, maintenance of rolling stock, maintenance of infrastructure, station operations and train/station cleaning, police and security, commercial, general and administrative. Each section summarizes assumptions for staffing, shifts, material and tool costs and other expenses (such as subcontractor costs) around which conceptual operating strategies are developed. The model does not attempt to optimize the operations to reduce costs but reflects an average and achievable operating scenario that could be further improved by the future operator. The consolidated model incorporates the relevant cost and revenue aspects from the Authority's perspective for all three building blocks.

2 PURPOSE OF THE MODEL

Consistent with previous business plans, the Operations and Maintenance Cost Model aims to test different operating scenarios, ridership, service and commercial options. Specifically, the model helps test whether these different scenarios would follow Proposition 1A as to the system's ability to operate without an operating subsidy. For this purpose, the results of this O&M cost model should be compared to the revenue forecasts for each year. The model also provides estimates of the total employees needed to run the system.

Note: All dollar figures presented in this document are base year as of June 2023. The 2024 Business Plan escalates these figures to 2023 dollars for consistency with base year capital and lifecycle costs.

3 UPDATES TO THE MODEL SINCE THE 2022 BUSINESS PLAN

For the 2024 Business Plan, the Authority has commissioned the responsibilities of the biennial update to the Early Train Operator, DB Engineering & Consulting (DB E&C USA Inc.). For the 2024 Business Plan, the 2022 Business Plan Operations and Cost Model was used with a few updates and modifications.

The key assumptions and structural model upgrades are documented in this section. Minor adjustments, such as cost escalation of wages, are embedded in the body of the Technical Supporting Document.

For core areas, subject matter experts have checked the assumptions for plausibility and have done, when appropriate, a new assessment, taking into account current technologies, regulations and processes.

3.1 Model Phasing

Due to the ongoing evaluation of planning and financing of the Silicon Valley to Central Valley and the Phase 1 alternatives, CHSRA is unable to define a discrete opening year horizon for either scenario. Therefore, the analysis for both alternatives for the 2024 Business Plan provides data streams in parallel for each alternative. The following table shows the operating segments and the corresponding phasing.

Table 1 Segment and Phasing of 2024 Business Plan

Step	Operating Segment
Silicon Valley to Central Valley	San Francisco 4th & King to Bakersfield
Phase 1	San Francisco Transbay/Merced to Los Angeles/Anaheim

3.2 Ramp Up Factor

In the transition from the 2018 Business Plan to the 2020 Business Plan, the ramp-up factors were removed. The 2020 Business Plan assumed that operation will be full in year one. The assumption is that the railroad will already operate on a large part of the line before Silicon Valley to Central Valley is put into operation. The 2024 Business Plan has the same assumptions with a 100 percent service from day one.

3.3 Unit Prices and Labor Cost Growth

The 2024 Business Plan unit prices were escalated, where applicable, from June 2019 dollars to June 2023 dollars using the California Consumer Price Index-All Urban Consumers series.¹ The index produces a compound annual growth rate of 4.5 percent between 2019 and 2023.

In the 2024 Business Plan financial estimate the salaries are represented by paygrades. The salaries from 2020 were taken as a basis, reviewed and assigned to the closest paygrade. Subsequently, the paygrades were escalated from June 2019 dollars to June 2023 dollars using the mean annual wage in the state of California.² The mean annual wage in the state of California compound annual growth rate was 6.3 percent between 2019 and 2023.

¹ California Department of Industrial Relations. California Consumer Price Index. Accessed September 2023. <https://www.dir.ca.gov/OPRL/CPI/EntireCCPI.PDF>

² Occupational Employment and Wage Statistics. California Employment Development Department. Accessed September 2023. <https://www.labormarketinfo.edd.ca.gov/data/oes-employment-and-wages.html>

3.4 Personnel Calculation

The personnel calculation is consistent with the 2022 Business Plan. The inputs for the personnel calculation were reviewed and slightly adjusted, where appropriate.

The maintenance of infrastructure costs were, consistent with the 2022 Business Plan, estimated for only dedicated high-speed rail infrastructure. As in the 2022 Business Plan, the following blended sections were removed from consideration:

- Silicon Valley to Central Valley: San Francisco to Gilroy, thereof:
 - Owned by Caltrain: San Francisco to CP Lick
 - Authority owned: CP Lick to Gilroy
- Phase 1 (in addition):
 - Owned by Metrolink: Burbank to Anaheim

It is assumed that the maintenance costs for the blended sections, which are not owned by the Authority, are covered by track access charges, paid by the Authority to the owner of the assets. Conversely, the Authority will be paid track access charges from Caltrain for using the Authority's assets from CP Lick to Gilroy.

3.5 Energy Costs

The 2022 Business Plan assumed an energy unit cost of \$0.1312 per kilowatt-hour (kWh) (in 2019 dollars). This estimate was based on Pacific Gas & Electric (PG&E) transmission voltage rates available in the E-20 tariff, which is applicable to services to customers demanding over 1000 kW³. The 2024 Business Plan assumes the identical tariff (please note: the tariff was renamed to B-20) and includes an updated energy unit cost of \$0.20322 per kilowatt-hour (kWh) (in 2023 dollars). The 2024 Business Plan includes the costs for train operation, ancillary energy consumption for heating, ventilation and air conditioning (HVAC) and energy for facilities. The energy unit cost is based on Phase 1 system demand. The Silicon Valley to Central Valley phase was not discretely modeled. Please read Section 5.3 for additional information on assumptions for energy unit cost and energy usage, Section 7.3.1 for additional information on energy usage in maintenance facilities and Section 9.5.2.1 for more on station energy usage.

3.6 County Population Projections

Updates to population figures were made in the 2024 Business Plan Operations and Maintenance Cost Model, based on forecasts by county developed by California Economic Forecast and the California Department of Finance and Traffic Analysis Zone-level forecasts from respective Metropolitan Planning Organizations. The county population forecasts impact the advertising costs in the Operations and Maintenance Model. Please read Section 11.1 for additional information on marketing assumptions and Appendix D—for detailed county population forecasts.

3.7 Insurance

Currently, the Authority is evaluating the overall insurance strategy. In the present 2024 Business Plan it is assumed that the Authority is responsible for taking out insurance policies. For the 2020 Business Plan, Marsh, a global leader in insurance broking and risk management, provided updated coverage rates, which depend on ridership, revenues and asset values. As there were no major changes to the

³ PG&E. Industrial B-20 Current. Accessed September 2023. <https://www.pge.com/tariffs/Industrial_B-20_Current.xlsx>

Authority's insurance strategy, for the present 2024 Business Plan the insurance costs were escalated using the California Consumer Price Index-All Urban Consumers series. Insurance rates from Marsh reflect insurers' risk factors at the time of the production of the 2024 Business Plan and may change in future years as the high-speed rail system design and concept of operations advances to a higher level of completion. Marsh's insurance estimates include fixed and variable components depending on the type of coverage. Please see Section 13 for additional information on insurance assumptions.

3.8 Bus Costs

In the 2024 Business Plan, it is assumed a fully electric bus fleet for comprehensive coverage of the high-speed rail system, in alignment with the state's regulation for a transition to zero-emission public buses by 2040, and the California Air Resources Board (CARB) Zero-Emission Bus Implementation Guidebook mandating transit agencies to purchase zero-emission buses (ZEBs) from 2029. For 2024 Business Plan, the cost per mile for these buses has been determined using specific to battery electric buses assumptions based on the study Costs and Benefits of Electrifying and Automating Bus Transit Fleets.⁴ It is assumed that the bus service provider incurs a cost of \$1,200,000 per bus. This cost rate, considered comprehensive, encompasses expenses such as financing, depreciation, insurance, electricity, maintenance and labor, and has been translated into a per-mile fee of \$9.19.

3.9 All Other Model Assumptions and Inputs

All other model assumptions and inputs from the 2022 Business Plan Operations and Maintenance Cost Model were reviewed by subject matter experts and found to be consistent with the current concept of operations for the California High-Speed Rail System. These validated inputs were re-used for the 2024 Business Plan Operations and Maintenance Cost Model, and where necessary, California Consumer Price Index escalation was used to escalate unit cost amounts from 2019 dollars into 2023 dollars (assumption number 3 in Section 4).

This Technical Supporting Document captures only the assumptions for the O&M costs (which cover operations and routine maintenance). For lifecycle costs (rehabilitation and replacement), please see the 50-Year Lifecycle Capital Cost Model Technical Supporting Document.

⁴ Multidisciplinary Digital Publishing Institute (MDPI). May 13, 2020. Accessed October 2023. <<https://www.mdpi.com/2071-1050/12/10/3977>>

4 UNIVERSAL ASSUMPTIONS

The Operations and Maintenance Cost Model aims to present a realistic scenario for operation of the high-speed rail system. The scenario aims to be technically sound based on conventional rail practice in the U.S. and applicable adjustments for high-speed rail service from around the world. For the medium (base) cost scenario, the following assumptions are applicable across all categories of costs/personnel.

Table 2 System Implementation Phasing from the 2024 Business Plan

Step	End Points	Anticipated Year Opening
Silicon Valley to Central Valley	San Francisco 4th & King to Bakersfield	N/A ^[1]
Phase 1	San Francisco Transbay/Merced to Los Angeles/Anaheim	N/A ^[1]

Note:

- 1 Due to the ongoing evaluation of planning and financing of the Silicon Valley to Central Valley and Phase 1 alternatives, the Authority is unable to define a discrete opening year horizon for either scenario. Therefore, the analysis for both alternatives for the 2024 Business Plan provides data streams in parallel for each alternative.
 1. The model assumes the phasing as proposed in the 2024 Business Plan, which appears in Table 3 above.
 2. The length of the system, the stations that are assumed to be operating and other system details are based on the system, service and implementation assumptions outlined in the 2024 Business Plan and Technical Supporting Document: Service Planning Methodology. This information builds on the system assumptions used in the development of the 2022 Business Plan, but includes some key differences, specifically the use of the Viriato timetable tool with which a more refined and optimized timetable could be created and thus, for example, the trip times were updated. Furthermore, some of the service parameters were changed (e.g., the extension of service peak hours, differentiation into business day and weekend), which have an impact on the key metrics of the service.
 3. Unit cost assumptions from the 2024 Business Plan California High-Speed Rail System Operations and Maintenance Model used again in the 2022 Business Plan California High-Speed Rail System Operations and Maintenance Model were escalated to June 2023 dollars from June 2019 dollars using the California Consumer Price Index Annual Series – All Urban Consumers. The escalation rate assumed between 2019 and 2023 on an annual basis is approximately 4.5 percent.
 4. Fringe rates are applicable to all positions except contracted positions.
 5. Fringe rates were extracted from the Brotherhood of Locomotive Engineers and Trainmen document valid for 2023 with minor adjustments, provided by subject matter experts. With the addition of costs for the Federal Employers Liability Act⁵, they are as follows:
 - \$25,000 for the health, vision, dental and retiree health plans
 - 4.15 percent of wage up to \$22,700 for Railroad Unemployment Insurance Act benefits
 - 13.1 percent of wage up to \$118,800 for Railroad Retirement Tier 2

⁵ Brotherhood of Locomotive Engineers and Trainmen. Fringe Benefits 2022. Accessed September 2022. <https://ble-t.org/Fringe-Benefits/#:~:text=The%20maximum%20daily%20benefit%20rate,July%201%2C%202022%20and%20thereafter.>

- 6.2 percent of wage up to \$160,200 for Railroad Retirement Tier 1
 - 0.9 percent of wage up to \$153,164 for State Disability Insurance
 - 0.1 percent of wage up to \$7,000 for Employment Training Tax
 - 7.45 percent of wage with no limit (1.45 percent for Medicare and 6 percent for Federal Employers Liability Act compensation)
6. The model conservatively assumes that the system workload will be filled by an equivalent number of full-time employees (FTEs) and that no employee will need to work overtime and be paid at overtime rates. It is acknowledged that this is not the most efficient way to operate and that a private operator can improve its labor costs by using overtime for short additional labor needs instead of using higher levels of personnel as currently assumed in the model. Where appropriate, subcontractors were also used for specific tasks.
 7. General and administrative personnel are assumed to be an additional 10 percent of the total workforce (including supervisors, managers and engineers). In addition, a contingency of 21 percent was allocated as a buffer, same as in the 2022 Business Plan.
 8. Of the 365 days in the year, employees will be unavailable to work on some days. To calculate the number of staff, every employee was assumed to work 1,794 hours per year. This number of hours takes into account an average of 40 hours per week, as well as holidays, sickness and training.
 9. Generally, the time-based calculation applies to non-contract positions.
 10. The same number of train services, and therefore the same number of crews, will operate on business days. For the weekend and holidays, a constant reduced service is assumed throughout the day. To cover absence times (holiday, sickness, training) it is assumed, that one FTE works 1,794 hours per year.
 11. Wages gathered from existing railroad and transit properties were provided by different subject matter experts.
 12. The costs for shared facilities (i.e., the Caltrain corridor, Metrolink guideway and others) were calculated to reflect track access charges. In Northern California, the track access charges were derived based on cost information outlined in the Caltrain Business Plan Technical Memoranda - Operating Cost Memo,⁶ as well as train mileage data extracted from the actual service plan for Silicon Valley to Central Valley and Phase 1. In Southern California, the track access charges were determined based on eligible operation and maintenance costs, along with train mileage data from the BNSF Railway Company's Class 1 Railroad Annual Report⁷ and the Metrolink Annual Comprehensive Financial Report⁸. A weighted average approach was employed for the track access fee charges in Phase 1.

⁶ Caltrain Business Plan - Operating Cost Memo. 2019. Accessed September 2023.
<<https://www.caltrain.com/media/24041/download?inline>>

⁷ BNSF Railway Company Class 1 Railroad Annual Report. 2019. Accessed September 2023.
<<https://www.bnsf.com/about-bnsf/financial-information/pdf/19R1.pdf>>

⁸ Metrolink Southern California Regional Rail Authority Annual Comprehensive Financial Report - Fiscal Years Ended June 30, 2022&2021. 2022. Accessed September 2023.
<https://metrolinktrains.com/globalassets/about/financial-reports/annual-comprehensive-financial-report-2022-fisca_alexander-barber.pdf>

In sections that have track access charges, only a speed up to 110 mph is possible due to the mixed traffic with slower Caltrain and Metrolink regional trains. The following track access fee is used in the 2024 Business Plan.

- Silicon Valley to Central Valley: \$13.22 per train mile (escalated to 2023 dollars)
- Phase 1: \$14.48 per train mile (escalated to 2023 dollars)
- The following categorization of stations is used in the 2024 Business Plan; although, in certain cases, this categorization may deviate.
 - a. Terminal Stations:
 - Silicon Valley to Central Valley: Not applicable
 - Phase 1: San Francisco Transbay Center, Anaheim
 - b. Key Intermediate Stations with Turnback Service:
 - Silicon Valley to Central Valley: Not applicable
 - Phase 1: San Jose, LA Union Station
 - c. Temporary Terminal Stations:
 - Silicon Valley to Central Valley: San Francisco 4th & King, Bakersfield, Merced
 - Phase 1: Anaheim, Merced
 - d. Intermediate Stations:
 - All other stations

5 TRAIN OPERATIONS COST

The Train Operations portion of the Operations and Maintenance Cost Model consists of personnel, electrical and other costs directly involved in the operation of the trainsets.

5.1 Related Personnel

For the purpose of the model, personnel in the calculation of the train operations cost are considered to be on-board train crews consisting of train engineers, conductors and assistant conductors. On-board service attendants, with possible functions like customer service or on-board service, are not considered.

Additionally, the protect trains are crewed with train engineers, conductors and assistant conductors.

Road managers function as supervisors, are in charge of the quality of daily train operations and supervise the train personnel.

5.2 Assumptions and Model Inputs

5.2.1 Primary Drivers

The main driver to optimize the use of the existing workforce is matching personnel shifts with train shifts—throughout all timetabling and personnel and asset planning processes. The employees' working time should be used in the best possible manner. The main assumption is a yearly availability of 1,794 hours for all operational personnel. The total time of train operations in hours divided by the individual working time per each position—moderated by a certain percentage of inefficiency of matching employees' and trains' shifts—results in the number of required employees.

All federal, state and other relevant guidelines will be taken into account.

5.2.2 General Assumptions

The following specific assumptions have been made:

1. On-board service personnel are not considered in the headcount. For example, one to two on-board service attendants per train offer on-board refreshment services from coffee carts and in restaurant cars. These on-board services may be outsourced to a subsidiary of the Train Operating Company (TOC) or to a third party. In both cases, the outsourced entity would benefit from a steady stream of clients and the marketing efforts of the TOC.
2. All trainsets are considered to be single trainsets. No double trainsets are taken into account.
3. It is intended that—whenever possible—train crews start and finish at the same location, i.e., the same stabling yards located at the Heavy Maintenance Facility (HMF) or at the Light Maintenance Facility/ies (LMF) or the station platform near the HMF or the LMF, in particular, when a regular crew change takes place during the day. In the latter case, or when the timetable or operational reasons require to deviate from the general rule “start point = end point,” the minibuses will help reduce the inconvenience to train crews.
4. Road managers constitute the hierarchic level between the operational train personnel and the train operations director and represent a professional profile which includes several supervisory functions (such as road foreman⁹). This key position represents onsite leadership, communicates between staff levels above and below and takes on overall responsibility for the operational quality of daily train services, the disposition of traincrews as well as the operational emergency management.

⁹ A road foreman is in charge of supervising the engineers.

5.2.3 Personnel Headcount

The following on-board personnel are assumed for each type of crew:

- For a **single-consist trainset**: one train engineer, one conductor, two assistant conductors (Table 3).
- **Protect train**: one train engineer, one conductor and one assistant conductor (Table 5). These trains are manned during commercial service hours.
- The number of **road managers** depends on the number of personnel to be supervised and the complexity of the train operations in the respective track section (Table 6) and is determined according to the following calculation:
 - **Supervision of up to 100 employees**: The number of road managers increases proportionally, comprising 10 percent of the employees. In this range, the workload of the road manager is considered to be 50 percent leadership/supervision and 50 percent administration.
 - **Supervision of 100 or more employees**: The efforts for administration increase proportionally at 50 percent for leadership/supervision, but only at 25 percent for administration, as administrative synergies will become more effective. This leads to a road manager's quota of 7.5 percent starting with the 101st employee.

The following tables summarize the information discussed above for each type of on-board crew member.¹⁰

Table 3 Headcount per Single Trainset in Commercial Service Including Empty Trips

Position	Silicon Valley to Central Valley ^[1]	Phase 1 ^[1]
Number of Trainsets to Cover the Service Plan	17	58
Train Engineers	1 position x 79,284 hours x 1.25 ≈ 56 FTE	1 position x 235,217 hours x 1.25 ≈ 164 FTE
Conductor	1 position x 79,284 hours x 1.25 ≈ 56 FTE	1 position x 235,217 hours x 1.25 ≈ 164 FTE
Assistant Conductor (2 per train)	2 positions x 79,284 hours x 1.25 ≈ 112 FTE	2 positions x 235,217 hours x 1.25 ≈ 328 FTE
Total	224	656

Note:

- 1 Headcount includes a 25 percent mark-up factor for inevitable inefficiencies in crew shift planning of commercial trains.

¹⁰ Occurring deviations are caused by rounding.

Table 4 Headcount per Protect Train, Crewed During Commercial Service Hours

Position	Silicon Valley to Central Valley	Phase 1
Number of Protect Trainsets During Commercial Service Hours ^[1]	2	6
Train Engineers	1 position x 13,870 hours ≈ 8 FTE	1 position x 41,610 hours ≈ 24 FTE
Conductor	1 position x 13,870 hours ≈ 8 FTE	1 position x 41,610 hours ≈ 24 FTE
Assistant Conductor (1 per train)	1 position x 13,870 hours ≈ 8 FTE	1 position x 41,610 hours ≈ 24 FTE
Total	24	72

Note:

1 The staffing for the protect trains is a conservative approach, with the maximum number of people required.

Table 5 Headcount for Management Train Operations

Position	Silicon Valley to Central Valley	Phase 1
Train Operations Director	1 position 8 hours	1 position 8 hours
Road Manager	24	72
Total	25	73

5.3 Energy Costs for Traction Power

Energy costs are based on the usage of energy for the movement of trains. The Authority has committed to using 100 percent renewable energy.

5.3.1 Energy Cost Calculation

For the determination of the traction power consumption, the following parameters are used:

- The unit cost based on the industrial “B-20” tariff of PG&E, the utility with the widest distribution along the California High-Speed Rail tracks.
- The calculative average power consumption per mile of an eight-car high-speed trainset with 130 persons on board.
- The mileage of all trainsets in operation per day multiplied respectively per year.

To determine the average power consumption (kwh per mile) of the trainsets, extensive consumption studies under different conditions have been undertaken. Energetic recoveries during train deceleration into the network will not be reimbursed by PG&E.

5.3.2 Energy Usage

Energy usage is based on the following:

- The preliminary timetable concepts for the different stopping patterns with a total yearly mileage, including deadhead miles, of 6,315,960 miles in Silicon Valley to Central Valley and 20,475,538 miles in Phase 1.
- The calculative and experience-based traction power consumption of approximately 37 kWh per trainset mile (with 130 persons on board).

Conservative annual estimates of energy usage were calculated to total:

- 252.4 GWh for Silicon Valley to Central Valley with 17 trainsets being operational
- 811.5 GWh for Phase 1 with 58 trains being operational

5.4 Equipment, Other Costs

Each member of the on-board crew will require a uniform. The uniform allowance is based on the uniform costs from U.S. Office of Personnel Management – Uniform Allowance.¹¹ Uniform costs are estimated at \$800 per employee per year.

Mainly the road managers will require a small number of Non-Rail Vehicles, particularly when rail service is not an option, to be flexible in the fulfilment of their tasks as supervisors, quality assurers and incident responders.

The vehicle fleet will consist of the following types:

- 4WD Ext. Cab Pick Up/Sport Utility Vehicle (SUV):
 - 15 (Silicon Valley to Central Valley)
 - 40 (Phase 1)
- Minibus (for crew transport):
 - 2 (Silicon Valley to Central Valley)
 - 2 (Phase 1)

The vehicles are located in the HMF and LMF(s), or temporarily wherever needed to fulfill the tasks.

The road manager will incur office supply costs, which are assumed to be \$656 per year per employee based on the Sonoma-Marin Area Rail Transit District Fiscal Year 2023/2024 Adopted Budget.¹² Cell phones are assumed for every employee with an estimated allowance of \$499 per year per employee (escalated to 2023 dollars).¹³ In addition, the Global System for Mobile Communications-Railway (GSM-R) is assumed with a similar cost level as for cell phones. The assumption is that there is one GSM-R device per trainset.

By the use of minibuses, it is assumed that no travel expenses will arise.

¹¹ U.S. Office of Personnel Management. Fact Sheet: Uniform Allowances. 2023. Accessed September 2023. <<https://www.opm.gov/policy-data-oversight/pay-leave/pay-administration/fact-sheets/uniform-allowances>>

¹² SMART. Sonoma-Marin Area Rail Transit District Fiscal Year 2023/2024 Adopted Budget. 2023. Accessed September 2023. <<https://www.sonomamarintrain.org/sites/default/files/Financial%20Documents/FY2023-2024Draft%20BudgetDocument%20-05-22-2023.pdf>>

¹³ Samsung and Oxford Economics. "How much should you reimburse BYOD employees for mobile expenses?" 2022. Accessed September 2023. <<https://insights.samsung.com/2022/05/16/how-much-should-you-compensate-byod-employees-for-mobile-expenses-3/#:~:text=What%20is%20the%20average%20mobile,per%20year%20for%20each%20employee>>

6 DISPATCHING AND CONTROL COSTS

The dispatching and control portion of the Operations and Maintenance Cost Model consists of the personnel and costs directly related to directing and controlling train operations, which includes the Planning Department.

6.1 Related Personnel

Dispatching personnel for train operations, including control of the Supervisory Control and Data Acquisition for the Overhead Catenary Line, located in the Operations Control Center (OCC) at the Heavy Maintenance Facility (HMF) or at stabling yard interlocking units in the HMF and the Light Maintenance Facility/ies (LMF) is clearly separated from other control personnel dealing with maintenance-related duties and therefore being allocated to the respective maintenance sections herein.

6.2 Assumptions and Model Inputs

6.2.1 Primary Drivers

A high degree of automation and reliability in the transfer of control commands, both electronic or digital interlocking systems, allow for long main line distances to be dispatched from one OCC, which will most likely be located in the HMF/main stabling yard area.

The two (Silicon Valley to Central Valley) and three (Phase 1) stabling yards, situated at the HMF and the LMF(s), however, will be dispatched independently from the main line. The local interlocking units installed do not dispose of full signal protection of the turnouts. The depot dispatchers' workplaces will be located near the yard and shunting tracks.

Infrastructure maintenance facilities, hosting the yellow plant, do not dispose of internal interlocking systems. Their access to the mainline will be dispatched from the OCC.

6.2.2 General Assumptions

The OCC will be run all day in three shifts, the stabling yard interlocking units in two to three shifts (LMF) or three shifts (HMF), according to the needs of the train movements.

Blended services: With the Authority's services reaching San Francisco during the Silicon Valley to Central Valley phase and therefore using Caltrain's tracks between San Jose (CP Lick) and San Francisco, it would be beneficial to have a presence in Caltrain's OCC located in Menlo Park. This would promote good communication and cooperation between the parties and represent the Authority's interests regarding Caltrain's dispatching decisions. Dispatching rules such as how train movements are prioritized must be agreed on and documented between the railroad organizations.

6.2.3 Personnel Headcount

Trains are being dispatched:

- On the mainline, controlled by the line dispatchers of the OCC; and
- In the stabling yards, controlled by the depot dispatchers locally situated in HMF and LMFs.

Furthermore, regular and construction timetables have to be created in the Planning Department for high-speed trains and for intermodal exchange between high-speed trains and other transportation providers, such as conventional trains or buses, to create seamless transportation chains. Operational data will be aggregated and evaluated by the performance and data manager as to identify the need for improvement and increase efficiency.

Table 6 shows the staffing for the OCC and the Planning Department under different system phases.

Table 6 Operations Control Center and Planning Headcount by System Phase

Position	Silicon Valley to Central Valley	Phase 1
Operation Control Director ^[1]	1 position 8 hours = 1 FTE	1 position 8 hours = 1 FTE
Chief Line Dispatcher ^[2]	[1 position 24 hours ≈ 4.9 FTE] = 5 FTE	[1 position 24 hours ≈ 4.9 FTE] = 5 FTE
Line Dispatcher ^[3]	[2 positions 24 hours ≈ 9.8 FTE] = 10 FTE	[3 positions 24 hours ≈ 14.6 FTE] = 15 FTE
Depot Dispatcher, One Yard Master	[2 × 2 positions 24 hours ≈ 19.5 FTE] = 20 FTE	[3 × 2 positions 24 hours ≈ 29.3 FTE] = 30 FTE
Information Controller	[1 position 18 hours ≈ 3.7 FTE] = 4 FTE	[1 position 18 hours ≈ 3.7 FTE] = 4 FTE
Planning Director ^[1]	1 position 8 hours = 1 FTE	1 position 8 hours = 1 FTE
Scheduler (regular/construction) ^[1]	1 position 8 hours = 1 FTE	2 position 8 hours = 2 FTE
Performance and Data Manager ^[1]	1 position 8 hours = 1 FTE	1 position 8 hours = 1 FTE
Total	43	59

Notes:

- 1 These positions do not work in shifts.
- 2 In the function of "Deputy Director Operation Control.
- 3 Train Dispatcher.

6.3 Equipment, Other Costs

The dispatching department will require two non-revenue vehicles at the OCC for supervisors to respond to incidents and get between locations on occasions when rail service is not an option. The purchase price of \$47,272 for the vehicles is assumed to be lease-based and includes insurance, maintenance and fuel costs.

All dispatch personnel will incur office supply costs and will require cell phones. The office supplies are assumed to be \$656 per year per dispatch employee based on the Sonoma-Marín Area Rail Transit District Fiscal Year 2023/2024 Adopted Budget.¹⁴ The cell phone allowance is estimated at \$499 per year (escalated to 2023 dollars).¹⁵ In addition, GSM-R and landline communication is assumed at a similar cost level as for cell phones. The assumption is one GSM-R and landline device per workstation.

¹⁴ SMART. Sonoma-Marín Area Rail Transit District Fiscal Year 2023/2024 Adopted Budget. 2023. Accessed September 2023. <<https://www.sonomamarintrain.org/sites/default/files/Financial%20Documents/FY2023-2024Draft%20BudgetDocument%20-05-22-2023.pdf>>

¹⁵ Samsung and Oxford Economics. "How much should you reimburse BYOD employees for mobile expenses?" 2022. Accessed September 2023. <<https://insights.samsung.com/2022/05/16/how-much-should-you-compensate-byod-employees-for-mobile-expenses-3/#:~:text=What%20is%20the%20average%20mobile,per%20year%20for%20each%20employee>>

7 MAINTENANCE OF ROLLING STOCK COSTS

The estimated costs for maintenance of rolling stock consists of personnel and other costs required for maintaining the trainsets. It is assumed that the warranty period for major work will be handled by the rolling stock manufacturer for three years (with two of those years before revenue train operations start).

7.1 Related Personnel

Personnel in the rolling stock maintenance department are divided into the following categories:

1. Technicians (mechanical and electrical)
2. Supervisors
3. Laborers
4. Storehouse employees

A mark-up of 25 percent is applied to cover any inefficiencies in operational procedures, such as inefficiencies between train maintenance times and shift scheduling, additional expenses due to delayed arrival of trains and delays in individual maintenance activities.

7.2 Assumptions and Model Inputs

7.2.1 Inspections

1. Regulatory inspections are guided by the Code of Federal Regulations and the Federal Railroad Administration (FRA). The Authority is currently discussing the use of new train inspection technologies with federal stakeholders; however, pending any future changes in federal guidance, the following rolling stock assumptions have been utilized in the 2024 Business Plan.
2. Each maintenance facility will perform regulatory inspections and testing at the required intervals to maintain FRA compliance. Additionally, the manufacturer's recommended tasks, cleaning and servicing of trainset facilities and rolling stock will take place.
3. Staffing at each facility will be based on the number of trainsets being serviced at the facilities as established in the key metrics for service specification starting with location requirements, the frequency of the required inspection and testing, and the effort needed to perform each task. Assumptions are based on current state-of-the-art technologies and regulations with the likelihood that advances in inspection and testing techniques as well as changes to regulations will occur prior to implementation, testing and commissioning of the train operation and maintenance processes and procedures. The number of staff in Table 7 on the next page is assumed for each facility.
4. Assumptions for occurrence of inspections:
 - Daily, 311 inspections per year per trainset
 - Every 2 weeks (15,000 miles), 25 inspections per year per trainset
 - Every 2 months (65,000 miles), 6 inspections per year per trainset
 - Wheel truing every 5 months (160,000 miles), 2.3 per year per trainset
5. Material costs for these inspections (escalated to 2023 dollars):¹⁶

¹⁶ Costs based on the German High-Speed Train "Inter-City-Express."

- Daily, \$49 per inspection per trainset
 - Every 2 weeks, (15,000 miles) \$49 per inspection per trainset
 - Every 2 months, (65,000 miles) \$5,198 per inspection per trainset
 - Wheel truing every 5 months, \$112 per inspection per trainset
6. Corrective maintenance consists of identifying a defect, determining the root cause, taking corrective action and preventive measures. Corrective maintenance is performed in response to defects:
- Identified during inspections and servicing by maintenance personnel;
 - Reported in service by operating crews; and
 - Transmitted through the rolling stock onboard diagnosis systems.

It is assumed corrective maintenance will be performed at a yearly trainset material cost of \$196,609 for Silicon Valley to Central Valley and \$247,778 for Phase 1.

As an example of a task carried out during the inspections, wheel truing is part of the Rolling Stock Maintenance Plan, when the wheel profile is measured during scheduled maintenance intervals by precision equipment and is found to be out of the tolerances of the optimal wheel profile. Wheel truing will take place when conditions of a wheel approach the recommended defect limits of the Rolling Stock Maintenance Plan and prior to reaching FRA condition limits. The depth of the cut to renew the profile has an influence on the number of times that a wheel can be reprofiled and contributes to its life span. Wheel truing is assumed to occur every 160,000 miles at material costs of \$112 per service.

Table 7 Maintenance Facility Periodic Inspection Staffing

Inspection Staffing	Silicon Valley to Central Valley	Phase 1
HMF	<ul style="list-style-type: none"> • 7 supervisors • 36 technicians • 3 laborers • 4 storehouse employees 	<ul style="list-style-type: none"> • 8 supervisors • 35 technicians • 6 laborers • 6 storehouse employees
Bay Area	<ul style="list-style-type: none"> • 7 supervisors • 48 technicians • 3 laborers • 4 storehouse employees 	<ul style="list-style-type: none"> • 8 supervisors • 77 technicians • 6 laborers • 6 storehouse employees
Los Angeles Area	N/A	<ul style="list-style-type: none"> • 9 supervisors • 107 technicians • 7 laborers • 7 storehouse employees

7.2.2 Overhauls

1. General inspections and overhauls are driven by the mileage of the trainsets. For example, bogie inspections are performed at 250,000-mile and 600,000-mile intervals, and overhauls are performed at 1,200,000 miles, then at 2,000,000 miles and at 3,000,000-mile intervals.

2. With the projected annual miles per trainset of 371,527 for Silicon Valley to Central Valley and 353,027 for Phase 1 service, the corresponding scheduling for both operating periods for the first bogie inspection would occur at approximately 8 months, then the second at 18 months, and overhaul of the bogies would begin at 36 months.
3. Overhauls take place at the HMF, and with the projected frequencies it is critical that the HMF is designed and equipped to support a workload of frequent and numerous overhauls of trainsets including the removal, replacement and renewal of bogies, wheelsets and other under-floor equipment such as transformers and transmission components, roof-mounted equipment such as HVAC units and pantographs, and doors as well as other interior and exterior systems and appointments. Additionally, capital spares of bogies, wheelsets, transformers, brake components, HVAC units and other systems or components must be sufficient to provide an adequate float of materials to support the overhauls by allowing renewed rolling stock to be swapped out with removed equipment, rather than removing, overhauling and reinstalling. This approach reduces out-of-service time and facility resource bottlenecks.
4. Wheelset changeout: Although it is difficult to provide an accurate projection of wheel wear patterns until dynamic testing is performed on the high-speed rail system with the actual trainsets, it is assumed for this cost model that the high-speed train rail-to-wheel interfaces will require an interval of 1,200,000 miles before approaching their end of safety-relevant lifespan and will require changeout.
5. The additional staffing required to support the overhaul works appears in Table 8 on the next page.
6. Trainsets are anticipated to be delivered with pre-installed wireless internet/Wi-Fi equipment. Maintenance for this equipment will take place during the overhaul process and is included in the existing cost of trainset overhauls. Connection charges for this equipment are estimated to be \$6,061 per trainset per year based on operational data from the Northern Indiana Commuter Transportation District.
7. Materials for overhauls¹⁷ include:
 - Overhaul general inspection interval at 250,000 miles including HVAC, brakes, bogies and wheelsets, energy system and sanitary facilities cost \$7,566 per trainset (escalated to 2023 dollars).
 - Overhaul general inspection interval at 600,000 miles requiring additional work on HVAC, brakes, bogies and wheelsets, energy system and sanitary facilities cost \$8,968 per trainset (escalated to 2023 dollars).
 - Major overhaul interval at 1,200,000 miles including bogies, wheelset changeout, attenuators, suspension, energy system, mechanical coupling, pneumatics/hydraulics, auxiliary systems, Automatic Train Protection, HVAC, interior/exterior doors and brakes cost \$820,707 per trainset (escalated to 2023 dollars).
 - Second major overhaul interval at 2,000,000 miles including bogies, attenuators, suspension, energy system, auxiliary systems, Automatic Train Protection, HVAC, interior/exterior doors and brakes cost \$1,374,908 per trainset (escalated to 2023 dollars).

¹⁷ Costs based on the German High-Speed Train, "Inter-City-Express."

- Third major overhaul interval at 3,000,000 miles including bogies, attenuators, suspension, energy system, auxiliary systems, Automatic Train Protection, HVAC, interior/exterior doors and brakes cost \$505,740 per trainset (escalated to 2023 dollars).
8. It is assumed that the Authority’s maintenance facilities are able to conserve the use of water. Due to rainwater harvesting and gray water recycling technologies, drinking water is replaced, as much as possible, by treated process water. For the amount that cannot be replaced, train maintenance water consumption is reflected in the Operations and Maintenance Cost Model’s Maintenance of Rolling Stock cost forecasts.

Table 8 Maintenance Facility Periodic Overhaul Staffing

Overhaul Staffing at HMF	Silicon Valley to Central Valley	Phase 1
General Inspection and Overhaul	<ul style="list-style-type: none"> • 4 supervisors • 27 technicians • 2 laborers • 3 storehouse employees 	<ul style="list-style-type: none"> • 13 supervisors • 60 technicians • 8 laborers • 8 storehouse employees

7.3 Utilities

7.3.1 Energy Usage

Maintenance facility energy usage is estimated at 27 kWh per square foot based on the average of Santa Clara Valley Transportation Authority’s Guadalupe Facility (25 kWh per square foot) and Utah Transit Authority’s Jordan River Facility (29 kWh per square foot).¹⁸ Energy unit cost for maintenance facilities is assumed to be the same as presented in Section 3.5, though facilities will be supported by local service providers.

7.3.2 Water and Sewer

Maintenance facility water and sewer costs are estimated at \$0.2419 per year per square foot and \$0.2213 per year per square foot, respectively. These are based on the San Francisco Municipal Transportation Agency Operating Budget for FY 2013–2014 (escalated to 2023 dollars).¹⁹

7.3.3 Facility Size

The staffing requirements for the maintenance of rolling stock are driven by the number of trainsets to be maintained, which is comprised of the required number of trainsets for the service and assumptions for a maintenance and protect reserve. Based on the required number of trainsets, assumptions are made on the size and level of facility. The size of these facilities also influences their energy usage. The facilities’ levels of maintenance stipulate the set of functions that they can perform. Typically, a facility will be able to perform functions up to a certain level (including all lower-level functions). The functions are described as follows.²⁰

1. Level 1: In-Service Monitoring

¹⁸ VTA Guadalupe Facility energy consumption provided by VTA on Nov. 26, 2012. UTA Jordan River Facility energy consumption provided by UTA on Nov. 27, 2012.

¹⁹ SFMTA. SFMTA Operating Budget for FY 2013-2014. July 1, 2012. Accessed September 2023. <<http://www.sfmta.com/sites/default/files/FY2013FY2014BUDGETBOOKopt.pdf>>

²⁰ California High-Speed Rail Authority. Concept of Operations. California High-Speed Train Project. May 4, 2012.

2. Level 2: Examination
3. Level 3: Periodic Inspections
4. Level 4: Overhauls
5. Level 5: Modifications and Major Repair

The facilities planned at each stage of the program are as follows.

Table 9 Maintenance Facilities and Levels by Phase

Facility	Silicon Valley to Central Valley	Phase 1
Level 5: HMF	X	X
Level 3: LMF - Los Angeles Area	0	X
Level 3: LMF - Bay Area	X	X

The HMF and LMF facilities have the following buildings and sizes, which are used to calculate the approximate energy consumption for these facilities.

Table 10 Heavy Maintenance Facility Buildings and Sizes

Heavy Maintenance Facility Building Function	Size (square feet)
Support & Administration Building	283,800
Maintenance Building	101,900
Wheel True Building	54,600
MOW Building	40,050
Car Wash Building	58,200
Paint & Body Shop Building	54,600
Service & Inspection Building	134,650
Total (square feet)	727,800

Table 11 Light Maintenance Facility Buildings and Sizes

Light Maintenance Facility Building Function	Bay Area Size ⁽¹⁾ (square feet)	LA Area Size ⁽¹⁾ (square feet)
Support & Administration Building	127,960	127,960
Maintenance Building	45,935	45,935
Wheel True Building	24,610	24,610
MOW Building	18,050	18,050
Car Wash Building	26,250	26,250
Service & Inspection Building	60,700	60,700
Total (square feet)	303,505	303,505

Note:

- 1 Facility sizes are preliminary and subject to change.

7.4 Equipment, Other Costs

Each member of the maintenance of rolling stock staff will require a **uniform**. The uniform allowance is based on the uniform costs from the U.S. Office of Personnel Management – Uniform Allowance.²¹ Uniform costs are estimated at \$800 per employee per year.

Maintenance of rolling stock personnel will require a small number of **non-rail vehicles** to move people and materials between various locations within the facilities and between facilities. The vehicle fleet will consist of one car for each maintenance facility. The vehicles are priced based on a rate of \$27,131 per car per year, which includes a lease rate, fuel, maintenance and insurance costs (escalated to 2023 dollars). Additionally, there will be two stake body trucks at the HMF. The stake body trucks are priced with a rate of \$39,605, which includes lease rate, maintenance, fuel and insurance costs (escalated to 2023 dollars). The calculation base is described in Appendix A. The Operations and Maintenance Cost Model includes a conservative allocated contingency rate of 25 percent placed on leased vehicles to account for the acquisition of alternative vehicle models which may be utilized by the eventual operator.

Tools and other consumables are assumed to be 5 percent of the total rolling stock labor cost.

Supervisors will incur **office supply** costs and will require **cell phones**. The office supplies are assumed to be \$656 per year per supervisor based on the Sonoma-Marín Area Rail Transit District Fiscal Year 2023/2024 Adopted Budget.²² The cell phone allowance is estimated at \$499 per year per supervisor (escalated to 2023 dollars).²³

Maintenance of rolling stock facilities will require some information technology/software functionality. Based on the General Services Administration (GSA) per person cost model (escalated to 2023 dollars), the information technology costs are estimated at \$6,873 per user profile. It is assumed that at each maintenance facility, supervisors, storehouse employees and inspections technicians have a user profile. In addition, an allocated contingency rate of 18 percent was assumed to account for additional specialty systems which may be implemented by the eventual operator.

One of the many anticipated amenities to be offered on-board California High-Speed Rail System trains is wireless internet (Wi-Fi) service. The following assumptions are behind the Wi-Fi cost estimates:

1. The cost of maintaining Wi-Fi equipment is included in the recurring trainset maintenance of rolling stock overhaul costs.
2. Wi-Fi equipment will be pre-installed in the frame of each trainset delivered.
3. Wi-Fi will be a free amenity offered to California High-Speed Rail passengers.
4. The monthly cost of Wi-Fi service per train car is approximately \$63.14 (2023 dollars). This estimate is based on Internet connection charges the Northern Indiana Commuter Transportation

²¹ U.S. Office of Personnel Management. Fact Sheet: Uniform Allowances. 2023. Accessed September 2023. <<https://www.opm.gov/policy-data-oversight/pay-leave/pay-administration/fact-sheets/uniform-allowances>>

²² SMART. Sonoma-Marín Area Rail Transit District Fiscal Year 2023/2024 Adopted Budget. 2023. Accessed September 2023. <<https://www.sonomamarintrain.org/sites/default/files/Financial%20Documents/FY2023-2024Draft%20BudgetDocument%20-05-22-2023.pdf>>

²³ Samsung and Oxford Economics. "How much should you reimburse BYOD employees for mobile expenses?" 2022. Accessed September 2023. <<https://insights.samsung.com/2022/05/16/how-much-should-you-compensate-byod-employees-for-mobile-expenses-3/#:~:text=What%20is%20the%20average%20mobile,per%20year%20for%20each%20employee>>

District has paid for in a trial of Wi-Fi service on its commuter rail line between Chicago Millennium Station and South Bend International Airport.²⁴

5. Each California High-Speed Rail trainset would include eight train cars, all with active Wi-Fi equipment that incurs the monthly Wi-Fi service charge. Therefore, the annual Wi-Fi charge per trainset is \$6,061.
6. Wi-Fi service is categorized as a Maintenance of Rolling Stock expense in the Operations and Maintenance Cost Model. As with other Maintenance of Rolling Stock trainset expenditures, an allocated contingency rate of 23 percent is applied on top of annual Wi-Fi expenditures. Please see Section 14.2 for more information on allocated contingency rates.

²⁴ South Bend Tribune. "South Shore testing free Wi-Fi on some cars through the fall" 2015. Accessed September 2023. <<https://www.southbendtribune.com/story/news/local/2015/08/31/south-shore-testing-free-wi-fi-on-some-cars-through-the-fall/46611727/>>

8 MAINTENANCE OF INFRASTRUCTURE

The Maintenance of Infrastructure portion of the model includes the personnel, materials, tools and equipment required to maintain the tracks, systems, structures and facilities. It is assumed that most Maintenance of Infrastructure activities will occur during one tour at night and that daytime Maintenance of Infrastructure staffing will respond to incidents.

8.1 Related Operating Personnel

Personnel for the Maintenance of Infrastructure are divided into the following units:

1. Track and Systems
2. Structures
3. Facilities (stations and rolling stock maintenance facilities)

8.2 Assumptions and Model Inputs

8.2.1 Duties and Responsibilities of Maintenance of Infrastructure Units

The description and duties and responsibilities of the Maintenance of Infrastructure units are as follows:

1. **Track and Systems**—This group is responsible for performing all preventative and corrective maintenance activities required for Track, Signal, Communications, Overhead Catenary System and Electric Traction.
2. **Structures**—This group is responsible for all preventative and corrective maintenance activities required for civil structures including bridges, tunnels, culverts, drainage systems, etc.
3. **Facilities**—This group is responsible for all train maintenance facilities (HMF and LMFs), Maintenance of Way (MOW) facilities and train stations. This encompasses all aspects including but not limited to janitorial services, lighting, HVAC, plumbing and roadways.

8.2.2 Pricing Assumptions

The maintenance staffing is based on a series of assumptions. These assumptions may impact the estimate if they change as the design and construction periods progress.

8.2.2.1 Operations

The Revenue Service Period will be 18 hours per day from 6 a.m. to 12 a.m. The Maintenance Period or Non-Revenue Service Period will be 6 hours per day from 12 a.m. to 6 a.m. These periods will remain the same every day for the entire year.

8.2.2.2 Maintenance

Systems personnel will handle both train control and communications systems with single personnel. There will not be separate train control and communications personnel. During revenue hours, personnel will only respond to incidents, and repairs will happen after the revenue service period has ended for the day, unless all train traffic has been stopped.

- Visual track inspections will not be required. A track geometry system will be installed on a revenue service train.
- A mechanic will be assigned to each track crew during the non-revenue hours.
- Employees will work a minimum of 8 hours per day.
- Major rehabilitation work has not been included.
- Support for adjacent and/or third-party work requiring protection from the Overhead Catenary System (OCS) and/or Track has not been included.

- There will be access to the right of way from adjacent roadways.
- Welders will work in two-person crews.

8.2.2.3 Assets—Silicon Valley to Central Valley

- All track is direct fixation.
- Fencing will be installed on both sides of the track for the entire distance.
- Approximate track miles are 570 for CP Lick to Bakersfield.
- There will be two MOW facilities plus the HMF for a total of three maintenance bases.
- MOW facilities will have track connections and sidings for storage of equipment and accessing the mainline. The MOW facilities will be located near mainline crossovers to allow access to both mainlines.
- The stations to be maintained are Gilroy, Merced, Madera*, Fresno, Kings-Tulare and Bakersfield. Square footages to be maintained are based on the following table.

Table 12 Silicon Valley to Central Valley Station Areas to Be Maintained

Station Name	Track Side (square feet)	Land Side (square feet)	Crew Facility Size (square feet)	Total Facility Area (square feet)
Gilroy	71,177	53,307	0	124,484
Merced	55,177	65,775	810	121,762
Madera ^[1]	59,124	0	0	59,124
Fresno	55,049	14,065	810	69,924
Kings/Tulare	55,177	22,547	0	77,724
Bakersfield	79,577	33,208	810	113,595

Note:

1 Environmentally cleared and funded by others.

- Approximately 15 percent of the track will be built on structures, in a trench or a tunnel.
- There will be WiFi along the entire system.
- The signal system will include Positive Train Control (PTC) and Automatic Train Operation (ATO).
- The track alignment does not include any tight curves that will require more frequent rail replacement.
- Traction power substations and communications and signal houses will be placed at regular intervals along the alignment.
- Communications and signal houses will be combined.
- HMF and LMF in the San Francisco area will be operational.

8.2.2.4 Assets—Phase 1

- All track is direct fixation.
- Fencing will be installed on both sides of the track for the entire distance.
- Approximate track miles are 810 for CP Lick to Burbank.
- There will be three MOW facilities plus the HMF for a total of four maintenance bases.
- MOW facilities will have track connections and sidings for storage of equipment and accessing the mainline. The MOW facilities will be located near mainline crossovers to allow access to both mainlines.
- The stations to be maintained are Gilroy, Merced, Madera*, Fresno, Kings-Tulare, Bakersfield, Palmdale and Burbank. Square footages to be maintained are based on the following table.

Table 13 Phase 1 Station Areas to Be Maintained

Station Name	Track Side (square feet)	Land Side (square feet)	Crew Facility Size (square feet)	Total Facility Area (square feet)
Gilroy	71,177	53,307	0	124,484
Merced	55,177	65,775	810	121,762
Madera ^[1]	59,124	0	0	59,124
Fresno	55,049	14,065	810	69,924
Kings/Tulare	55,177	22,547	0	77,724
Bakersfield	79,577	33,208	810	113,595
Palmdale	113,077	42,508	0	155,585
Burbank	55,177	43,412	60	98,649

Note:

1 Environmentally cleared and funded by others.

- Approximately 15 percent of the track will be built on structures, in a trench or a tunnel.
- There will be WiFi along the entire system.
- The signal system will include PTC and ATO.
- The track alignment does not include any tight curves that will require more frequent rail replacement.
- Traction power substations and communications and signal houses will be placed at regular intervals along the alignment.
- Communications and signal houses will be combined.
- HMF and LMF in the San Francisco area and the Los Angeles area will be operational.

8.2.3 Personnel Headcount

The following personnel are required. All full-time equivalent positions are based on 1,794 hours of work to account for 10 holidays, 15 days of vacation on average, 6 sick/personal days, and 4.75 days of training. The staffing calculations for Silicon Valley to Central Valley and Phase 1 follow these principles:

Revenue Service Period staffing calculations: Staffing levels during the Revenue Service Period were established to provide for 1 to 1.5 hours of response time to an incident.

Maintenance Period staffing calculations: The following staffing levels are based on the performance of required preventative maintenance tasks and availability to perform corrective maintenance tasks as necessary. Personnel were dispersed through the three (Silicon Valley to Central Valley) and four (Phase 1) maintenance bases to reduce travel time due to limited maintenance time.

Table 14 Silicon Valley to Central Valley Full-time Personnel

Position	Division	Total	Revenue Hours	Non-Revenue Hours	Overtime ⁽¹⁾
Chief Engineer	Engineering	1	1	0	-
Deputy Chief Engineer	Engineering	1	1	0	-
Administrative Assistant	Engineering	2	2	0	-
Stores Manager	Track & Systems	1	1	0	-
Stores Clerk	Track & Systems	1	1	0	-
Stores Handling	Track & Systems	3	1	2	-
Procurement Specialist	Track & Systems	1	1	0	-
Track Manager	Track & Systems	2	1	1	-
Track Engineer	Track & Systems	2	2	0	-
Track Supervisor	Track & Systems	3	1	2	-
Track Inspector/Foreman	Track & Systems	13	8	5	15%
Track Laborer	Track & Systems	10	0	10	15%
Equipment Operator	Track & Systems	12	2	10	15%
Welder	Track & Systems	6	0	6	15%
Mechanic	Track & Systems	8	3	5	15%
Systems Manager	Track & Systems	2	1	1	-
Systems Inspector	Track & Systems	8	4	4	15%
Systems Tech.	Track & Systems	26	11	15	15%
Systems Tech. (San Jose to Gilroy Monday-Friday)	Track & Systems	6	6	0	15%
Systems Tech. (San Jose to Gilroy Weekends)	Track & Systems	2	2	0	15%
Systems Engineer	Track & Systems	8	4	4	-
Power/OCS Manager	Track & Systems	2	1	1	-
OCS Supervisor	Track & Systems	2	0	2	-
Power/OCS Inspector/Foreman	Track & Systems	5	0	5	15%
Power Techs	Track & Systems	10	0	10	-
OCS Tech.	Track & Systems	21	11	10	15%
OCS Tech. (CDL License)	Track & Systems	5	0	5	15%
Structures Manager	Structures	1	1	0	-
Structures Engineer	Structures	2	1	1	-
Bridge Inspector	Structures	4	0	4	-
Structures Foreman	Structures	3	0	3	15%

Position	Division	Total	Revenue Hours	Non-Revenue Hours	Overtime ^[1]
Structures Laborer	Structures	5	0	5	15%
Facilities Manager	Facilities	1	1	0	-
Asst. Facility Manager	Facilities	2	1	1	-
Facilities Foreman (HMF & LMF)	Facilities	6	4	2	15%
Facilities Technician (HMF & LMF)	Facilities	7	4	3	15%
Facilities Foreman (Stations)	Facilities	9	9	0	15%
Facilities Technician (Stations)	Facilities	9	9	0	15%
Train Engineer	Not applicable	1	0	0	-
Train Conductor	Not applicable	1	0	0	-
Total FTEs		214	N/A	N/A	N/A

Note:

1 Overtime translated into 35 FTE in the O&M calculation.

8.2.3.1 Silicon Valley to Central Valley Staffing Calculations During the Revenue Service Period

The staffing of certain positions is based on the following calculations:

- Track and Systems
 - Track Inspector
 - 1 person x 18 hours x 365 days X 2 maintenance bases
 - This provides approximately 1.5 hours of response time to an incident.
 - 13,140
 - 8 FTEs
 - Systems Maintainer
 - 1 person x 18 hours x 365 days X 3 maintenance bases
 - This provides for approximately 1 hour of response time to an incident.
 - 19,710 hours
 - 11 FTEs
 - Systems Inspectors
 - 1 per 4 Systems Maintainers
 - 4 FTEs
 - OCS Technician
 - 1 person x 18 hours x 365 days X 3 bases
 - This provides for approximately 1 hour of response time to an incident.
 - 19,710 hours
 - 11 FTEs
- Structures
 - No hourly personnel during revenue service period.
- Facilities
 - Heavy Maintenance Facility
 - Facilities Foreman
 - 1 person x 16 hours per day X 224 days
 - 3,584 hours

- 2 FTEs
 - Facilities Technician
 - 1 person x 16 hours per day X 224 days
 - 3,584 hours
 - 2 FTEs
 - Light Maintenance Facility
 - Facilities Foreman
 - 1 person x 16 hours per day X 224 days x 1 bases
 - 3,584 hours
 - 2 FTEs
 - Facilities Technician
 - 1 person x 16 hours per day X 224 days x 1 bases
 - 3,584 hours
 - 2 FTEs
- Stations—Merced, Gilroy, Fresno and Bakersfield will have 1 person on duty during the Revenue Service Period with overlap to allow for exchanging of information and tasks.
 - Facilities Foreman
 - 1 person x 10 hours per day X 365 days x 4 stations
 - 14,600 hours
 - 9 FTEs
 - Facilities Technician
 - 1 person x 10 hours per day X 365 days x 4 stations
 - 14,600 hours
 - 9 FTEs

8.2.3.2 Silicon Valley to Central Valley Staffing Calculations During the Maintenance Period

- Track and Systems
 - Track
 - Track—Crew of 1 Foreman, 2 Operators, and 2 Laborers operating from each base
 - Track Foreman
 - 1 x 8 hours x 365 days x 3 maintenance bases
 - 8,760 hours
 - 5 FTEs
 - Operator
 - 2 x 8 hours x 365 days x 3 maintenance bases
 - 17,520 hours
 - 10 FTEs
 - Track Laborer
 - 2 x 8 hours x 365 days x 3 maintenance bases
 - 17,520 hours
 - 10 FTEs
 - Welders—Crews of 2 Welders operating from each base
 - 2 people x 8 hours x 224 days x 3 maintenance bases
 - 10,752 hours
 - 6 FTEs

- Facilities Foreman
 - 1 person x 8 hours per day X 224 days x 1 bases
 - 1,792 hours
 - 1 FTEs
- Facilities Technician
 - 1 person x 8 hours per day X 224 days x 1 bases
 - 1,792 hours
 - 1 FTEs
- Stations—No personnel on duty during the Maintenance Period.

Table 15 Phase 1 Full-time Personnel

Position	Division	Total	Revenue Hours	Non-Revenue Hours	Overtime ^[1]
Chief Engineer	Engineering	1	1	0	-
Deputy Chief Engineer	Engineering	1	1	0	-
Administrative Assistant	Engineering	2	2	0	-
Stores Manager	Track & Systems	1	1	0	-
Stores Clerk	Track & Systems	1	1	0	-
Stores Handling	Track & Systems	3	1	2	-
Procurement Specialist	Track & Systems	1	1	0	-
Track Manager	Track & Systems	2	1	1	-
Track Engineer	Track & Systems	2	2	0	-
Track Supervisor	Track & Systems	3	1	2	-
Track Inspector/ Foreman	Track & Systems	15	8	7	15%
Track Laborer	Track & Systems	14	0	14	15%
Equipment Operator	Track & Systems	18	4	14	15%
Welder	Track & Systems	8	0	8	15%
Mechanic	Track & Systems	11	4	7	15%
Systems Manager	Track & Systems	3	1	2	-
Systems Inspector	Track & Systems	10	5	5	15%
Systems Tech.	Track & Systems	35	15	20	15%
Systems Tech. (San Jose to Gilroy Monday-Friday)	Track & Systems	6	6	0	15%
Systems Tech. (San Jose to Gilroy Weekends)	Track & Systems	2	2	0	15%
Systems Engineer	Track & Systems	8	4	4	-
Power/OCS Manager	Track & Systems	2	1	1	-
OCS Supervisor	Track & Systems	2	0	2	-
Power/OCS Inspector/Foreman	Track & Systems	7	0	7	15%

Position	Division	Total	Revenue Hours	Non-Revenue Hours	Overtime ^[1]
Power Techs	Track & Systems	10	0	10	-
OCS Tech.	Track & Systems	29	15	14	15%
OCS Tech. (CDL License)	Track & Systems	7	0	7	15%
Structures Manager	Structures	1	1	0	-
Structures Engineer	Structures	2	1	1	-
Bridge Inspector	Structures	4	0	4	-
Structures Foreman	Structures	5	0	5	15%
Structures Laborer	Structures	10	0	10	15%
Facilities Manager	Facilities	1	1	0	-
Asst. Facility Manager	Facilities	2	1	1	-
Facilities Foreman (HMF & LMF)	Facilities	9	6	3	15%
Facilities Technician (HMF & LMF)	Facilities	9	6	3	15%
Facilities Foreman (Stations)	Facilities	13	13	0	15%
Facilities Technician (Stations)	Facilities	13	13	0	15%
Train Engineer	Not applicable	1	0	0	-
Train Conductor	Not applicable	1	0	0	-
Total FTEs		275	N/A	N/A	N/A

Note:

1 Overtime translated into 45 FTE in the O&M calculation.

8.2.3.3 Phase 1 Staffing Calculations During the Revenue Service Period

The staffing of certain positions is based on the following calculations:

- Track and Systems
 - Track Inspector
 - 1 person x 18 hours x 365 days X 2 maintenance bases
 - This provides approximately 1.5 hours of response time to an incident.
 - 13,140
 - 8 FTEs
 - Systems Maintainer
 - 1 person x 18 hours x 365 days X 4 maintenance bases
 - This provides for approximately 1 hour of response time to an incident.
 - 26,280 hours
 - 15 FTEs
 - Systems Inspectors
 - 1 per 4 Systems Maintainers
 - 4 FTEs
 - OCS Technician
 - 1 person x 18 hours x 365 days X 4 bases
 - This provides for approximately 1 hour of response time to an incident.
 - 26,280 hours

- 15 FTEs
- Structures
 - No hourly personnel during revenue service period.
- Facilities
 - Heavy Maintenance Facility
 - Facilities Foreman
 - 1 person x 16 hours per day X 224 days
 - 3,584 hours
 - 2 FTEs
 - Facilities Technician
 - 1 person x 16 hours per day X 224 days
 - 3,584 hours
 - 2 FTEs
 - Light Maintenance Facility
 - Facilities Foreman
 - 1 person x 16 hours per day X 224 days x 2 bases
 - 7,168 hours
 - 4 FTEs
 - Facilities Technician
 - 1 person x 16 hours per day X 224 days x 2 bases
 - 7,168 hours
 - 4 FTEs
- Stations—Merced, Gilroy, Fresno, Bakersfield, Palmdale and Burbank will have 1 person on duty during the Revenue Service Period with overlap to allow for exchanging of information and tasks.
 - Facilities Foreman
 - 1 person x 10 hours per day X 365 days x 6 stations
 - 21,900 hours
 - 13 FTEs
 - Facilities Technician
 - 1 person x 10 hours per day X 365 days x 6 stations
 - 21,900 hours
 - 13 FTEs

8.2.3.4 Phase 1 Staffing Calculations During the Maintenance Period

- Track and Systems
 - Track
 - Track—Crew of 1 Foreman, 2 Operators, and 2 Laborers operating from each base.
 - Track Foreman
 - 1 x 8 hours x 365 days x 4 maintenance bases
 - 11,680 hours
 - 7 FTEs
 - Operator
 - 2 x 8 hours x 365 days x 4 maintenance bases
 - 23,360 hours
 - 14 FTEs
 - Track Laborer

- 2 x 8 hours x 365 days x 4 maintenance bases
 - 23,360 hours
 - 14 FTEs
 - Welders—Crews of 2 Welders operating from each base.
 - 2 people x 8 hours x 224 days x 4 maintenance bases
 - 3,584 hours
 - 8 FTEs
- Systems—Systems Maintainer working as individuals or a team depending on the work to be performed.
 - Systems Maintainer
 - 3 people x 8 hours x 365 days x 4 bases.
 - 35,040 hours
 - 20 FTEs
 - Systems Inspectors
 - 1 Inspector per 4 Signal Maintainers
 - 5 FTEs
- OCS—Crews of 1 Foreman and 3 Technicians; 1 of the Technicians will have a commercial truck driver's license.
 - OCS Inspector/Foreman
 - 1 person x 8 hours x 365 x 4 bases
 - 11,680 hours
 - 7 FTEs
 - OCS Technicians
 - 2 people x 8 hours x 365 days x 4 bases
 - 23,360 hours
 - 14 FTEs
 - OCS Technician-Commercial Driver's License
 - 1 person x 8 hours x 365 days x 4 bases
 - 11,680 hours
 - 7 FTEs
- Electric Transmission
 - Power Technicians
 - 2 people x 8 hours x 365 days x 3 bases
 - 17,520 hours
 - 10 FTEs
- Structures—Crews of 1 Foreman and 2 Laborers working from 2 bases
 - Structures Foreman
 - 1 person x 8 hours x 365 days x 2 bases
 - 5,840
 - 4 FTEs
 - Structures Laborers
 - 2 people x 8 hours x 365 days x 2 bases
 - 11,680 hours
 - 7 FTEs
- Facilities
 - Heavy Maintenance Facility
 - Facilities Foreman
 - 1 person x 8 hours per day X 224 days

- 1,792 hours
- 1 FTE
- Facilities Technician
 - 1 person x 8 hours per day X 224 days
 - 1,792 hours
 - 1 FTE
- Light Maintenance Facility
 - Facilities Foreman
 - 1 person x 8 hours per day X 224 days x 2 bases
 - 3,584 hours
 - 2 FTEs
 - Facilities Technician
 - 1 person x 8 hours per day X 224 days x 2 bases
 - 3,584 hours
 - 2 FTEs
- Stations—No personnel on duty during the Maintenance Period.

8.2.4 Materials and Other Costs

1. Based on the Union Internationale des Chemins de fer’s International Benchmarking of Track Cost, materials for Maintenance of Infrastructure are estimated as 15 percent of the total Maintenance of Infrastructure labor cost.²⁵
2. An additional 5 percent of the total labor cost is assumed for miscellaneous tools, uniforms and other costs.

8.2.5 Maintenance Vehicles

The Maintenance of Infrastructure teams will also need to have both rubber tire and on-track vehicles. All vehicles are assumed to be leased based on the following table. Lease costs are calculated based on a 5 percent annual interest rate with the term coinciding with the life expectancy of the vehicle. A per gallon fuel rate of \$6.54 was utilized for both gas and diesel vehicles. Annual maintenance was estimated based on a percentage of the purchase price ranging from 1 percent to 5 percent. The table below provides the details by vehicle.

Table 16 Silicon Valley to Central Valley and Phase 1 Non-revenue Vehicles and Equipment

Division	Description	Model	Type	Silicon Valley to Central Valley	Phase 1
Facilities	Stake Body Truck	N/A	Vehicle	1	1
Facilities	Pick-up Truck-Extended Cab	F-150	Vehicle	7	10
CS	4X4 HR Crew Cab Truck	F-250	Vehicle	3	5
CS	Bridge Inspection Truck-HR	N/A	Equipment	2	2

²⁵ US Department of Transportation, Federal Railroad Administration: Technical Monograph: Estimating Maintenance Costs for Mixed High-Speed Passenger and Freight Rail Corridors 2004. Accessed January 2024.
https://railroads.dot.gov/sites/fra.dot.gov/files/fra_net/15003/Technical%20Monograph%20-%20Estimating%20Maintenance%20Costs%20for%20Mixed%20High-Speed%20Passenger%20and%20Freight%20Rail%20Corridors%20%28UNPUBLISHED%29.pdf

Division	Description	Model	Type	Silicon Valley to Central Valley	Phase 1
CS	Pick-up Truck-Extended Cab	F-150	Vehicle	3	3
CS	Vacuum Truck-HR	N/A	Equipment	1	2
T&S	4X4 HR Crew Cab Truck	F-250	Vehicle	4	4
T&S	Backhoe-HR	N/A	Equipment	2	2
T&S	Bucket Loader	N/A	Equipment	2	2
T&S	Bucket Truck-OCS	N/A	Equipment	4	4
T&S	Catenary Car	N/A	Equipment	1	1
T&S	Excavator-HR	N/A	Equipment	2	2
T&S	Flat Cars	N/A	Equipment	3	3
T&S	Fuel & Lube Truck	N/A	Equipment	1	1
T&S	Hi-Rail Inspection Truck	F-250	Vehicle	4	9
T&S	Inspection Car	N/A	Equipment	1	1
T&S	Locomotive	N/A	Equipment	1	1
T&S	Logging Truck-HR	N/A	Equipment	3	4
T&S	Lowboy trailer	N/A	Vehicle	2	2
T&S	Pick-up Truck-Extended cab	F-150	Vehicle	17	0
T&S	Pick-up Truck-Extended cab	N/A	Vehicle	0	31
T&S	Rail Dollies	N/A	Equipment	2	2
T&S	Rail Puller	N/A	Equipment	2	2
T&S	Speedswing	N/A	Equipment	2	2
T&S	Stake Body Truck	N/A	Vehicle	1	2
T&S	Swivel Dump-HR	N/A	Equipment	4	4
T&S	Tractor trailer	N/A	Vehicle	2	2
T&S	Utility Trucks-Mechanic	N/A	Vehicle	3	4
T&S	Utility Trucks-Power	N/A	Vehicle	3	4
T&S	Utility Trucks-Signal	N/A	Vehicle	11	15
T&S	Utility Trucks-Signal Crew	N/A	Vehicle	3	4
T&S	Water Tank	N/A	Equipment	2	2
T&S	Welders Truck	N/A	Vehicle	3	4
Total				102	137

Key: CS = Civil Structure; T&S = Track & Systems.

The calculation base for Table 16 is described in Appendix A.

8.3 Subcontracted Service

Subcontractors will be utilized to perform some maintenance activities including but not limited to the below list:

- Rail grinding
- Vegetation spraying along the right of way
- Janitorial
- Landscaping
- HVAC
- Elevator
- Fire alarm and suppression
- Plumbing
- Electrical in stations and facilities

Table 17 Silicon Valley to Central Valley and Phase 1 Subcontractor Service Costs

Task	Department	Unit	Unit Cost	Silicon Valley to Central Valley Units	Silicon Valley to Central Valley Costs	Phase 1 Units	Phase 1 Costs
Rail Grinding	Track	Track Mile	\$8,425	610	\$5,139,167	818	\$6,891,539
Weed Spraying	Track	Track Mile	\$602	610	\$367,083	818	\$492,253
Janitorial—Stations	Facilities	Sq Ft	\$6.25	522,539	\$3,264,904	692,876	\$4,329,196
Roads—Stations	Facilities	Sq Ft	\$0.5476	522,539	\$286,151	692,876	\$379,430
Landscaping—Stations	Facilities	Sq Ft	\$0.1993	522,539	\$104,146	692,876	\$138,096
General Maintenance Services—Stations	Facilities	Sq Ft	\$4.21	522,539	\$2,201,160	692,876	\$2,918,693
Janitorial—HMF & LMF	Facilities	Sq Ft	\$2.45	472,995	\$1,159,693	618,510	\$1,516,467
Road—HMF & LMF	Facilities	Sq Ft	\$0.5476	472,995	\$259,020	618,510	\$338,706
Landscaping—HMF & LMF	Facilities	Sq Ft	\$0.1993	472,995	\$94,272	618,510	\$123,274
General Maintenance Services—HMF & LMF	Facilities	Sq Ft	\$5.14	472,995	\$2,430,800	618,510	\$3,178,626
On-board Train Cleaning	Facilities	Sq Ft	\$6.25	144,000	\$899,734	144,000	\$899,734
Janitorial—Maintenance of Infrastructure (MOI) Bases	Structures	Sq Ft	\$2.45	30,000	\$73,554	40,000	\$98,072
General Maintenance Services—MOI Bases	Structures	Sq Ft	\$5.14	30,000	\$154,175	40,000	\$205,567

The estimates in Table 17 are based on information from the International Facility Management Association.

8.4 Equipment, Other Costs

Each member of the Maintenance of Infrastructure staff will require a uniform. The uniform allowance is based on the uniform costs from the U.S. Office of Personnel Management – Uniform Allowance.²⁶ Uniform costs are estimated at \$800 per employee per year. This does not apply to the management.

Maintenance of Infrastructure personnel will require cell phones. The cell phone allowance is estimated at \$499 per year per employee based on the U.S. General Services Administration Cost Per Person Model (escalated to 2023 dollars)²⁷ and applies to 210 employees for Silicon Valley to Central Valley and 262 for Phase 1.

The same number of employees is assumed to require information technology/software functionality. Based on the GSA per person cost model (escalated to 2023 dollars), the information technology costs are estimated at \$6,873 per user profile. In addition, an allocated cost contingency of 18 percent was assumed to account for additional specialty systems which may be implemented by the eventual system operator.

²⁶ U.S. Office of Personnel Management. Fact Sheet: Uniform Allowances. 2023. Accessed September 2023. <<https://www.opm.gov/policy-data-oversight/pay-leave/pay-administration/fact-sheets/uniform-allowances>>

²⁷ Samsung and Oxford Economics. "How much should you reimburse BYOD employees for mobile expenses?" 2022. Accessed September 2023. <<https://insights.samsung.com/2022/05/16/how-much-should-you-compensate-byod-employees-for-mobile-expenses-3/#:~:text=What%20is%20the%20average%20mobile,per%20year%20for%20each%20employee>>

9 STATION OPERATIONS AND TRAIN AND STATION CLEANING

The station operations portion of the model consists of personnel and costs directly involved in the operation of passenger stations. Costs for train cleaning at stations, along with yards, are also included in this section.

9.1 Background

Station elements are constructed over time and consist of essential station elements, extended elements, commercial development and blended service corridor planning principles. All signage and wayfinding elements are assumed to be Americans with Disabilities Act compliant.

9.1.1 Essential Elements

The following station operations and customer service essential elements are provided at the platform.

Infrastructure elements:

- Operable platform
- Canopies/climate protection shading
- Vertical circulation escalators and elevators and fixed stairs
- Seating (i.e., benches)
- Pedestrian access
- Vehicular access for maintenance and train commissary services
- Tactile pavers for visually impaired persons
- Fire protection services (fire extinguisher, sprinkler system, visual and audible alarms, detectors)
- Janitor's closet (simple cleaning of the platforms)
- Operations management support/booths
- Restrooms

Operational elements:

- Passenger visual information system based on dynamic information
- Speaker/PA system
- Closed-circuit television (CCTV), security cameras
- Validators and automated fare collection (AFC) devices (optional: ticket vending machines (TVMs))
- Emergency and evacuation facilities (i.e., emergency phones and automated external defibrillator)
- Customer assistance
- Security services
- Facility management services
- Train grooming and light maintenance services
- Waste management services (trash bins, etc.)

Informational elements:

- Timetable and time information
- Station signage (station name, track number, platform sectionized in zones, direction, e.g., North/Southbound)
- Passenger signage and wayfinding (parking, connecting services, passenger amenities)
- Emergency signage and wayfinding
- Station directory and map

9.1.2 Extended Elements

The following station operations and customer service extended elements are provided at station concourse, station building and station entrance facilities.

Infrastructure elements:

- Passenger amenities (seating facilities and waiting areas, restrooms)
- Non-passenger amenities (smart lockers, exhibitions, retail, food courts, convenience stores, mother rooms/nursing stations, pet stations, etc.)
- Entrance lobby and emergency exits
- TVMs (optional)
- Track and System operations facilities (back-of-house technical rooms)
- Train crew support/facilities (crew check-in kiosk/lounge/rest quarters)*
- Station operations crew and control support facilities (station control room)
- Train food service (commissary rooms, temperature-controlled rooms)
- Waste management service area (loading deck, storage area)

Operational elements:

- Customer services
- Security services
- Communication services
- Fire protection services

Informational elements:

- Signage and wayfinding elements (including station directory and map)
- Emergency and evacuation information

All facilities are assumed to be in an enclosed space.

* Only applies to terminal stations, temporary terminal stations, intermediate stations with turnback service or other intermediate stations that service at least 50 percent of daily train trips.

9.1.3 Commercial Development

While all passenger amenity spaces (such as retail and foodservice facilities) may not be provided on the first day of California High-Speed Rail revenue operations, local stakeholders may choose to enhance the sites by providing commercial development or provisions for temporary and flexible activities, such as civic events and food trucks. Other commercial development not related to passenger rail services may also be provided as part of larger station area planning activities.

9.1.4 Blended Service Corridor Planning Principles

The Authority will operate on blended service corridors from San Francisco Transbay to Gilroy and Burbank to Anaheim, and service agreements will be needed with each operator to define scope of responsibility and costs for access to stations in these sections. The Authority has developed and outlined the following core planning principles to guide the development of these service agreements.

- The Authority is a tenant at blended service corridor stations.
 - Blended service corridor station operators will provide:
 - Station operations including station control, staff areas (restrooms, breakrooms and locker rooms)
 - Station maintenance
 - Station infrastructure—including mechanical, electrical, plumbing, fire protection and communications systems
 - Station security and police
 - Passenger functions: Restrooms, wellness rooms, vendor spaces
 - Track and Systems operations
 - Platforms: dedicated platforms to meet Authority-level boarding requirements

- Platform access concourse common spaces (concourses, stairs, elevators, escalators, ramps, etc.)
- Track and Systems spaces on the platform for electrical/communications equipment
- Platform maintenance rooms
- Space for Authority-required functions such as train cleaning/grooming, crew, maintenance and commissary
- The Authority will provide equipment and staff for its ticketing and fare collection and communications.
 - Design criteria includes:
 - Station facility elements that are designed and constructed to the blended service corridor operators' design criteria and should accommodate Authority space requirements.
 - Track and System elements that are designed and constructed to the blended service corridor operators' design criteria and Authority operational requirements, e.g., train envelope, power, track geometry, etc.

9.2 Station Functions

In Section 4, Universal Assumptions, assumption 13 describes the assignment of stations to different station categories. The categories can be described as follows.

9.2.1 Terminal (End-of-Line) Stations

Because trains dwell on terminal station (e.g., SF Transbay) platforms for a longer time than at intermediate stations, these end-of-line stations provide the following operational functions:

1. Track configuration: During Silicon Valley to Central Valley and Phase 1 service, stations should have dedicated platforms and tracks for high-speed rail trains, with the possibility to turn trains based on the signaling system.
2. Grooming and commissary services: Light interior cleaning of the train, trash removal, onboard food service to be provided at dedicated platforms.
3. Crew facilities: Check in/check out (including changeover) and lounge facilities.
4. Ticketing: AFC or TVMs (optional); no staff assumed for ticketing services.

9.2.2 Key Intermediate Stations with Turnback Service

Key intermediate stations with turnback service (e.g., LA Union Station) may have more extensive access to connecting feeder services or a higher level of ridership than regular intermediate stations. During the early stages of the system phase-in, some trains may originate and terminate at these stations to optimize utilization of the train fleet. These stations will have level 2 crew services and police service. These stations provide the following operational functions:

1. Track configuration: During Silicon Valley to Central Valley and Phase 1 service, stations should have the capacity to turn trains (dedicated turning track) and the signaling system to allow for the turn. The track configuration should have dedicated through tracks and switches to connect platform tracks with main tracks.
2. Grooming and commissary services: Light interior cleaning of the train, trash removal, onboard food services to be provided at side track facilities.
3. Crew facilities: Check-in/check-out and lounge facilities.
4. Ticketing: AFC or TVMs (optional); no staff assumed for ticketing services.

9.2.3 Temporary Terminal Stations

During the initial operating phases of the program, some future intermediate stations function as temporary terminal stations (e.g., Merced). Temporary terminal station activities may include the following operational functions:

1. Track configuration: During Silicon Valley to Central Valley and Phase 1 service, stations should be equipped with high floor platform, dedicated boarding area.
2. Grooming and commissary services: Not to be provided.
3. Crew facilities: Check in/check out and lounge facilities.
4. Ticketing: AFC or TVMs (optional); no staff assumed for ticketing services.

9.2.4 Key Intermediate Stations

Key intermediate stations (e.g., Fresno) function as intermediate stations with the specific element of crew lounges allowing for changeovers. The following operational functions are considered: For security and safety reasons, such as to reduce excessive passenger congestion, long-term waiting by passengers is encouraged and facilitated in the concourse area rather than on platforms.

1. Track configuration: During Silicon Valley to Central Valley and Phase 1 service, station track configuration should have dedicated through tracks and switches to connect platform tracks with main tracks. Intermediate stations all have two platform tracks on the side.
2. Grooming and commissary services: Not to be provided.
3. Crew facilities: Check in/check out and lounge facilities.
4. Ticketing: AFC or TVMs (optional), no staff assumed for ticketing services.

9.2.5 Intermediate Stations

Basic California High-Speed Rail stations not functioning as end-of-line or other terminal-type facilities are considered intermediate stations (e.g., Gilroy). The following operational functions are considered: For security and safety reasons, such as to reduce excessive passenger congestion, long-term waiting by passengers is encouraged and facilitated in the concourse area rather than on platforms.

1. Track configuration: During Silicon Valley to Central Valley and Phase 1 service, station track configuration should have dedicated through tracks and switches to connect platform tracks with main tracks. Intermediate stations all have two platform tracks on the side.
2. Grooming and commissary services: Not to be provided.
3. Crew facilities: Check in/check out facilities.
4. Ticketing: AFC or TVMs (optional); no staff assumed for ticketing services.

9.3 Related Personnel

Station personnel include ticket agents and passenger assistance representatives.

Station maintenance and cleaning will be outsourced to subcontractors. In addition, the cost of personnel for cleaning train cars is included in this section. The cost of police and security for stations and trains is covered in Section 10.

9.4 Assumptions and Model Inputs

The following assumptions apply to station operation and cleaning, train cleaning staff and station energy usage.

9.4.1 Station Operations and Cleaning

9.4.1.1 Primary Drivers

The primary driver affecting escalation of station personnel headcount are assumed to be the number of stations in the system and station ridership in each phase. Stations fall under the following classifications.

Table 18 Station Functions and Services for Silicon Valley to Central Valley and Phase 1

High-Speed Rail Station	Station Function	Station Services during Silicon Valley to Central Valley	Station Services during Phase 1
SF Transbay	Terminal	Not applicable	Extended
SF 4th & Townsend	Intermediate	Not applicable	Extended
SF 4th & King	Temporary terminal during Silicon Valley to Central Valley Services, no longer used during Phase 1	Extended	Not applicable
Millbrae	Intermediate	Essential	Essential
San Jose	Intermediate during Silicon Valley to Central Valley Services; key Intermediate with turnback service during Phase 1	Essential	Extended
Gilroy	Intermediate	Essential	Extended
Merced	Temporary terminal	Extended	Extended
Madera ⁽¹⁾	Stop	Not applicable	Not applicable
Fresno	Key intermediate	Extended	Extended
Kings/Tulare	Intermediate	Essential	Essential
Bakersfield	Temporary terminal during Silicon Valley to Central Valley Services; key intermediate during Phase 1	Extended	Extended
Palmdale	Intermediate	Not applicable	Essential
Burbank	Intermediate	Not applicable	Essential
LA Union Station	Key intermediate with turnback service	Not applicable	Extended

Note:

1 Environmentally cleared and funded by others.

9.4.1.2 General Assumptions

- Station personnel consist of ticket clerks/customer service representatives. The primary function of a ticket clerk/customer service representative is to:
 - Give general information about connections, schedule, etc.
 - Assist people with buying tickets.

- Assist people in need of help to get on the train.

Though each station will have automated ticket vending machines, ticket clerks/customer service representatives are expected to provide in-person assistance to customers for a variety of needs. As with most of the operations, this is contingent on the delivery model chosen for the program and the ultimate operator of the system. Given the current concept of operations for the program, it is expected that ticket clerks/customer service representatives will be available at stations to provide a high-level of service consistent with the business class experience envisioned for the system. It is possible that the eventual operator chooses to use more TVMs than assumed in the model. The station staffing is driven by the function of the stations on the system, the train stops per station and the size of the station.

2. Stations may be open for customer operations for up to 18 hours. It is assumed that customer service representatives will be staffed at the stations during those 18 hours. The following table shows the assumed staffing at the respective stations:
3. All stations that have passengers going through them will also require cleaning personnel. This service is contracted out to a third party and depends on the size of each station. Only high-speed rail stations are considered in these costs.

Table 19 Staffing of Station Platforms with Customer Service Personnel

Station	Silicon Valley to Central Valley Peak	Silicon Valley to Central Valley Off-Peak	Phase 1 Peak	Phase 1 Off-Peak
SF Transbay	0	0	4	3
SF 4th & Townsend	3	2	3	2
Millbrae	2	1	2	1
San Jose	2	1	2	1
Gilroy	2	1	3	2
Merced	2	1	3	2
Madera	2	1	2	1
Fresno	3	2	3	2
Kings/Tulare	2	1	2	1
Bakersfield	2	1	3	2
Palmdale	0	0	3	2
Burbank	0	0	3	2
LA Union Station	0	0	4	3
Anaheim	0	0	2	1

9.4.1.3 Personnel Headcount

Customer service staff according to group are listed in assumption 2 above. In addition to those customer service representatives, it is assumed that a manager for passenger services will oversee a pool of station assistants in the field. When Phase 1 starts, an additional manager will be considered.

9.5 Train Cleaning Staff

9.5.1 Primary Drivers

1. Trains going from revenue service to revenue service will generally be cleaned in the stations where they are being turned.
2. Trains going from revenue service to deadhead or from deadhead to revenue service will be cleaned at the maintenance facilities.
3. It is assumed that cleaning services at stations and in the yard are provided by a subcontractor.

9.5.2 Utilities

9.5.2.1 Energy Usage

Table 20 below summarizes the total building area of each station as currently planned. These stations are generally in their conceptual levels of design and will continue to change as the design advances through coordination with local municipalities and agencies.²⁸ These figures are used to calculate the projected energy cost for stations. Station energy usage is assumed to be 14.3 kWh per square foot, based on the Energy Information Agency's average for retail buildings.²⁹

Table 20 Station Building Areas During Silicon Valley to Central Valley and Phase 1

Station	Total Building Area (square feet)
San Francisco Transbay (incl. Caltrain) ^[1]	171,261
San Francisco 4th & Townsend ^[2]	60,964
San Francisco 4th & King ^[3]	89,724
Merced	121,762
Millbrae	58,270
San Jose	152,888
Gilroy	124,484
Madera ^[4]	59,124
Fresno	69,924
Kings/Tulare	77,724
Bakersfield	113,595
Palmdale	155,585
Burbank	98,649

²⁸ The model includes the ability to add the other stations under consideration for the system including infill stations such as Mid-Peninsula and Phase 2 stations, but all of those stations are currently turned off.

²⁹ Energy Information Agency. Commercial Building Energy Consumption Survey. 2003.

<http://www.eia.gov/emeu/cbecs/cbecs2003/detailed_tables_2003/detailed_tables_2003.html> Accessed Dec. 2012.

Station	Total Building Area (square feet)
LA Union Station	152,383
Anaheim	127,498

Notes:

- 1 San Francisco Transbay will only be a Phase 1 station.
- 2 San Francisco 4th & Townsend will only be a Phase 1 station.
- 3 San Francisco 4th & King will only be a station for the Silicon Valley to Central Valley phase.
- 4 Environmentally cleared and funded by others.

9.5.2.2 Water and Sewer

Station water and sewer costs are estimated at \$0.2419 per year per square foot and \$0.2213 per year per square foot, respectively. These are based on the San Francisco Municipal Transportation Agency Operating Budget for FY 2013-2014 (escalated to 2023 dollars).³⁰

9.6 Equipment, Other Costs

9.6.1 Uniforms

Each member of the station staff will require a uniform. The uniform allowance is based on the uniform costs from U.S. Office of Personnel Management – Uniform Allowance.³¹ Uniform costs are estimated at \$800 per employee per year.

9.6.2 Vehicles

Station personnel will require a small number of non-rail vehicles to move supervisors and other personnel around, as necessary. The vehicle fleet will consist of one pick-up truck-extended cab at each high-speed rail station. The price is outlined in the assumptions register and includes the lease rate, fuel costs, maintenance costs and costs for licensing and insurance. The Operations and Maintenance model includes a conservative allocated cost contingency rate of 25 percent placed on leased vehicles to account for other acquisition models which may be utilized by the eventual operator.

9.6.3 Supplies and Cell Phones

Station personnel will incur office supply costs and will require cell phones. The office supplies are assumed to be \$656 per year per employee based on the Sonoma-Marín Area Rail Transit District Fiscal Year 2023/2024 Adopted Budget.³² The cell phone allowance is estimated at \$499 per year per employee (escalated to 2023 dollars).³³

9.6.4 Information Technology/Software

Each station will require some information technology/software functionality. Based on the GSA per person cost model, the information technology costs are estimated at \$6,873 per user profile (escalated

³⁰ SFMTA. SFMTA *Operating Budget for FY 2013–2014*. 14 October, 2013.

<<http://www.sfmta.com/sites/default/files/FY2013FY2014BUDGETBOOKopt.pdf>>

³¹ U.S. Office of Personnel Management. Fact Sheet: Uniform Allowances. 2023. Accessed September 2023.

<<https://www.opm.gov/policy-data-oversight/pay-leave/pay-administration/fact-sheets/uniform-allowances>>

³² SMART. Sonoma-Marín Area Rail Transit District Fiscal Year 2023/2024 Adopted Budget. 2023. Accessed September 2023.

<<https://www.sonomamarintrain.org/sites/default/files/Financial%20Documents/FY2023-2024Draft%20BudgetDocument%20-05-22-2023.pdf>>

³³ Samsung and Oxford Economics. "How much should you reimburse BYOD employees for mobile expenses?" 2022. Accessed September 2023. <<https://insights.samsung.com/2022/05/16/how-much-should-you-compensate-byod-employees-for-mobile-expenses-3/#:~:text=What%20is%20the%20average%20mobile,per%20year%20for%20each%20employee>>

to 2023 dollars). It is assumed that each station will have two user profiles, and each terminal will have four user profiles. In addition, an allocated cost contingency of 18 percent was assumed to account for additional specialty systems which may be implemented by the eventual operator.

10 POLICE AND SECURITY POSITIONS

This section provides background information, positions, assumptions and headcount analysis for police and security functions.

An independent risk assessment can be conducted on each location/facility which would help to assess specific hazards, risks and provide potential mitigations. Police and security staffing can be adjusted accordingly to the inherent risk identified at those locations, for example, high crime areas, remoteness of location and availability/timeliness of police response.

10.1 Primary Drivers

1. The planned number of facilities and passenger stations for each segment and the total route miles of the system.
2. The planned size and function of the stations.
3. Supervisory requirements for a workforce of various sizes.
4. Twenty-four-hour, seven-day-a-week security guard coverage.

10.2 General Assumptions

10.2.1 Police (California Highway Patrol)

Under the current Operations and Maintenance Cost Model, all policing for the California High-Speed Rail System (train and infrastructure) will be provided by the California Highway Patrol (CHP) funded through a legislative budgetary action. Therefore, at this time, the details are not included in this section.

10.2.2 Security Officers

The California High-Speed Rail Authority will be responsible for the **security** portion across Silicon Valley to Central Valley and Phase 1, executed by unsworn officers.

Thus, only **unsworn officers** are included in the current model.

- An **unsworn officer** or **security guard** is a trained security person in the employ of a certified security firm/contractor. Unsworn officers will be positioned at each station, equipment maintenance facility and maintenance of infrastructure base.
- Unsworn officers/security guards are assumed to be employed under agreements with private security firms. However, for current modeling purposes, the costs are estimated to be consistent with the rest of the model as non-contracted positions but using the appropriate rates from those organizations.
- It is recommended that one security contract be executed to include all facilities in lieu of many separate security contracts for logistical and cost considerations.

10.2.3 Facility Design

The following assumptions are made regarding the security concept of the facilities:

- The Maintenance of Equipment (MOE) and Maintenance of Way (MOW) facilities are completely fenced and are provided with a security guard booth at the main gate entrance.
- The administration buildings are included within the fenced compound.
- An access control system is provided for all MOE and MOW facilities.
- Station parking areas are fenced, well-lit and provided with blue light (call for help) stations.

- Parking areas will be patrolled on a periodic/random basis by one of the two security guards assigned to each station.
- CCTV cameras are provided in all stations and parking areas and are monitored off-site by other personnel (non-security guards).

10.3 Security Functions

Security functions will include providing 24-hour coverage to all maintenance facilities as well as all stations operational in each phase of the project. The functions of the security officers are the same for either segment, but the manpower requirements differ due to size of the facility.

Additionally, an electronic Security Guard Checkpoint System should be installed around all facilities patrolled by security guards. This system will ensure the guards are actively patrolling all areas of each facility.

The following requirements are defined for staffing the individual facilities.

10.3.1 Maintenance of Equipment Facilities

There are two MOE facilities assumed for Silicon Valley to Central Valley. Three guards per shift would be required for security:

- One guard posted in a guard booth at the entrance to the complex;
- One guard posted at a security desk in the administration building; and
- One guard who would “rove” the entire complex including all buildings, grounds and employee parking areas.

It is anticipated that this would be a 24-hour operation (three shifts) per day. Security for Phase 1 would provide the same coverage and manpower requirements, except that the concept would be extended to three facilities.

Access control to the MOE complexes should have card readers installed at the guard booths for employee access and plans developed for deliveries and non-employees.

10.3.2 Maintenance of Way Facilities

Three MOW facilities for Silicon Valley to Central Valley and four for Phase 1 are assumed. Functions and manpower requirements are consistent with the MOE facilities with the exception that no administration buildings are located within these complexes. Therefore, there is one less guard required per shift.

Access control to the MOW complexes should have card readers installed at the guard booths for employee access and plans developed for deliveries and non-employees.

10.3.3 Stations

The Silicon Valley to Central Valley Line includes nine stations which are provided with 24-hour/7-day-a-week coverage. It is assumed that two guards would be assigned to each station per shift, which would allow for periodic/random security checks of the parking facilities.

For Phase 1, it is assumed that the same coverage would be provided, including manpower for providing security for the 14 stations.

For two of the 14 stations (San Francisco Transbay and Los Angeles Union Station), it is assumed that four security guards per shift are required. These guards would be located throughout the station and allow for one guard to perform periodic random checks of the parking facilities.

Supervisory headcount is added based on the number of security guards associated with each facility.

10.4 Personnel Headcount

The required full-time equivalents are depending on the location and the classification of the station in the system. The following full-time equivalents are assumed:

Table 21 Silicon Valley to Central Valley and Phase 1 Security Headcount

Stations/Facilities	Silicon Valley to Central Valley	Phase 1
SF Transbay & LA Union Station	0	34
All Other Stations	75	109
Maintenance of Equipment Facilities	24	35
Maintenance of Way Facilities	26	34
Total FTE	125	212

10.5 Equipment, Other Costs

The security functions will require minimal equipment for their day-to-day operations which should be included in the security contract. The equipment needs and drivers for the unsworn officers, including command staff, are as follows:

- Personal equipment
- All-terrain vehicles, including fuel and disposables
- Communications equipment (cell phone/radios)

11 COMMERCIAL COSTS AND FUNCTIONS

The commercial costs portion of the Operations and Maintenance Cost Model consists of the costs and functions to market the Authority's high-speed rail services, the revenue collected from those who use these services as well as environmental, health and safety cost considerations.

11.1 Marketing, Revenue Collection and Environmental, Health and Safety

The marketing budget that the marketing and branding department spends to increase ridership includes advertising costs. Revenue collection describes the assumed approach related to ticket sales and the associated costs. Other commercial costs address the obligations related to environment as well as ensure the health and safety of riders and staff.

11.1.1 Marketing and Branding Department

For the purpose of the 2024 Business Plan, the following assumptions for marketing and branding were made:

- Primary marketing and branding staff will have a central location for the entire system:
 - Silicon Valley to Central Valley (San Francisco to Bakersfield starting September 2033)
 - Phase 1 (San Francisco to Los Angeles to Anaheim starting July 2035)
- Staffing will need to be in place six months to approximately a year before service begins to develop the launch campaign and develop awareness and demand for the service.
- Station assistants are assumed to be available at all stations 18 hours, seven days per week.
- A full-service advertising agency will be engaged to develop an advertising campaign and to plan and place media. Other out-sourced services include research, a loyalty program support agency, an on-call graphic designer, a public relations/crisis communications agency and call center support.
- System investments include customer relationship management (CRM) and website programming, support and analytics.

Local outreach subcontractors will be engaged to help drive up demand and will be located in the Central Valley and Bay Area during the Silicon Valley to Central Valley phase and located in the Los Angeles area during Phase 1.

11.1.1.1 Marketing and Branding Development

Marketing and branding (M&B) are essential to overall ridership and revenue success. This program will build excitement, anticipation, interest and intent to try rail services.

The Train Operating Company (TOC) early, customer-centric approach is assumed to be subcontracted with an accomplished California-based marketing firm to conduct market research that helps identify the most effective messaging and visuals as a compelling brand identity to be created for California High-Speed Rail. It will define the key elements for the brand in close cooperation with the Authority, including developing an inspiring product name that triggers positive emotions, is related to local roots and resonates with different cultures across California. 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 California High-Speed Rail. The campaign 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.

The following types of functions are assumed to be performed by the TOC:

- 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.

11.1.1.2 Cost Drivers

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

- **Advertising agency service contract:** integrated marketing campaign and paid media advertising
- **Customer Call Center:** passenger assistance with ticketing, schedule/trip planning, refunds
- **Loyalty program**
- **PR/crisis communications firm service contract**
- **Web and mobile integration and analytics support:** customer account management (CRM) licensing agreements—account management that interfaces with the revenue collection function

In line with the scope of this budget, upfront fixed costs related to realization of customer account management/CRM platform, customer call center, website and customer facing app are excluded, as these are assumed to have been put in place and paid for on commencement of full stand-alone revenue service.

11.1.2 Advertising

Advertising costs are based on the number of people that the advertising campaign is trying to reach and the number of impressions required for the campaign to have an impact. This is expressed as a cost per thousand impressions, or cost per mille (CPM). People generally need to see an ad multiple times to be influenced by it; this concept is called the effective frequency of advertising, and it generally ranges from three to five times, depending on the campaign, product or service, target audience, media channels, etc.

When the operator of California High-Speed Rail plans an advertising campaign, the Authority targets specific market segments and populations based on current market conditions, research, strategy, budget and geographic priorities at the time of execution. For the purposes of this cost model, we have assessed two geographic scenarios for the first two phases:

1. Silicon Valley to Central Valley (San Francisco to Bakersfield)
2. Phase 1 (San Francisco to Los Angeles)

The geographic coverage for each phase includes the following markets.

Table 22 Geographic Coverage by Phase

Silicon Valley to Central Valley	Phase 1
Bakersfield	Bakersfield
Fresno	Fresno
Modesto	Modesto
Sacramento	Sacramento
Stockton	Stockton
Visalia	Visalia
Monterey/Salinas/Santa Cruz	Monterey/Salinas/Santa Cruz
San Francisco/Oakland/San Jose	San Francisco/Oakland/San Jose
San Luis Obispo	San Luis Obispo
Santa Barbara	Santa Barbara
Santa Maria-Lompoc	Santa Maria-Lompoc
Not applicable	Los Angeles/Orange County
Not applicable	Oxnard/Ventura
Not applicable	Riverside/San Bernardino

For the purposes of the cost calculation, the model assumes that the campaign will reach every person in a select number of counties in California. It also assumes that no advertising will take place in other states. The counties that will be targeted by each phase are as follows:

Silicon Valley to Central Valley: Alameda, Contra Costa, Fresno, Kern, Kings, Los Angeles, Madera, Marin, Mariposa, Merced, Monterey, Sacramento, San Benito, San Francisco, San Joaquin, San Luis Obispo, San Mateo, Santa Barbara, Santa Clara, Santa Cruz, Stanislaus, Tulare, Ventura

Phase 1 (in addition to the aforementioned counties): Orange, Riverside, San Bernardino

Costs are estimated with a primary audience of adults aged 18 and older, assuming sufficient budget to execute a combination of local mass media channels, including TV, radio, outdoor and digital (display, mobile, over the top (OTT)³⁴, social media and video). The impression allocation for this estimation is as follows.

³⁴ OTT covers a wide range of content delivered through applications and third-party services (Hulu, Amazon Prime, etc.). Over-the-top content can be accessed directly through an Internet-connected platform such as a PC, laptop, tablet, smartphone, and other web enabled devices (smart TVs, Apple TV, Roku, etc.).

Table 23 Media Channel Impression Allocations

Media Channel	Percent of Impressions
Local TV	25%
Radio	20%
Outdoor	40%
Digital (including display, mobile, OTT, social media and video)	15%

Based on the above impression allocation and average media cost estimates for 2019-2020, the effective CPM (in June 2023 dollars) is \$27.13 for the Silicon Valley to Central Valley Phase and \$32.10 for Phase 1.

Table 24 Estimated CPM

Geography	Phase	Target Audience	Estimated CPM
San Francisco to Bakersfield	Silicon Valley to Central Valley	Adults 18+	\$27.13
San Francisco to Los Angeles/Anaheim	Phase 1	Adults 18+	\$32.10

This estimate is characterized by the following:

- The cost estimate takes into account newer digital media tactics, such as digital video and OTT video streaming services accessible through various devices and services.
- The cost estimate for broadcast media is based on regional advertising costs and include local and regional media CPMs.

11.1.3 Revenue Collection

The 2024 Business Plan includes several assumptions for a comprehensive revenue collection system. In the following approach, the entire system's costs are being accounted for.

In addition to customer convenience and travel experience, the following key goals are assumed:

- **Payment integration** so that travellers can easily plan and make a trip using multiple mobility services with a single transaction, identify price options and book trips across various connecting services, including high-speed rail.
- **Data security and identity protection** to consider current and upcoming consumer privacy laws and regulations. On January 1, 2020, significant changes to California's privacy laws went into effect. The California Consumer Privacy Act grants consumers the right to know what information companies have about them—and to have that information deleted. To ensure electronic identification for tickets, a code on a mobile device or a chip in a credit card can be used.
- **Multiple payment options** to address the needs of riders who rely on cash.
- **State of the art technology**, which is the most advanced in terms of software and technological infrastructure.

- **Minimizing the high cost of collecting revenues** is an important consideration. The cost reductions include specification development, implementing a full-scope software, refinements to hardware and information technology infrastructure, as well as system monitoring and analytics.

To implement these core objectives, the system must not have characteristics such as metal barriers or conventional ticket vending machines at stations. To enable individuals to make cash payments, partnerships can be established with retailers or other financial service institutions. Instead of having staffed ticket windows at stations to assist customers with tickets, customer service assistance is assumed (see Section 9 on stations) to ensure customers receive information and assistance with boarding.

A cost of 5 percent based on the revenue is assumed in the 2024 Business Plan to enable such a system. This estimate includes cost categories such as transaction fees; ticketing as a service implementation fees; system update and maintenance fees; and payment fees to the financial service provider.

11.1.4 Environmental, Health and Safety

11.1.4.1 Environmental Considerations

Assuming 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 Storage Tank Permitting

Obtain permits, implement plans, develop training modules, document inspections and certifications. This includes development of an associated Spill Prevention, Control and Countermeasure plan.

Storm Water/Wastewater Quality Compliance

Ensure compliance with regulations governing equipment service documentation, training, wastewater, facility water, Storm Water Pollution Prevention Plan (SWPPP), Industrial General Permit (IGP) and National Pollutant Discharge Elimination System permitting. The Environmental Technician will provide regular inspections, as required by the SWPPP and IGP. The Environmental Manager will consult with each affected Regional Water Quality Control Board (RWQCB) through which the alignment passes, including the:

- San Francisco RWQCB
- Central Coast RWQCB
- Central Valley RWQCB
- Lahontan RWQCB
- Los Angeles RWQCB
- Santa Ana RWQCB

Air Pollution Compliance

Obtain permits, schedule inspections and certify portable equipment for the Phase 1 corridor. 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 per the following district requirements:

- Bay Area Air Quality Management District
- Monterey Bay Air Resources District
- San Joaquin Valley Air Pollution Control District

- Eastern Kern Air Pollution Control District
- Antelope Valley Air Quality Management District
- South Coast Air Quality Management District

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

Develop and perform employee training, implement the weed control plan as per final CEQA/NEPA mitigation measures and biological permits. The Environmental Officer will act as Weed Management Officer during the operations period.

Hazardous Materials Management

Obtain permits, write performance reports, train personnel, perform inspections and prepare shipping manifests. In addition, the community right-to-know in the Emergency Planning and Community Right-to-Know Act, Superfund Amendments and Reauthorization Act Title III requires an Emergency Response Report, a Hazardous Materials Business Plan and a Chemical Inventory, all of which will be developed by the Environmental Officer. Hazardous Materials/Hazardous Waste Permits will likely be required at each Operations and Maintenance Facility. The Environmental Manager will manage permits and plan compliance with the associated jurisdictional Certified Unified Public Agency for the following as described:

- San Francisco: San Francisco Department of Public Health – EH Branch
- San Jose: County of Santa Clara Hazardous Materials Compliance Division
- Gilroy: County of Santa Clara Hazardous Materials Compliance Division
- Merced: Merced County Environmental Health
- Fresno: Fresno County Department of Public Health
- Bakersfield: Kern County Environmental Health Services Department
- Palmdale: Los Angeles County Fire Department
- San Fernando Valley: Los Angeles County Fire Department
- Los Angeles: Los Angeles County Fire Department

Sustainability Management

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

11.1.4.2 Health and Safety

The following elements are considered in the field of health and safety.

Injury and Illness Prevention Plan

Develop an Injury and Illness Prevention Plan (IIPP) which includes:

- 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 Plan

Develop a Heat Illness Prevention Plan that applies to all outdoor places of employment, including emergency response procedures. The plan must be reviewed annually.

Valley Fever Control Measures

Implement 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; and
- Making respiratory protection masks with particulate filters available to workers.

Emergency Preparedness Plan

Develop an Emergency Preparedness Plan that is available online for all emergency responders. The plan must be distributed every three years or when plans change and include:

- Procedures for initial and on-board notification to the control center; and
- Procedures to inform passengers and indicate corrective countermeasures. The control center notifies emergency responders, adjacent rail modes of transportation and appropriate railroad officials.

Fire Safety

Annually, develop written procedures for inspection, testing and maintenance of systems and equipment.

Emergency Action Plan

Develop and implement an Emergency Action Plan. The plan must be reviewed annually or when plans change and should 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; and
- 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 also be established.

Radiofrequency Radiation Exposure Limits and Electric System

Report maximum permissible levels for whole and partial body exposure to electromagnetic energy. Document safety standards and train personnel for proper operation, maintenance, repair and inspections of electrical systems.

Health and Safety Labor

Develop health and safety plans and ensure that the plans are implemented as required. Plans should include:

- Training procedures for employees working in various departments; and
- Information to direct health and safety personnel.

11.1.4.3 Cost Drivers

The major cost drivers associated with environmental compliance are labor, environmental permits and third-party inspection requirements.

11.2 Bus Costs

The O&M costs include costs for the Authority's own buses. Considering the state of California's regulation to transition to zero-emission public buses by 2040;³⁵ the CARB Zero-Emission Bus Implementation Guidebook for California Transit Fleets requiring that new purchases of buses by transit agencies beginning in 2029 must be ZEBs³⁶ and recent developments in the public transit sector, with agencies successfully implementing electric bus fleets and the assumed future advancements in the storage capacity of the batteries used in electric buses, the ETO assumed a fully electric bus fleet for the Business Plan. These buses are used to ensure complete coverage of the high-speed rail system.

The following bus services are assumed. Silicon Valley to Central Valley service is assumed connecting Bakersfield to Anaheim. One bus connection from Bakersfield is assumed, with a convenient transfer to the high-speed rail trains. The three bus line runs every half hour.

The bus costs per mile have been determined based on the study Costs and Benefits of Electrifying and Automating Bus Transit Fleets,³⁷ which describes assumptions for battery electric buses. The assumptions for the bus operating cost have then been adjusted to reflect the current price index and a motor coach bus operation. The purchase price for the bus service provider is assumed to be \$1,200,000 per bus. The cost rate is assumed to be a full cost rate and includes costs for financing, depreciation, insurance, electricity, maintenance, and labor. These costs have been converted into a per mile fee of \$9.19.

The number of bus miles is determined by the service plan for the system as well as connecting bus services expected to be offered. Deadhead miles are added to the revenue miles to reach total bus miles. The APTA 2019 Public Transportation Fact Book for 2017 shows national total bus vehicle miles of 2,291.4 million and revenue miles of 1,987.9 million. The percentage of deadhead miles in addition to revenue miles is 15.3 percent.³⁸ This percentage is assumed to be applicable to the planned bus connections to the high-speed rail system and is applied uniformly for each year. The per-mile fee is then applied to both the revenue and non-revenue miles to arrive at the total bus operating and maintenance cost. More information on bus miles can be found in the Service Planning Methodology Technical Supporting Document.

³⁵ California Air Resources Board Press Release. December 14, 2018. Accessed November 2021. <<https://ww2.arb.ca.gov/news/california-transitioning-all-electric-public-bus-fleet-2040>>

³⁶ California Air Resources Board Website, <<https://ww2.arb.ca.gov/our-work/programs/innovative-clean-transit>> with reference to the CARB Zero-Emission Bus Implementation Guidebook for California Transit Fleets, April 1, 2023. Accessed October 2023. <<https://escholarship.org/content/qt8x88036r/qt8x88036r.pdf?t=rt2ar8>>

³⁷ Multidisciplinary Digital Publishing Institute (MDPI). May 13, 2020. Accessed October 2023. <<https://www.mdpi.com/2071-1050/12/10/3977>>

³⁸ American Public Transportation Association. 2018 APTA Fact Book. Accessed November 2021. <<https://www.apta.com/wp-content/uploads/Resources/resources/statistics/Documents/FactBook/2018-APTA-Fact-Book.pdf>>

11.3 Operator Profit

It is currently assumed that operator profit will be calculated and evaluated separately during the contracting process. One of the key rationales for contracting is the reduced cost that can be achieved by the contractor (after taking profit into account). As such, it is not currently included in the model, as contracting decisions have not been finalized.

11.4 Tax Liability

It is currently assumed that tax liabilities will be calculated and evaluated separately. As such, tax liability is not currently included in the model.

12 GENERAL ADMINISTRATION AND EXECUTIVE MANAGEMENT

The executive and corporate organization is comprised of senior level personnel and experienced support staff who lead and direct the organization at the command and policy level. The organization's chief executive officer (CEO, president or executive director) chairs this group, and its members oversee the major departments and their functions. The positions described in this section are illustrative of the major functions that comprise management. However, the number of personnel required to fill these functions is calculated as a percentage of the total personnel employed at the system.

12.1 Related Personnel

The executive and corporate organization are comprised of several organizational levels. The top level consists of the CEO—the top officer of the organization. The CEO reports to a senior board of appointed individuals and is responsible for the highest level of decision-making and policy setting.

The executive/corporate functions of a railroad organization immediately below the CEO are generally divided into the following areas of responsibility and are represented by the titles which accompany them. The examples below illustrate management positions typically used in other organizations. Note that although these positions are most often considered senior within the organization, such organization placement is dependent upon the “corporate organization” philosophy. They are included here for the purpose of illustrating a typical corporate structure and providing an example of the functions required at the senior level.

1. The **chief operating officer** is responsible for the railroad's primary operating functions: the operation of trains and transportation of customers, the maintenance and repair of the rolling stock, the maintenance and repair of infrastructure, the selling of tickets and the customer services provided in the passenger station. These areas are directed and managed by department heads, reporting to the vice president of operations.
2. The **chief environmental health and safety officer** is responsible for corporate safety policies and procedures, for directing regulatory requirements and managing safety data and reporting, and overseeing the effectiveness of the departmental safety programs.
3. The **chief legal officer** is responsible for representing the railroad in general legal matters and litigation as determined by the general counsel. Such matters commonly relate to corporate law, liability and claims, contracts, labor law, insurance and so forth.
4. The **chief financial officer** is responsible for the development of the budget, payroll, general accounting, accounts payable, revenue accounting, and pertinent financial policies and procedures for the organization. The position manages financial forecasting and reporting, bookkeeping, and other corporate finance responsibilities as necessary.
5. The **chief human resources officer** (CHRO) is responsible for developing and managing the primary HR policies and procedures, functions of recruiting and hiring, personnel administration and records management, diversity management, and benefits administration. In addition, the CHRO is responsible for preparing and managing labor agreements for conducting labor negotiations, managing disputes, and providing direction to departments that are affected by labor contracts and practices. This role often falls under Human Resources.
6. The **chief procurement officer** directs and manages the development of contracts for material and services needed by the organization.
7. The **chief digitalization officer** (CDO) is responsible for developing the corporate strategy, policies, and procedures on information systems based upon the technology needs of the organization. Other activities include the purchase, development, installation and maintenance of

the information systems. Additionally, the CDO is responsible for the digitalization and system integration of commercial and operational services.

8. Other positions, including internal auditing, may be elevated to the corporate level as a way to maintain direct linkage to the chief executive and preserve the priority of the function.

12.2 Assumptions and Model Inputs

The following assumptions are made concerning the executive and corporate level of the organization:

1. The total headcount for management and administration of the system is assumed to be 10 percent of the total of the other departments, the so-called blue-collar workers. The calculated number (subtotal) forms the basis for distributing the number among the different levels.
2. Executive positions are estimated to comprise 5 percent of this subtotal and are assumed to be compensated at senior executive rates.
3. Senior manager positions below executives are estimated to comprise 10 percent of the subtotal and are assumed to be compensated at a rate 25 percent below executive rates.
4. Mid-managers are estimated to comprise 25 percent of the subtotal and are assumed to be compensated at a manager's/supervisor's rate.
5. Administration and other lower-level corporate staff are estimated to comprise 60 percent of the subtotal and will be compensated accordingly.
6. The allocation of positions with general and administrative staffing is based on a comparison with other railroad properties in the U.S. and high-speed rail systems abroad.

12.3 Equipment, Other Costs

General and administrative personnel will require a number of non-rail vehicles. The vehicle fleet is assumed to be 16 cars for Silicon Valley to Central Valley and for Phase 1. The cars are priced based on a standard SUV lease rate which includes fuel costs, maintenance and insurance with a rate of \$27,131 per car (escalated to 2023 dollars). In addition, a conservative cost contingency rate of 25 percent is assumed and calculated on leased vehicles to account for other acquisition models which may be utilized by the eventual operator.

All general and administrative personnel will incur office supply costs, and the managers will require cell phones. The office supplies are assumed to be \$656 per year per general and administrative employee based on the Sonoma-Marín Area Rail Transit District Fiscal Year 2023/2024 Adopted Budget.³⁹ The cell phone allowance is estimated at \$499 per year per manager, general and administrative employees at the mid-management level or higher (escalated to 2023 dollars).⁴⁰

Each general and administrative employee will require information technology/software functionality. Based on the GSA per person cost model, information technology costs are estimated at \$6,873 per user profile (escalated to 2023 dollars). It is assumed that each general and administrative employee will have a user profile. In addition, the Operations and Maintenance Cost Model assumes a conservative cost

³⁹ SMART. Sonoma-Marín Area Rail Transit District Fiscal Year 2023/2024 Adopted Budget. 2023. Accessed September 2023. <<https://www.sonomamarintrain.org/sites/default/files/Financial%20Documents/FY2023-2024Draft%20BudgetDocument%20-05-22-2023.pdf>>

⁴⁰ Samsung and Oxford Economics. "How much should you reimburse BYOD employees for mobile expenses?" 2022. Accessed September 2023. <<https://insights.samsung.com/2022/05/16/how-much-should-you-compensate-byod-employees-for-mobile-expenses-3/#:~:text=What%20is%20the%20average%20mobile,per%20year%20for%20each%20employee>>

contingency rate of 18 percent placed on leased vehicles to account for additional specialty systems which may be implemented by the eventual operator.

It is assumed that the managers will incur some amount of travel expenses per year. The costs are estimated at \$1,375 per year for mid-managers, \$4,124 per year for senior managers and \$13,747 per year for executive managers. These estimates are based on figures established in prior business plans and escalated to 2023 dollars using Consumer Price Index escalation.

13 INSURANCE

Currently, the Authority is evaluating the overall insurance strategy. In the 2024 Business Plan it is assumed that the Authority is responsible for taking out insurance policies. Marsh, a global leader in insurance broking and risk management, provided updated coverage rates for the 2022 Business Plan, which are based on ridership, revenues and asset values. For the 2024 Business Plan, the fixed and variable insurance rates were escalated to 2023-dollar values. The general insurance costs provided by Marsh are broken down into six categories, as described in the following table.

Table 25 Insurance Costs

Insurance Type	Self-Insured Retentions/ Deductible	Insurance Coverage Limits	Description
General and Rail Liability	\$1.0M	\$350M	Provides coverage for injury and damage caused by the Authority's operations, or occurring on the Authority's property. Commercial general liability insurance premiums for operations with significant rail exposure are determined through an analysis of many factors including passenger count, fare revenue, miles of rail, speed and number of trains, number of "at grade" crossings and whether the track utilized is single or double, shared with others or dedicated.
Real and Personal Property	\$1.0M to \$2.5M	\$1.0B	Provides coverage for structures, buildings, property within structures and other improvements in the event of damage. Includes base coverage for fire, water damage and earthquakes.
Rolling Stock Property	\$1.0M to \$2.5M	\$1.0B	Provides coverage for rolling stock and trainset property in the event of damage.
Business Interruption	\$1.0M	\$100M	Provides coverage for loss of net profits and continuing expenses in circumstances where insured physical damage to insured property forces to suspend high-speed rail operations, or where passengers or employees cannot gain access to the premises.
Track and Infrastructure Assets	\$2.5M	\$1.0B	Provides additional coverage for track and infrastructure assets, such as catenary, bridges and tunnels, in the event of insured loss or damage.
Earthquake and Flood	\$1.0M	\$100M	Provides additional coverage for insured high-speed rail property and assets in the event of flooding, earthquakes as defined in the policy.

Marsh's insurance estimates are applicable on an annual basis and include fixed and variable components depending on the type of coverage, as described in the following table.

Table 26 Fixed and Variable Insurance Rates

Insurance Type	Variable Rate (2023 \$)	Variable Rate Description	Insurance Costs 2040 Phase 1 (2023 \$)
General and Rail Liability	\$0.29	Per Passenger	\$8.2M
Real and Personal Property	\$1.42	Per \$1,000 of Insurable Value	\$7.8M
Rolling Stock Property	\$2.36	Per \$1,000 of Insurable Value	\$6.1M
Business Interruption	\$2.13	Per \$1,000 of Revenue	\$5.2M
Track and Infrastructure Assets	\$0.28	Per \$1,000 of Insurable Value	\$11.0M
Earthquake and Flood	N/A	Fixed Rate of \$6.0M	\$7.1M

Insurance rates from Marsh reflect risk factors at the time of the production of the 2024 Business Plan and may change in future years as the high-speed rail system design and concept of operations advances to a higher level of completion.

14 CONTINGENCY

The model contains two sets of contingencies: unallocated contingency to account for unknowns that may arise in the operations and maintenance of the system and allocated contingency to account for known risks, uncertainties and unknowns associated with individual cost categories. The contingency percentages that were applied followed the guidance from the Department of Transportation Inspector General's report for systems at intermediate stages of development and amount to a total of 20 to 30 percent total contingency, based on the various cost items.

14.1 Unallocated Contingency

Unallocated contingency is set at 5 percent of all cost items before consideration of allocated contingency. This is the same as the unallocated contingency applied in the lifecycle cost estimate and is deemed sufficient to account for unknowns and unexpected costs that may come up.

14.2 Allocated Contingency

The allocated contingency percentages used in the 2022 Business Plan Operations and Maintenance Cost Model assume the same ones used in 2020 Business Plan Operations and Maintenance Cost Model. Although, higher quality information is now available for each cost category, and as a result, confidence ratings have most likely increased since the 2020 Business Plan, it is proposed to maintain a level of conservatism. (However, to remain consistent with the 2020 Business Plan and to maintain a level of conservatism in the allocated contingency assumptions, allocated contingency percentages remain the same.)

Table 27 Allocated Contingency Percentages by Cost Category

Cost Category	Allocated Contingency Percentage (%)
Labor	See below
Maintenance of Equipment	20.00
Maintenance of Infrastructure	22.50
On-board Staff (including road manager and protect crews)	21.25
Dispatching	16.25
Train Cleaning and Station Maintenance Staff	18.75
Stations	22.50
Police and Security	18.33
General and Administrative Staff	21.25
Materials, Tools and Other Direct Costs	See below
Maintenance of Infrastructure Materials (including stations)	22.50
Maintenance of Infrastructure Tools, Uniforms, etc.	20.63
Maintenance of Infrastructure Vehicles	25.00
Vehicles Besides Maintenance of Infrastructure and Police and Security	21.67
Police and Security Vehicles	20.00
Police and Security Equipment	20.00

Cost Category	Allocated Contingency Percentage (%)
Employee Supplies and Expenses (e.g., uniforms, information technology, cell phones, office supplies, etc.) for Every Department	18.33
Maintenance of Equipment Tools, Uniforms, Etc.	20.63
Maintenance of Equipment Regulatory Inspections	21.25
Maintenance of Equipment General Overhauls and Bogie Inspections	22.50
Utilities	See below
Train Operations Energy	19.38
Stations and Maintenance Facilities Energy	22.50
Stations and Maintenance Facility Water and Sewer	24.17
Other Costs	See below
Bus Costs	23.13
Advertising	21.67
Revenue Collection	20.00
Marketing and Branding, Including Advertising and Call Center	21.67
Insurance	18.33

15 OPERATIONS STARTUP AND COMMISSIONING

15.1 Rolling Stock Procurement

Based on the required number of trainsets for service, protect and maintenance purposes, Table 28 below describes a possible delivery schedule for rolling stock. Assuming a realistic delivery of up to 10 trainsets per year after completion of a production ramp-up phase, the table shows how the required number of trainsets can be met. In addition, further considerations have been taken into account such as the service plans for the Silicon Valley to Central Valley Line and Phase 1 and the rate of ridership growth projected in the 2022 Business Plan. This delivery schedule may be modified at the time of trainset procurement based on vendor input and capital considerations.

Table 28 Potential Rolling Stock Delivery Schedule

Silicon Valley to Central Valley	Year	No. of Trainsets	Phase 1	Year	No. of Trainsets
Available from Central Valley Segment service	0	6	Available from Silicon Valley to Central Valley service	0	17
Before operations	-3	3	Before operations	-4	6
Before operations	-2	4	Before operations	-3	10
Before operations	-1	4	Before operations	-2	10
Start of operations	0	0	Before operations	-1	10
No data	0	0	Start of operations	0	5
	Total	17		Total	58

15.2 Testing and Commissioning

The 2024 Business Plan Operations and Maintenance Cost Model reflects a steady state operation after the start of revenue service. Costs for pre-operation activities, such as testing and commissioning, are currently not addressed in the Business Plan.

15.3 System Resiliency

In the rare event of a stranded train or an emergency, it is assumed that the train could be rescued by utilizing other units of the existing high-speed rail fleet, due to available standby trainsets stationed throughout the system. The costs for these trainsets are included in the O&M cost estimate.

16 MONTE CARLO RISK ANALYSIS

Monte Carlo simulations are part of a broad class of computational algorithms that rely on repeated random samplings from a range of variable inputs to determine the probability of different cost, schedule, revenue or other outcomes. Monte Carlo simulations are used in a variety of ways for the California High-Speed Rail Program to determine possible cost, schedule or revenue outcomes when uncertainty and risk are incorporated into the underlying models. Consistent with the 2022 Business Plan, the 2024 Business Plan utilized a top-down reference class analysis based on comparable rail projects around the globe to evaluate risks to the operations and maintenance forecasts for the California High-Speed Rail Program.

Another possible way Monte Carlo methods are used is as part of a “bottom-up” analysis, replacing point-estimates with probability distributions and incorporating risks into the baseline cost estimate, schedule or revenue projection to calculate possible cost, schedule, revenue or other outcomes. Single values or point estimates for inputs such as activity durations or line-item costs are replaced with probability distributions or ranges of possible cost or durations to account for the inherent uncertainty surrounding any particular point-estimate. For example, the 45 days a planned activity in a schedule is expected to take is replaced with a duration range, such as taking between 40 and 60 days.

The possibility of unplanned activities or unexpected costs (risks) may also be included as inputs. Risk “events,” that may or may not happen, may be added according to the assigned probability of occurrence, each having a defined impact range such as days of delay or additional costs. The algorithm selects (“samples”) a value from the range that has been given to that input, records it, goes on to the next activity or line-item, selects a value from its distribution, records it and continues to do so for every input to the model. When it runs into a risk, it will “roll the dice” to determine if the risk has happened on this particular run and if so, select from the range of possible impacts to determine its effect, just as with other inputs. If the risk has a high probability of occurring, then on most runs, the risk will happen and will impact the final result. If it is low, then on most runs, it will not. In other words, the dice are loaded based on what initial probability was assigned to the risk.

Once it has sampled from every input distribution and risk, completing one run or iteration, it calculates the result—in the case of a cost estimate, simply adding up all the different individual amounts for each line-item and risk event that happened on that particular iteration—simulating one possible outcome. Then the algorithm repeats this process to obtain another possible outcome. The algorithm will repeat this process thousands of times, depending on how complicated the underlying model and inputs are, until it is “satisfied” that a full range of possible outcomes and associated probabilities has been determined. These probabilities—how likely a particular cost, completion date or revenue projection is—are key differentiators between the results of Monte Carlo simulation techniques and the results of traditional “what-if” or scenario analysis which typically does not provide any guidance as to how likely (or not) a particular outcome is, such as how likely it is that a project will finish on time or on budget.

16.1 Utilizing a Top-down Vs. Bottom-up Analysis

In the 2024 Business Plan, Monte Carlo simulations were employed as part of a top-down or reference-class analysis. While reference class analysis cannot provide the granularity of a traditional bottom-up approach that is most useful from an internal management standpoint, the results of the reference-class analysis are based on actual project outcomes and are not dependent on the quality or comprehensiveness of internal risk identification or assessment efforts. In a top-down analysis, the algorithm works much the same way and is used for the same purposes, but instead of individual schedule activities or costs, it uses actual outcomes from similar projects to determine the probability of certain outcomes, for example, that a particular revenue projection will be met or costs will be below a certain target.

The results of a traditional or bottom-up risk analysis approach are typically captured in a risk register. As recommended in Department of Transportation Inspector General guidance and elsewhere, the risk register is eminently useful for systematizing and documenting the identification, assessment and mitigation of individual risks. For this reason, it is a key tool in California High-Speed Rail System risk management efforts as described in the Authority's Risk Management Plan. The risk register and underlying bottom-up approach do, however, have potentially significant limitations with regard to the accurate quantification of risk exposure, which also contributes to the decision to use a top-down approach. Chief of these limitations is that the degree to which such an effort captures the actual risk exposure is dependent on the ability of participants to comprehensively identify and then accurately quantify the impact of said risks.

To a greater or lesser extent, a bottom-up analysis is also affected by certain modeling decisions such as the correlation between individual risks—the actualization of some affects the likelihood and impact of others, sometimes making them more likely and/or expensive, sometimes less. For the vast majority of project risks, there is no objective means for determining the appropriate correlation factor. Additionally, to be complete, this methodology also requires a determination of the dollar value of any identified schedule impacts, which in turn requires a significant amount of foresight regarding not just what risk may strike a project but also when. The extent to which these activities are carried out by project personnel and/or stakeholders also introduces the potential for optimism bias. For business planning purposes, as opposed to internal tracking and risk management purposes, the key objective for the analysis was and is to develop an accurate, objective measure of the risk exposure as measured by the potential variance between actual (eventual) and estimated costs together with the probability of a given variance. Given the relative weaknesses of a bottom-up approach for such a determination, the O&M risk analysis employs a reference-class methodology for O&M cost risk quantification.

In reference-class analysis, the algorithm is given a set of outcomes from other, similar projects and then uses these in a Monte Carlo simulation to, in a sense, work backwards to determine a probability distribution that would lead to the given set of outcomes. From this resulting distribution, we can determine how likely a particular outcome is for this project based on the outcomes of other similar projects. This is akin to asking a number of people who live in your town how long it takes them to drive to another town. From this sample, you could develop a general idea of what is a reasonable amount of time to allot for your trip and what is not. The Monte Carlo simulation simply allows for much more specific predictions, e.g., there is a 75 percent chance that your trip will take between 41 and 57 minutes or there is a 2 percent chance that your trip will take longer than 80 minutes.

For the O&M risk analysis, the Authority identified the six reference projects in Table 29.

Table 29 Reference Project Cost Variances from Plan

System	O&M Variance from Plan
Sprinter	-1%
FrontRunner	1%
LGV Rhone-Alpes	4%
LGV-Nord	6%
Music City Star	27%
Réseau Express Régional E	34%

Based on these results, the Authority parameterized a risk exposure curve as follows:

1. Minimum: Medium cost scenario with unallocated contingency only.
2. Most Likely: Medium cost scenario with full contingency.
3. Maximum: Medium cost scenario with full contingency plus 34 percent.

The minimum (best case scenario) was set as the medium cost scenario plus unallocated contingency only. Unallocated contingency was equivalent to 5 percent of the baseline cost; all allocated contingency was removed. The most likely cost parameter for the risk curve was taken to be equivalent to the medium cost scenario with full contingency—allocated and unallocated. As in the 2024 Business Plan, the maximum is based on the worst reference case scenario, or the largest cost overrun as a percentage of the original cost estimate, and is set at 34 percent above the medium cost scenario with full contingency.

The above parameterization provides a reasonable, well-supported assessment of the potential risk exposure for O&M costs. However, if there is a bias, a number of factors suggest that the parameterization is more likely to overstate potential costs than understate them.

In particular:

- The Operations and Maintenance Cost Model is not yet optimized due to the fact that the system is not yet 100 percent designed. As more factors are defined, the easier it will be to think about efficiency measures.
- The 2024 Business Plan was based on the 2022 Operations and Maintenance Cost Model and associated assumptions, and the ETO and related subject matter experts reviewed the cost estimates. With regard to the approach for different cost categories, minor changes were made in the calculation structure of a few cost items for the 2024 Business Plan. Consistent with the 2022 Business Plan, the 2024 Business Plan retains the high-speed rail service planning and the use of the Viriato software tool, which allows for an improved timetable creation, as well as includes the calculation of train trip times with pad and the construction of conflict-free service concepts in areas of the high-speed rail operation with mixed service operation (Peninsula and South of Burbank).
- The Lignes à Grande Vitesse (LGV) Rhone-Alps and LGV Nord reference cases show 4 percent and 6 percent cost overruns, respectively, and are the two most on-point cases in the reference set, as they are both high-speed rail systems.⁴¹ Nevertheless, the maximum parameter was set based on the worst case in the reference set, a 34 percent cost overrun on the Réseau Express Régional E system.

These parameters were input to a Monte Carlo simulation(s), and individual simulations were run for each year of each phase, Silicon Valley to Central Valley (San Francisco to Bakersfield), and Phase 1 (San Francisco to Los Angeles/Anaheim) as well as for each year of all (combining Silicon Valley to Central Valley and Phase 1), based on the risk-adjusted cost estimates for those years and phases. The minimum, most likely and maximum scenarios were derived from the reference class parameters listed above.

The risk analysis was applied to the cost of each phase incrementally by using the same parameterization independently on Silicon Valley to Central Valley Line costs, (incremental) Phase 1 costs, and all (total) costs for each year. Within each phase, correlation factors were applied between years under the assumption that costs, whether high or low, had some year-to-year momentum; in other words, if costs in a particular year fell on the high side of the distribution, they were more likely to be high the following year

⁴¹ Even these, relatively minor, cost overrun percentages may overstate actual cost overruns.

on that particular iteration. A positive correlation of 0.50 was assumed for each year within the Silicon Valley to Central Valley Line and Phase 1.

Table 30 Correlation Rates Used for 2024 Business Plan Risk Analysis

Category	Silicon Valley to Central Valley	Phase 1
Correlation Rate	0.50	0.50

17 BREAKEVEN ANALYSIS

To help evaluate operational viability, a breakeven analysis was performed using a Monte Carlo risk analysis. The analysis determined a probability for fare box revenues to be equal to or greater than operations and maintenance costs. The analysis used the same revenue and O&M cost models discussed in the 2023 Project Update Report and in this Technical Supporting Document. In addition, the analysis assumed a 0.50 positive correlation factor between fare box revenue and O&M costs. This assumption was made to account for the possibility that if revenues were to be higher or lower than expected, there would be corresponding changes to service, resulting in similar movement in O&M costs. The results provide a probability distribution pairing different profit or loss outcomes with their likelihood, which allows the Authority to determine the probability of system revenues equaling or exceeding O&M costs.

Given the multi-year nature of the planned operating contract, the breakeven projections and the expertise of a private sector operator, the Authority fully anticipates that the ramp-up period cash flows can be well-managed through contractual payment structures and short-term working capital and the system will not require an operating subsidy.

Table 31 presents the results of the breakeven analysis during (1) Silicon Valley to Central Valley Line and (2) Phase 1. For the 2024 Business Plan, the Silicon Valley to Central Valley Line and Phase 1 have been modeled separately in a steady state, thus no ramp-up was applied. Table 31 shows that as the Silicon Valley to Central Valley Line and Phase 1 operations progress over time, the probability of equaling or exceeding breakeven reaches 100 percent.

Table 31 System Probability of Revenue Exceeding Operations and Maintenance Costs in Select Years

Timing	2030	2040	2050
Silicon Valley to Central Valley	78%	82%	84%
Phase 1	98%	98%	99%

APPENDIX A: ASSUMPTIONS REGISTER

1. Universal

Opening years of the train service:

- Silicon Valley to Central Valley: N/A*
- Phase 1: N/A*

* Due to the ongoing evaluation of planning and financing of the Silicon Valley to Central Valley and the Phase 1 alternatives, The Authority is unable to define a discrete opening year horizon for either scenario. Therefore, the analysis for both alternatives for the 2024 Business Plan provides data streams in parallel for each alternative.

Fringe benefits:

- \$25,000 for the health, vision, dental and retiree health plans
- 4.15 percent of wage up to \$22,700 for Railroad Unemployment Insurance Act benefits
- 13.1 percent of wage up to \$118,800 for Railroad Retirement Tier 2
- 6.2 percent of wage up to \$160,200 for Railroad Retirement Tier 1
- 0.9 percent of wage up to \$153,164 for State Disability Insurance
- 0.1 percent of wage up to \$7,000 for Employment Training Tax
- 7.45 percent with no limit (1.45 percent for Medicare and 6 percent for Federal Employers Liability Act compensation)

Overtime:

- The model doesn't assume overtime hours, as all workload needs are converted into regular FTE terms. It is assumed, that one FTE works 1,794 hours per year.

General and administrative staffing:

- General and administrative personnel are assumed to be 10 percent of the total workforce (including frontline supervisors).

Seasonality:

- The same number of trains, and therefore the same number of crews, will operate every day. Crews will work a 40-hour workweek, with relief days covered by separate crews.

Inflation:

- All cost items and wages are in June 2023 dollars.

Shared asset costs:

- For shared assets, it is assumed that the other party is paying track access fees.
 - Silicon Valley to Central Valley and Phase 1: The Authority pays track access fees from San Francisco to CP Lick using Caltrain assets. Caltrain pays track access fees to the Authority for the section CP Lick to Gilroy.
 - Phase 1 (additionally): The Authority pays track access fees to Metrolink for the section from Burbank to Anaheim.

2. Train Operations

Crew size:

- Crew size is calculated based on the total service time, including deadhead miles of the trains.

Single trainset crews:

- A single trainset crew consists of: one engineer, one conductor, two assistant conductors.

Protect crews:

- A protect crew, single trainset crew consists of: one engineer, one conductor, one assistant conductor.

Road manager:

- Up to 100 employees to be supervised: The number of Road Managers increases proportionally comprising 10 percent of the employees. In this range, the workload of the Road Manager is considered to be 50 percent leadership/supervision and 50 percent administration.
- Beyond 100 employees to be supervised: The efforts for administration increase proportionally at 50 percent for leadership/supervision, but only at 25 percent for administration, as administrative synergies will become more effective. This leads to a Road Manager's quota of 7.5 percent starting with the 101st employee.

Shunting driver:

- Headcount for 24 hours per stabling yard, is equivalent to five FTE.
- Silicon Valley to Central Valley: 10 FTE
- Phase 1: 15 FTE

Other positions:

- One Planning Director, one Performance and Data Manager for Silicon Valley to Central Valley and Phase 1
- One Scheduler for Silicon Valley to Central Valley and two Schedulers for Phase 1

Energy costs:

- \$0.203 per kWh, based on PG&E transmission voltage rates available in the B-20 tariff

Energy consumption:

- 37.0 kWh per trainset mile during Silicon Valley to Central Valley Line and 37.0 kWh per trainset mile during Phase 1

Vehicles:

- 15 4WD Ext. Cab Pick Up/SUV for Silicon Valley to Central Valley, 40 for Phase 1
- Two Minibuses for Silicon Valley to Central Valley and Phase 1

3. Dispatching

Operations Control Center:

- There will be one Operations Control Center on the system.

- The Operations Control Center will have one Director—Operations Control, one Chief Line Dispatcher (5 FTE), two Line Dispatchers (10 FTE) in the Silicon Valley to Central Valley Line and three Line Dispatchers (15 FTE) in Phase 1.
- There will be one Information Controller for Silicon Valley to Central Valley and Phase 1.
- The Operations Control Center will be on for three tours per day.

Yard:

- Two Depot Dispatchers per yard (10 FTE) for Silicon Valley to Central Valley and three per yard (15 FTE) for Phase 1

Vehicles:

- Two 4WD Ext. Cab Pick Up/SUV for Silicon Valley to Central Valley and Phase 1

4. Maintenance of Rolling Stock

Regulatory inspection staffing:

- See Table 8

Regulatory inspection frequency:

- Daily, 311 inspections per year per trainset
- Every 2 weeks (15,000 miles), 25 inspections per year per trainset
- Every 2 months (65,000 miles), 6 inspections per year per trainset
- Wheel Truing: each 160,000 miles
- Corrective maintenance

Regulatory inspection materials costs:

- Daily, \$49 per inspection
- Every 2 weeks (15,000 miles), \$49 per inspection
- Every 2 months (65,000 miles), \$5,198 per inspection
- Wheel truing: \$112 per inspection
- Corrective maintenance: Assumed to be performed at a yearly trainset material cost of \$196,609 for Silicon Valley to Central Valley and \$247,778 for Phase 1.

Overhaul staffing (bogies inspection):

- See Table 9

Overhaul inspection frequency:

- Overhaul general inspection 1: each 250,000 miles
- Overhaul general inspection 2: each 600,000 miles
- Major overhaul 1: each 1,200,000 miles
- Major overhaul 2: each 2,000,000 miles
- Major overhaul 3: each 3,000,000 miles

Overhaul material costs:

- Overhaul general inspection 1: \$7,566 per cycle
- Overhaul general inspection 2: \$8,968 per cycle
- Major overhaul 1: \$820,707 per cycle
- Major overhaul 2: \$1,374,908 per cycle
- Major overhaul 3: \$505,740 per cycle

Energy:

- Maintenance facility utility costs are estimated at 27 kWh per square foot.

Facility levels:

- Level 5: HMF
- Level 3: Bay Area
- Level 3: Los Angeles Area

Facility size:

- HMF—727,800 sq. ft.
- Bay Area—303,505 sq. ft.
- Los Angeles Area—303,505 sq. ft.

Vehicles:

- One car per maintenance facility
- Two stake body trucks at the HMF

Tools:

- 5 percent of total labor cost

5. Maintenance of Infrastructure

Staffing:

- See Table 15 and Table 16

Materials:

- 15 percent of Maintenance of Infrastructure labor cost

Tools:

- 5 percent of Maintenance of Infrastructure labor cost

Vehicles

- See Table 32 and Table 33

Table 32 Silicon Valley to Central Valley Maintenance of Infrastructure Costs

Division	Type	Model	Vehicle or Equip.?	Quantity	Purchase Price	Total Purchase Price	Fuel Type	Fuel Consumption	Annual Mileage	Annual Fuel Consumption	Annual Mtce as % of capex	Lease Rate 5%	Fuel Cost Per Gallon \$4.25	Annual Mtce Cost	Annual Licensing as % of Purchase 2%	Insurance per Vehicle \$5,000	Total Annual Cost	Life Expectancy
CS	4X4 HR Crew Cab Truck	F-250	Vehicle	3	88,635	265,906	G	12	20,000	5,000	3%	61,418	32,500	7,977	1,228	17,727	120,850	5
CS	Bridge Inspection Truck-HR	N/A	Equipment	2	1,009,950	2,019,901	D	10	20,000	4,000	2%	261,586	26,000	40,398	5,232	11,818	345,034	10
CS	Pick-up Truck-Extended Cab	F-150	Vehicle	3	47,272	141,817	G	10	20,000	6,000	3%	32,756	39,000	4,254	655	17,727	94,393	5
CS	Vacuum Truck-HR	N/A	Equipment	1	406,886	406,886	D	5	10,000	2,000	3%	52,694	13,000	12,207	1,054	5,909	84,863	10
RS Maint.	Stake Body Truck	N/A	Vehicle	1	147,726	147,726	D	10	15,000	1,500	3%	19,131	9,750	4,432	383	5,909	39,605	10
Facilities	Pick-up Truck-Extended Cab	F-150	Vehicle	7	47,272	330,905	G	10	8,000	5,600	3%	76,431	36,400	9,927	1,529	41,363	165,650	5
Facilities	Stake Body Truck	N/A	Vehicle	1	147,726	147,726	D	10	15,000	1,500	3%	19,131	9,750	4,432	383	5,909	39,605	10
G&A	SUV	N/A	Vehicle	16	47,272	756,355	G	15	20,000	21,333	3%	174,699	138,667	22,691	3,494	94,544	434,095	5
Ops	SUV	N/A	Vehicle	17	47,272	803,627	G	15	20,000	22,667	3%	185,618	147,333	24,109	3,712	100,453	461,225	5
T&S	4X4 HR Crew Cab Truck	F-250	Vehicle	4	88,635	354,541	G	12	20,000	6,667	3%	81,890	43,333	10,636	1,638	23,636	161,134	5
T&S	Backhoe-HR	N/A	Equipment	2	338,420	676,841	D	5	3,500	1,400	3%	65,208	9,100	20,305	0	11,818	106,432	15
T&S	Bucket Loader	N/A	Equipment	2	531,812	1,063,624	D	5	3,500	1,400	3%	75,467	9,100	31,909	0	11,818	128,293	25
T&S	Bucket Truck-OCS	N/A	Equipment	4	265,906	1,063,624	G	10	20,000	8,000	2.5%	137,744	52,000	26,591	2,755	23,636	242,726	10
T&S	Catenary Car	N/A	Equipment	1	2,441,314	2,441,314	D	3	10,000	3,333	1%	235,202	0	24,413	0	0	259,615	15
T&S	Excavator	N/A	Equipment	2	649,992	1,299,985	D	3	6,000	4,000	2%	125,243	26,000	26,000	2,505	11,818	191,566	15
T&S	Flat Cars	N/A	Equipment	3	13,563	40,689	N/A	0	0	0	5%	2,887	0	2,034	0	17,727	22,648	25
T&S	Fuel & Lube Truck	N/A	Equipment	1	623,390	623,390	D	10	20,000	2,000	3%	80,732	13,000	18,702	1,615	5,909	119,957	10
T&S	Hi-Rail Inspection Truck	F-250	Vehicle	4	76,817	307,269	G	10	30,000	12,000	3%	70,971	78,000	9,218	1,419	23,636	183,245	5
T&S	Inspection Car	N/A	Equipment	1	33,907,141	33,907,141	N/A	0	0	0	1%	2,205,708	0	339,071	0	0	2,544,780	30
T&S	Locomotive	N/A	Equipment	1	2,712,571	2,712,571	D	3	10,000	3,333	5%	176,457	0	135,629	0	0	312,085	30
T&S	Logging Truck-HR	N/A	Equipment	3	443,177	1,329,530	D	5	15,000	9,000	2%	172,180	58,500	26,591	3,444	17,727	278,441	10
T&S	Lowboy Trailer	N/A	Vehicle	2	177,271	354,541	N/A	0	0	0	3%	34,157	0	10,636	0	11,818	56,612	15
T&S	Pick-up Truck-Extended Cab	F-150	Vehicle	17	47,272	803,627	G	10	20,000	34,000	3%	185,618	221,000	24,109	3,712	100,453	534,892	5
T&S	Production Tamper	N/A	Equipment	0	4,018,135	0	D	2	0	0	3%	0	0	0	0	0	0	20
T&S	Rail Dollies	N/A	Equipment	2	23,636	47,272	N/A	0	0	0	1%	3,793	0	473	0	0	4,266	20
T&S	Rail Puller	N/A	Equipment	2	13,563	27,126	N/A	0	0	0	5%	6,265	0	1,356	125	11,818	19,565	5
T&S	Speedswing	N/A	Equipment	2	413,631	827,263	D	5	20,000	8,000	2%	58,696	52,000	16,545	1,174	11,818	140,234	25
T&S	Stake Body Truck	N/A	Vehicle	1	147,726	147,726	D	10	15,000	1,500	3%	19,131	9,750	4,432	383	5,909	39,605	10
T&S	Swivel Dump-HR	N/A	Equipment	4	436,485	1,745,942	D	5	15,000	12,000	1.5%	226,107	78,000	26,189	4,522	23,636	358,455	10
T&S	Tractor trailer	N/A	Vehicle	2	531,812	1,063,624	D	5	7,000	2,800	2.5%	102,472	18,200	26,591	0	11,818	159,081	15
T&S	Utility Trucks-Mechanic	N/A	Vehicle	3	88,635	265,906	D	10	20,000	6,000	3%	61,418	39,000	7,977	1,228	17,727	127,350	5
T&S	Utility Trucks-Power	N/A	Vehicle	3	76,817	230,452	G	12	20,000	5,000	3.5%	53,229	32,500	8,066	1,065	17,727	112,586	5

Division	Type	Model	Vehicle or Equip.?	Quantity	Purchase Price	Total Purchase Price	Fuel Type	Fuel Consumption	Annual Mileage	Annual Fuel Consumption	Annual Mtce as % of capex	Lease Rate 5%	Fuel Cost Per Gallon \$4.25	Annual Mtce Cost	Annual Licensing as % of Purchase 2%	Insurance per Vehicle \$5,000	Total Annual Cost	Life Expectancy
T&S	Utility Trucks-Signal	N/A	Vehicle	11	76,817	844,990	G	12	20,000	18,333	3.5%	195,171	119,167	29,575	3,903	64,999	412,815	5
T&S	Utility Trucks-Signal Crew	N/A	Vehicle	3	82,726	248,179	G	12	20,000	5,000	3.5%	57,323	32,500	8,686	1,146	17,727	117,383	5
T&S	Water Tank	N/A	Equipment	2	29,545	59,090	N/A	0	0	0	2%	4,742	-	1,182	95	11,818	17,836	20
T&S	Welders Truck	N/A	Vehicle	3	384,086	1,152,259	D	10	20,000	6,000	2%	149,223	39,000	23,045	2,984	17,727	231,980	10
Total				136	N/A	58,659,361	N/A	N/A	N/A	219,367	N/A	5,470,498	1,382,550	990,386	51,383	774,082	8,668,899	N/A

Table 33 Phase 1 Maintenance of Infrastructure Costs

Division	Type	Model	Vehicle or Equip.?	Quantity	Purchase Price	Total Purchase Price	Fuel Type	Fuel Consumption	Annual Mileage	Annual Fuel Consumption	Annual Mtce as % of capex	Lease Rate 5%	Fuel Cost Per Gallon \$4.25	Annual Mtce Cost	Annual Licensing as % of Purchase 2%	Insurance per Vehicle \$5,000	Total Annual Cost	Life Expectancy
G&A	SUV	N/A	Vehicle	16	47,272	756,355	G	15	20,000	21,333	3%	174,699	138,667	22,691	3,494	94,544	434,095	5
Ops	SUV	N/A	Vehicle	47	47,272	2,221,792	G	15	20,000	62,667	3%	513,178	407,333	66,654	10,264	277,724	1,275,153	5
RS Maint.	Stake Body Truck	N/A	Vehicle	1	147,726	147,726	D	10	15,000	1,500	3%	19,131	9,750	4,432	383	5,909	39,605	10
Facilities	Stake Body Truck	N/A	Vehicle	1	147,726	147,726	D	10	15,000	1,500	3%	19,131	9,750	4,432	383	5,909	39,605	10
Facilities	Pick-up Truck-Extended Cab	F-150	Vehicle	10	47,272	472,722	G	10	8,000	8,000	3%	109,187	52,000	14,182	2,184	59,090	236,642	5
CS	4X4 HR Crew Cab Truck	F-250	Vehicle	5	88,635	443,177	G	12	20,000	8,333	3%	102,363	54,167	13,295	2,047	29,545	201,417	5
CS	Bridge Inspection Truck-HR	N/A	Equipment	2	1,009,950	2,019,901	D	10	20,000	4,000	2%	261,586	26,000	40,398	5,232	11,818	345,034	10
CS	Pick-up Truck-Extended Cab	F-150	Vehicle	3	47,272	141,817	G	10	20,000	6,000	3%	32,756	39,000	4,254	655	17,727	94,393	5
CS	Vacuum Truck-HR	N/A	Equipment	2	406,886	813,771	D	5	10,000	4,000	3%	105,387	26,000	24,413	2,108	11,818	169,726	10
T&S	4X4 HR Crew Cab Truck	F-250	Vehicle	4	88,635	354,541	G	12	20,000	6,667	3%	81,890	43,333	10,636	1,638	23,636	161,134	5
T&S	Backhoe-HR	N/A	Equipment	2	338,420	676,841	D	5	3,500	1,400	3%	65,208	9,100	20,305	1,304	11,818	107,736	15
T&S	Bucket Loader	N/A	Equipment	2	531,812	1,063,624	D	5	3,500	1,400	3%	75,467	9,100	31,909	1,509	11,818	129,803	25
T&S	Bucket Truck-OCS	N/A	Equipment	4	265,906	1,063,624	G	10	20,000	8,000	2.5%	137,744	52,000	26,591	2,755	23,636	242,726	10
T&S	Catenary Car	N/A	Equipment	1	2,441,314	2,441,314	D	3	10,000	3,333	1%	235,202	21,667	24,413	0	5,909	287,191	15
T&S	Excavator-HR	N/A	Equipment	2	649,992	1,299,985	D	3	6,000	4,000	2%	125,243	26,000	26,000	2,505	11,818	191,566	15
T&S	Flat Cars	N/A	Equipment	3	13,563	40,689	N/A	0	0	0	5%	2,887	0	2,034	0	17,727	22,648	25
T&S	Fuel & Lube Truck	N/A	Equipment	1	623,390	623,390	D	10	20,000	2,000	3%	80,732	13,000	18,702	1,615	5,909	119,957	10
T&S	Hi-Rail Inspection Truck	F-250	Vehicle	9	76,817	691,355	G	10	30,000	27,000	3%	159,686	175,500	20,741	3,194	53,181	412,301	5
T&S	Inspection Car	N/A	Equipment	1	33,907,141	33,907,141	N/A	0	0	0	1%	2,205,708	0	339,071	0	5,909	2,550,689	30
T&S	Locomotive	N/A	Equipment	1	2,712,571	2,712,571	D	3	10,000	3,333	5%	176,457	0	135,629	0	5,909	317,994	30
T&S	Logging Truck-HR	N/A	Equipment	4	443,177	1,772,706	D	5	15,000	12,000	2%	229,574	78,000	35,454	4,591	23,636	371,255	10
T&S	Lowboy Trailer	N/A	Vehicle	2	177,271	354,541	N/A	0	0	0	3%	34,157	0	10,636	0	11,818	56,612	15
T&S	Rail Dollies	N/A	Equipment	2	23,636	47,272	N/A	0	0	0	1%	3,793	0	473	0	11,818	16,084	20
T&S	Rail Puller	N/A	Equipment	2	13,563	27,126	N/A	0	0	0	5%	6,265	-	1,356	125	11,818	19,565	5
T&S	Speedswing	N/A	Equipment	2	413,631	827,263	D	5	20,000	8,000	2%	58,696	52,000	16,545	1,174	11,818	140,234	25
T&S	Stake Body Truck	N/A	Vehicle	2	147,726	295,451	D	10	15,000	3,000	3%	38,262	19,500	8,864	765	11,818	79,209	10
T&S	Pick-up Truck-Extended Cab	N/A	Vehicle	31	47,272	1,465,437	G	15	15,000	31,000	3%	338,479	201,500	43,963	6,770	183,180	773,891	5
T&S	Swivel Dump-HR	N/A	Equipment	4	436,485	1,745,942	D	5	15,000	12,000	1.5%	226,107	78,000	26,189	4,522	23,636	358,455	10
T&S	Tractor trailer	N/A	Vehicle	2	531,812	1,063,624	D	5	7,000	2,800	2.5%	102,472	18,200	26,591	0	11,818	159,081	15
T&S	Utility Trucks-Mechanic	N/A	Vehicle	4	88,635	354,541	D	10	20,000	8,000	3%	81,890	52,000	10,636	1,638	23,636	169,800	5
T&S	Utility Trucks-Power	N/A	Vehicle	4	76,817	307,269	G	12	20,000	6,667	3.5%	70,971	43,333	10,754	1,419	23,636	150,115	5
T&S	Utility Trucks-Signal	N/A	Vehicle	15	76,817	1,152,259	G	12	20,000	25,000	3.5%	266,143	162,500	40,329	5,323	88,635	562,930	5

Division	Type	Model	Vehicle or Equip.?	Quantity	Purchase Price	Total Purchase Price	Fuel Type	Fuel Consumption	Annual Mileage	Annual Fuel Consumption	Annual Mtce as % of capex	Lease Rate 5%	Fuel Cost Per Gallon \$4.25	Annual Mtce Cost	Annual Licensing as % of Purchase 2%	Insurance per Vehicle \$5,000	Total Annual Cost	Life Expectancy
T&S	Utility Trucks-Signal Crew	N/A	Vehicle	4	82,726	330,905	G	12	20,000	6,667	3.5%	76,431	43,333	11,582	1,529	23,636	156,510	5
T&S	Water Tank	N/A	Equipment	2	29,545	59,090	N/A	0	0	0	2%	4,742	-	1,182	95	11,818	17,836	20
T&S	Welders Truck	N/A	Vehicle	4	384,086	1,536,346	D	10	20,000	8,000	2%	198,964	52,000	30,727	3,979	23,636	309,306	10
Total				201	N/A	63,379,833	N/A	N/A	N/A	297,600	N/A	6,420,589	1,912,733	1,126,062	73,198	1,187,713	10,720,296	N/A

6. Stations Operation and Station Cleaning

Station classification:

- Terminal (End-of-Line) Stations
- Intermediate Stations with Turnback Service
- Temporary Terminal Stations
- Key Intermediate Stations
- Intermediate Stations

The stations are classified as follows:

- SF Transbay: Terminal
- SF 4th & Townsend: Intermediate
- SF 4th & King: Temporary Terminal Station (Silicon Valley to Central Valley)
No usage in Phase 1
- Millbrae: Intermediate
- San Jose: Intermediate (Silicon Valley to Central Valley)
Intermediate with Turnback Service (Phase 1)
- Gilroy: Intermediate
- Merced: Temporary Terminal
- Madera: Stop (environmentally cleared and funded by others)
- Fresno: Key Intermediate
- Kings/Tulare: Intermediate
- Bakersfield: Temporary Terminal (Silicon Valley to Central Valley)
Intermediate (Phase 1)
- Palmdale: Intermediate
- Burbank: Intermediate
- LA Union Station: Intermediate with Turnback Service
- Anaheim: Terminal

Other station services:

- Subcontractors assumed for
 - Janitorial Services
 - Landscaping
 - General Maintenance Services

Train cleaning location:

- Trains going from revenue service to revenue service will generally be cleaned in the stations where they are being turned.
- Trains going from revenue service to deadhead or from deadhead to revenue service will be cleaned at the maintenance facilities.

Train cleaning staff at stations and maintenance facilities:

- Service is assumed to be subcontracted

Energy:

- Stations are assumed to use 14.3 kWh per square foot.
- For Station Sizes, please see Table 13 and Table 14.

Vehicles:

- One car is assumed per station and for the HMF/LMF facilities.
- Additionally, one Stake Body Truck at the HMF for Rolling Stock Maintenance and one Stake Body Truck for Facility purposes assumed.

7. Police and Security

Policing:

- All policing for the California High-Speed Rail System (train and infrastructure) will be provided by the California Highway Patrol funded through a legislative budgetary action.

Security:

- Staffing (security guards per shift):
 - Group A station (SF Transbay/LA Union Station): 4
 - Group B/C station (all other stations): 2
 - Maintenance of Rolling Stock facility: 3
 - Maintenance of Infrastructure facility: 2

8. Commercial Costs

Marketing:

- The following contracts are assumed:
 - Advertising agency service contract
 - Customer Call Center
 - Loyalty program
 - PR/crisis communications firm service contract
 - Web and mobile integration and analytics support

Advertising:

- Three campaigns per year are assumed with an effective frequency of five.
- For counties that will have advertising in each phase, please see Section 11.1.2. For their populations by year, please see County Population Projections in Appendix D.
- Cost per 1,000 impressions is assumed to be \$27.13 for Silicon Valley to Central Valley and \$32.10 for Phase 1.

Revenue collection:

- To cover all payment related costs, including credit card costs, 5 percent of the revenue is assumed.

Bus costs:

- Connecting bus services cost \$9.19 per mile.
- Connecting bus services average 15.3 percent deadhead miles.

9. General and Administrative Costs

Staffing levels:

- General and administrative staffing is assumed to be 10 percent of total other staffing.
- Within general and administrative, the following breakdown is assumed:
 - Executives—5 percent
 - Senior managers—10 percent
 - Mid-managers—25 percent
 - Administrative and low-level corporate staff—60 percent

Vehicles:

- 16 cars for Silicon Valley to Central Valley and for Phase 1 assumed

10. Insurance

- Rate per insurance category: see Table 26.

11. Contingency

Unallocated contingency:

- 5 percent of subtotal costs

Allocated contingency:

- See Table 27.

12. Operations Startup and Commissioning

Testing and commissioning:

- Not part of routine operations and maintenance costs; included in capital costs.

Rolling stock procurement schedule:

- Illustrative schedule for rolling stock delivery is shown in Table 28.

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APPENDIX B: WAGES

Wages for the staff positions described in this Technical Supporting Document were obtained from various experts. The assumptions for the salaries are based on comparable Amtrak positions as well as the experts' estimates.

The following table shows the salaries used in the Operations and Maintenance Cost Model.

Table 34 Raw Wage Data Collected by Position (2023 dollars)

Position Type	Position Title	Wage (2023 dollars)
Transportation	Road Manager	155,424
Transportation	Train Engineer	129,520
Transportation	Conductor	103,616
Transportation	Assistant Conductor	77,712
Transportation	On-board Attendant (not used)	58,284
Dispatching	Operations Control Director	194,280
Dispatching	Chief Line Dispatcher	129,520
Dispatching	Line Dispatcher	103,616
Dispatching	Yard Train Dispatcher	103,616
Dispatching	Information Controller	77,712
Maintenance of Rolling Stock	Supervisors	129,520
Maintenance of Rolling Stock	Technicians (including electrical and mechanical technicians)	103,616
Maintenance of Rolling Stock	Storehouse Employees	77,712
Maintenance of Rolling Stock	Laborers	77,712
MOI—Engineering	Chief Engineer	259,041
MOI—Engineering	Deputy Chief Engineer	259,041
MOI—Engineering	Administrative Assistant	77,712
MOI—Track and Systems	Stores Manager	103,616
MOI—Track and Systems	Stores Clerk	77,712
MOI—Track and Systems	Stores Handling	77,712
MOI—Track and Systems	Procurement Specialist	129,520
MOI—Track and Systems	Track Manager	155,424
MOI—Track and Systems	Track Engineer	129,520
MOI—Track and Systems	Track Supervisor	129,520

Position Type	Position Title	Wage (2023 dollars)
MOI—Track and Systems	Track Inspector/Foreman	103,616
MOI—Track and Systems	Track Laborer	77,712
MOI—Track and Systems	Equipment Operator	77,712
MOI—Track and Systems	Welder	77,712
MOI—Track and Systems	Mechanic	77,712
MOI—Track and Systems	Systems Manager	194,280
MOI—Track and Systems	Systems Inspector	103,616
MOI—Track and Systems	Systems Technician	103,616
MOI—Track and Systems	Systems Engineer	155,424
MOI—Track and Systems	Power/OCS Manager	194,280
MOI—Track and Systems	OCS Supervisor	155,424
MOI—Track and Systems	Power/OCS Inspector/Foreman	103,616
MOI—Track and Systems	Power Technicians	103,616
MOI—Track and Systems	OCS Technician	103,616
MOI—Track and Systems	OCS Technician (CDL License)	103,616
MOI—Facilities	Facilities Manager	194,280
MOI—Facilities	Assistant Facility Manager	155,424
MOI—Facilities	Facilities Foreman (HMF & LMF)	103,616
MOI—Facilities	Facilities Technician (HMF & LMF)	77,712
MOI—Facilities	Facilities Foreman (Stations)	103,616
MOI—Facilities	Facilities Technician (Stations)	77,712
MOI—Structures	Structure Foreman	103,616
MOI—Structures	Structures Laborer	77,712
MOI—Structures	Bridge Inspector	155,424
MOI—Structures	Structures Manager	155,424
MOI—Structures	Structures Engineer	155,424
MOI—Work Train	Train Engineer	129,520
MOI—Work Train	Train Conductor	103,616
Others—Managers	Executives	259,041
Others—Managers	Senior Management	194,280

Position Type	Position Title	Wage (2023 dollars)
Others—Managers	Mid-Level Managers	129,520
Others—Managers	Admin/Lower-Level Corporate Staff	77,712
Others—Marketing and Branding	Senior Manager: Marketing	155,424
Others—Marketing and Branding	Specialist: Advertising/Marketing Program	103,616
Others—Marketing and Branding	Specialist: Channel Marketing/Sales	103,616
Others—Marketing and Branding	Graphic Artist	77,712
Others—Marketing and Branding	Manager: Communications	129,520
Others—Marketing and Branding	Specialist: Communications	103,616
Others—Marketing and Branding	Specialist: Passenger Communications	103,616
Others—Marketing and Branding	Coordinator: Community Outreach	77,712
Others—Marketing and Branding	Manager: Product	129,520
Others—Marketing and Branding	Data Analyst: Product	103,616
Others—Marketing and Branding	Senior Manager: Customer Service	155,424
Others—Marketing and Branding	Specialist: Customer Service	103,616
Others—Marketing and Branding	Customer Engagement Director	194,280
Others—Marketing and Branding	Executive Assistant	77,712
Others—Stations	Manager Passenger Services	129,520
Others—Stations	Ticket Clerk/Customer Service Representative	77,712
Others—Security	Unsworn Security Officer	58,284

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APPENDIX C: MAINTENANCE OF INFRASTRUCTURE POSITION DESCRIPTIONS

Position	Description
Foreman/Inspector	All work crews perform prescribed work under the supervision of the foreman. This position requires the experience, training and proven ability to lead employees to successfully and safely complete work as assigned. The foreman reads work orders and prescribes corrective action, applying appropriate materials and personnel. This person is responsible to report time and material usage for work completed and advises the dispatcher that the work group is clear of the track, and the track can be returned to service. A maintenance leader may have expertise in a special area such as production surfacing, turnout-surfacing, continuous welded rail repair, structures or other maintenance activities and be assigned accordingly. Track foremen/inspectors perform required inspections of all tracks and report findings. They review all climatic and wheel/rail reporting and determine at field locations the accuracy of data reported by remote and wireless reporting equipment.
Inspector	Structure inspectors perform regulatory visual inspections of all bridges, aerial structures, tunnels, culverts, buildings and system facilities. Inspections are performed on foot and by hi-rail trucks and bucket trucks.
Welder	Welders are responsible for completing all welding and grinding requirements for track, bridges, aerial structures, tunnels and other related tasks. Welders are to be qualified for oxy-acetylene, wire-feed and in-field electronic welding applications. Working in conjunction with work gangs, their work is performed as prescribed by the daily work orders. They are equipped with a hi-rail specially outfitted vehicle such to perform any welding task.
Equipment Operator	Equipment operators are trained on specific equipment units for their safe and practical use. They may be trained on multiple equipment units and assigned various work assignments during each work window. They report to the foreman as assigned and have total responsibility for safe and practical operation of assigned equipment.
Laborer	Laborer positions support the work group as assigned under the direction of the foreman leader and are responsible to provide such non-technical, miscellaneous labor services as required for an assigned task. Specifically, licensed and qualified individuals will operate trucks requiring a commercial driver license.
Mechanic	Mechanics are responsible for maintaining non-revenue equipment.
Systems Inspector	Systems inspectors are responsible for all signal and communications maintenance activities and manage the systems technicians assigned to their territory. Systems inspectors are responsible for ensuring that all required preventative maintenance tasks are performed within the required timeframes and that corrective maintenance activities are performed in accordance with the systems manuals.
Systems Technicians	Systems technicians are responsible for the maintenance of all signal and communications equipment. Systems technicians perform the required maintenance inspections and are the first responders to systems problems on the alignment.
Power/OCS Inspector/Foreman	The power/OCS inspector/foreman is responsible for overseeing the power and OCS personnel and performing inspections of the OCS.
OCS Technician	The OCS technician is responsible for the maintenance activities for the overhead catenary systems.
Power Technician	The power technician is responsible for the maintenance of the electric traction systems.
Structures Foreman	The structures foreman is responsible for the maintenance of the bridges, tunnels, retaining walls, drainage systems and the MOW facilities. The structures foreman manages the structures laborers.

Position	Description
Structures Laborer	Structures laborers report to the structures foreman and are responsible for performing the maintenance tasks related to bridges, tunnels, retaining walls, drainage systems and the MOW facilities.
Facilities Foreman	The facilities foreman is responsible for the maintenance activities related to the heavy maintenance facility, light maintenance facilities and stations. The facilities foreman is responsible for various subcontractors performing tasks such as janitorial services, HVAC system maintenance and landscaping. The facilities foreman manages the facilities technicians.
Facilities Technician	Facilities technicians are responsible for performing the maintenance activities at the heavy maintenance facility, light maintenance facility and stations that do not require a specialized license or are not being performed by a subcontractor. The facilities technicians perform minor repairs and manage subcontractors when a facilities foreman is not available.

APPENDIX D: COUNTY POPULATION PROJECTIONS**Population (thousands)**

County	2020	2025	2030	2035	2040	2045	2050	2055	2060	2065	2070
Alameda	1,676.46	1,639.76	1,670.46	1,734.36	1,795.20	1,850.20	1,898.49	1,925.26	1,952.42	1,952.42	1,952.42
Alpine	1.20	1.16	1.20	1.20	1.19	1.18	1.20	1.20	1.21	1.21	1.21
Amador	40.45	40.33	41.58	41.35	40.62	39.67	38.93	38.52	38.11	38.11	38.11
Butte	210.43	208.77	211.00	216.70	224.03	232.44	242.08	246.82	251.66	251.66	251.66
Calaveras	45.28	44.52	43.74	42.44	40.75	39.05	37.69	36.96	36.24	36.24	36.24
Colusa	21.78	22.05	22.14	21.95	21.53	21.02	20.41	20.13	19.87	19.87	19.87
Contra Costa	1,165.56	1,140.48	1,171.95	1,225.37	1,274.71	1,319.50	1,361.14	1,383.68	1,406.60	1,406.60	1,406.60
Del Norte	27.64	25.47	24.74	24.07	23.35	22.60	21.84	21.47	21.12	21.12	21.12
El Dorado	191.03	186.19	185.43	183.48	179.46	174.27	168.42	165.78	163.17	163.17	163.17
Fresno	1,007.34	1,023.59	1,047.38	1,068.53	1,083.90	1,093.57	1,098.21	1,101.81	1,105.43	1,105.43	1,105.43
Glenn	28.89	28.92	29.18	29.02	28.51	27.62	26.58	26.12	25.67	25.67	25.67
Humboldt	136.20	133.83	131.73	129.25	126.48	123.89	121.54	120.34	119.14	119.14	119.14
Imperial	180.18	181.27	185.00	187.83	189.97	191.46	192.29	192.88	193.47	193.47	193.47
Inyo	18.99	18.94	18.89	18.73	18.55	18.35	18.09	17.98	17.87	17.87	17.87
Kern	905.24	919.15	940.26	956.19	966.31	970.79	969.97	970.88	971.80	971.80	971.80
Kings	152.20	154.07	157.53	159.85	161.19	161.27	160.45	160.26	160.08	160.08	160.08
Lake	67.64	67.57	68.45	68.12	67.56	67.11	67.07	66.94	66.82	66.82	66.82
Lassen	31.72	27.34	25.71	23.78	21.77	19.81	17.98	17.15	16.35	16.35	16.35
Los Angeles	10,013.54	9,676.33	9,566.66	9,462.09	9,306.76	9,111.73	8,877.94	8,773.98	8,671.24	8,671.24	8,671.24
Madera	156.14	159.82	161.98	163.00	163.35	162.74	161.94	161.59	161.24	161.24	161.24

County	2020	2025	2030	2035	2040	2045	2050	2055	2060	2065	2070
Marin	261.23	247.47	244.32	245.48	245.50	244.45	243.30	242.75	242.20	242.20	242.20
Mariposa	17.12	17.02	17.02	16.87	16.59	16.43	16.37	16.32	16.27	16.27	16.27
Mendocino	91.07	88.58	88.79	89.13	89.20	89.24	89.70	89.82	89.95	89.95	89.95
Merced	280.91	297.33	311.58	321.78	329.17	333.82	336.17	337.94	339.73	339.73	339.73
Modoc	8.70	8.67	8.35	7.93	7.46	6.95	6.46	6.24	6.02	6.02	6.02
Mono	13.31	13.17	12.99	12.59	12.07	11.48	10.88	10.60	10.33	10.33	10.33
Monterey	439.23	431.94	434.51	436.54	436.31	434.20	430.71	429.32	427.93	427.93	427.93
Napa	138.45	133.16	132.09	132.31	131.60	130.26	128.52	127.76	127.00	127.00	127.00
Nevada	102.18	98.30	97.46	96.53	94.44	91.91	89.65	88.49	87.35	87.35	87.35
Orange	3,187.19	3,153.65	3,201.36	3,251.62	3,283.81	3,300.46	3,307.39	3,313.31	3,319.24	3,319.24	3,319.24
Placer	405.94	419.85	443.94	462.28	474.91	483.52	490.67	494.69	498.75	498.75	498.75
Plumas	19.85	18.33	17.53	16.48	15.32	14.42	13.71	13.34	12.97	12.97	12.97
Riverside	2,422.13	2,471.00	2,540.56	2,596.89	2,637.46	2,661.20	2,670.07	2,678.28	2,686.53	2,686.53	2,686.53
Sacramento	1,586.80	1,571.92	1,611.31	1,663.04	1,708.46	1,747.26	1,782.52	1,801.55	1,820.78	1,820.78	1,820.78
San Benito	64.43	67.79	71.27	73.80	75.45	76.52	76.96	77.34	77.72	77.72	77.72
San Bernardino	2,186.00	2,206.22	2,257.52	2,289.10	2,302.29	2,300.69	2,287.28	2,283.54	2,279.81	2,279.81	2,279.81
San Diego	3,301.51	3,320.87	3,373.79	3,403.35	3,416.78	3,412.61	3,394.59	3,389.07	3,383.55	3,383.55	3,383.55
San Francisco	870.13	828.90	837.02	842.73	845.59	847.26	848.07	848.69	849.31	849.31	849.31
San Joaquin	780.21	798.02	831.96	866.55	896.03	920.96	942.10	954.00	966.05	966.05	966.05
San Luis Obispo	282.64	283.15	286.55	288.06	287.62	284.61	279.40	277.38	275.38	275.38	275.38
San Mateo	760.73	723.75	721.01	726.93	728.93	728.41	726.77	726.23	725.69	725.69	725.69
Santa Barbara	448.48	451.83	459.73	467.57	475.40	481.69	486.99	489.94	492.90	492.90	492.90

County	2020	2025	2030	2035	2040	2045	2050	2055	2060	2065	2070
Santa Clara	1,925.23	1,873.00	1,900.16	1,958.42	2,009.13	2,048.12	2,075.77	2,092.78	2,109.94	2,109.94	2,109.94
Santa Cruz	271.33	268.16	268.73	269.92	269.54	267.77	266.12	265.27	264.42	264.42	264.42
Shasta	182.54	178.50	178.72	179.76	180.25	180.53	181.49	181.81	182.12	182.12	182.12
Sierra	3.23	3.19	3.13	3.03	2.94	2.88	2.84	2.82	2.80	2.80	2.80
Siskiyou	44.06	43.58	43.07	42.15	41.09	40.02	39.11	38.63	38.16	38.16	38.16
Solano	452.10	442.64	451.28	464.32	476.16	485.71	494.49	499.18	503.92	503.92	503.92
Sonoma	488.02	477.85	475.83	469.56	459.45	447.47	434.41	428.37	422.42	422.42	422.42
Stanislaus	553.71	548.70	558.57	568.98	577.52	585.65	593.40	597.43	601.50	601.50	601.50
Sutter	99.36	100.76	104.01	105.39	105.80	105.49	104.60	104.31	104.01	104.01	104.01
Tehama	65.71	64.67	65.15	65.20	64.90	64.58	64.13	63.94	63.75	63.75	63.75
Trinity	16.14	15.96	16.04	15.92	15.73	15.56	15.44	15.37	15.30	15.30	15.30
Tulare	472.60	479.91	487.38	489.85	487.89	482.15	472.97	469.31	465.68	465.68	465.68
Tuolumne	55.44	51.73	50.08	49.44	48.96	48.62	48.54	48.44	48.34	48.34	48.34
Ventura	844.62	815.59	805.46	800.42	789.88	775.53	758.16	750.44	742.80	742.80	742.80
Yolo	218.18	225.40	230.48	236.02	240.26	242.64	243.41	244.20	245.00	245.00	245.00
Yuba	81.71	83.99	87.17	89.54	91.39	92.92	94.14	94.84	95.55	95.55	95.55
Grand Total	39,520.07	39,024.05	39,430.87	39,872.79	40,106.45	40,152.22	40,049.52	40,043.52	40,040.67	40,040.67	40,040.67

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APPENDIX E: ALLOCATED CONTINGENCY RISK/UNCERTAINTY RATINGS AND PERCENTAGES**Table 35 Overall Team Member Assessment and Allocated Contingency Percentages**

Cost Factor	Team Member 1 Assessment	Team Member 2 Assessment	Team Member 3 Assessment	Team Member 4 Assessment	Average	Contingency
Labor						
Maintenance of Rolling Stock	4	4	4	4	4.00	20.00
Maintenance of Infrastructure	3	4	3	4	3.50	22.50
On-board Staff (including road manager and protect crews)	3	4	3	5	3.75	21.25
Dispatching	5	5	5	4	4.75	16.25
Train Cleaning and Station Maintenance Staff	4	5	4	4	4.25	18.75
Stations	3	3	4	4	3.50	22.50
Police and Security	4	4	0	5	4.33	18.33
General and Administrative Staff	3	4	4	4	3.75	21.25
Materials, Tools and Other Direct Costs						
Maintenance of Infrastructure Materials (including stations)	3	4	4	3	3.50	22.50
Maintenance of Infrastructure Tools, Uniforms, Etc.	2.5	5	5	3	3.88	20.63
Maintenance of Infrastructure Vehicle Leasing Rates	2	3	3	4	3.00	25.00
Vehicles Besides Maintenance of Infrastructure and Police and Security	3	4	-	4	3.67	21.67
Police and Security Vehicles	4	4	-	4	4.00	20.00
Police and Security Equipment	4	4	-	4	4.00	20.00
Employee Supplies and Expenses (e.g., uniforms, information technology, cell phones, office supplies, etc.) for Every Department	4	4	-	5	4.33	18.33

Cost Factor	Team Member 1 Assessment	Team Member 2 Assessment	Team Member 3 Assessment	Team Member 4 Assessment	Average	Contingency
Maintenance of Rolling Stock Tools, Uniforms, Etc.	2.5	5	5	3	3.88	20.63
Maintenance of Rolling Stock Regulatory Inspections	3	4	4	4	3.75	21.25
Maintenance of Rolling Stock General Overhauls and Bogie Inspections	3	5	4	2	3.50	22.50
Utilities						
Train Operations Energy	3.5	5	4	4	4.13	19.38
Stations and Maintenance Facilities Energy	4	3	3	4	3.50	22.50
Station and Maintenance Facility Water and Sewer	3.5	2	-	4	3.17	24.17
Other Costs						
Bus Costs	4.5	2	4	3	3.38	23.13
Advertising	4	4	-	3	3.67	21.67
Revenue Collection	4	4	-	4	4.00	20.00
Marketing & Branding, Including Advertising and Call Center	3	4	-	4	3.67	21.67
Insurance	4	4	-	5	4.33	18.33

APPENDIX F: ANCILLARY REVENUE TECHNICAL DOCUMENTATION

Overview of Ancillary Revenues

The Authority's business plans contemplate the potential for the high-speed rail system to generate revenues ancillary to farebox revenues that support the system's financial feasibility. These ancillary revenues (i.e., non-farebox operating revenues) are captured in the final 2024 Business Plan as a percentage of farebox revenues.

Developing a List of Ancillary Revenue Opportunities

The Authority regularly evaluates opportunities to pursue ancillary revenues. In prior business plans, the Authority included planning assumptions, indicating ancillary revenues could range from 1 percent to 4 percent of farebox revenues. Since the publication of the 2016 Business Plan, the Authority has undertaken more extensive research and market analysis of potential ancillary revenue sources from the system's real property, rights of way and ridership.

The methodology to calculate an ancillary revenue estimate for the final 2024 Business Plan follows the guiding principles and values driving the Authority's advancement of the high-speed rail program. Ancillary revenue opportunities potentially available to the Authority were identified and screened. The screening process included:

- **Research into peer agencies and the airline industry**, which enabled the sourcing of creative commercial options, identification of a potential range of benefits and identification of benchmarks from which estimates could be evaluated; and
- **An Authority review process** that identified and narrowed the field of available opportunities, as well as determined order of magnitude estimates for each opportunity.

Categorizing the Ancillary Revenues

The Authority's ability to access and generate revenue from an ancillary revenue opportunity is dependent, in part, on the ease of implementation and alignment with its policies and regulatory environment.

The ancillary revenue opportunities were grouped into four stand-alone categories (i.e., Category 1, Category 2, Category 3 and Category 4), which correspond to their relative implementation profile. The revenue categories were defined as follows:

- **Category 1 – Line of Site Opportunities:** Category 1 ancillary revenues represent the most directly accessible revenue sources, given their low complexity of implementation.
- **Category 2 – Joint Development/Partnership:** Category 2 ancillary revenues represent the next most accessible grouping. Each contemplates or materially is tied to a partnership with a public partner, developer or third-party to commercially develop station sites, right-of-way and/or other Authority-owned parcels. Consequently, the feasibility of achieving revenue related to these sources hinges on the Authority's ability to enter into commercial agreements.
- **Category 3 – Public Tools for Financing/Funding Development:** Category 3 ancillary revenues represent potential tools for financing and funding development at or within a certain radius of the station sites.
- **Category 4 – New Tax/Fee:** Category 4 ancillary revenues represent the least accessible set of options based on the relevant approvals required for a new tax or fee.

Shortlisting and Benchmarking Revenue Opportunities for the 2024 Business Plan

The Authority undertook a review of various ancillary revenue opportunities and down-selected 13 streams for inclusion in the final 2024 Business Plan. Down-selection of these 13 opportunities was informed by the opportunities' ease of implementation, as well as a desire to arrive at a reasonable and conservative estimate for planning purposes. Opportunities potentially requiring legislative action and/or posing significant risk were excluded. For the purpose of estimating ancillary revenue to inform the final 2022 Business Plan, the 13 ancillary revenue opportunities outlined on [page G-3](#) were included.

For each of the ancillary revenue opportunities included in the 2024 Business Plan, the Authority analyzed peer agencies and comparable operators (both in the transit and airline sectors), as well as local market conditions, to establish a set of low, medium and high order-of-magnitude benchmarks to estimate the ancillary revenue potential. Each of these benchmarks was applied against a base metric such as ridership, number of stations or right of way. By way of example, transit agencies and airport advertising contracts were researched to determine a low, medium and high benchmark for advertising revenue per passenger. These benchmarks were then applied against the system's annual ridership forecasts provided by the Authority's technical consultants. Each of the ancillary revenues were calculated on a net ancillary revenue basis, taking into account the costs of their pursuit. Revenue from each opportunity incorporated key timing parameters and drivers of project phases, including the timing of pre-operations, operations and mature operations periods for the Silicon Valley to Central Valley Line and Phase 1 segments.

Since the 2020 Business Plan, therevenue source, Low Carbon Fuel Standard Credits, was added to the list of potential revenue sources. The decision to include this revenue source was a policy decision by the Authority.

Excursus:

California's Low Carbon Fuel Standard (LCFS) is one of several regulations intended to reduce the carbon intensity of California's transportation fuels by creating a commodity (LCFS credits), of which positive amounts (credits) are generated by low-carbon fuel producers and negative amounts (deficits or obligations) are generated by high-carbon fuel producers. LCFS credits are traded by generators, obligated parties and intermediaries/traders.

As a fixed-guideway transportation system, under current CARB regulations, the Authority will be eligible to generate LCFS credits from its use of electricity as a transportation fuel.

The LCFS regulation determines eligibility to generate credits as well as the formulas for the quantity of credits generated. The volume of credits depends on the transportation fuel being used, the carbon intensity (CI) of the fuel, the fuel that is being displaced (either gasoline or diesel), the CI of the displaced fuel and the amount of fuel being used for transportation by the reporting party. The marketplace determines the value of the credits.

Under current regulations, electrified heavy-rail transportation coming into service after January 1, 2011 produces LCFS credits according to the following formula. This formula uses input values from CARB (2020); Energy Economy Ratio is EER.

$$\text{Credits} = [\text{Diesel CI} - (\text{Grid Electricity CI} / \text{EER})] * \text{EER} * \text{Energy Density} / 1,000,000 * \text{kWh}$$

The 2024 Business Plan does not include any revenues from LCFS credits. The actual program expires before the Silicon Valley to Central Valley operation starts. Even if a follow-up program is implemented, to maintain a conservative approach, no revenues are considered.

Ancillary Revenue Opportunities Evaluated for the 2024 Business Plan

1. Category 1 ancillary revenue opportunities (12 total):
 - Billboard advertising
 - Advertising (rolling stock and station level)
 - Excess land (fee simple interest)
 - Parking fees
 - Retail (station level)
 - Sponsorship – branding exclusivity
 - Sponsorship – station naming
 - Sponsorship – system naming
 - Telco – towers
 - Telco – longitudinal fiber⁴²
 - Web-based advertising
 - Low carbon fuel standard credits
2. Category 2 ancillary revenue opportunities (one total):
 - Ground leases
3. Category 3 ancillary revenue opportunities (zero):
 - None were considered for inclusion in the 2024 Business Plan⁴³
4. Category 4 ancillary revenue opportunities (zero):
 - None were considered for inclusion in the 2024 Business Plan⁴⁴

Ancillary Revenue Analysis Results

The analysis for the ancillary revenues for the 2024 Business Plan The analysis for the ancillary revenues. The estimates are offered in the form of revenues available and as a percentage of farebox revenue assuming high, medium and low ridership as forecasted by the Authority’s technical consultants. The results of the analysis are presented as follows:

Ancillary totals in the table on the next page are raw model outputs used to derive a 3.3 percent estimate in Silicon Valley to Central Valley scenario and 1.9 percent estimate in Phase 1 scenario and reflect opportunities through 2060.

⁴² While the Authority believes there is market support for the telecommunications fiber revenue opportunity, it likely requires some changes to existing legislation or executive action for revenues to be realized by the Authority.

⁴³ Category 3 opportunities are excluded from this analysis due to their uncertainty and the high degree of complexity associated with realizing such revenues.

⁴⁴ Category 4 opportunities are excluded from this analysis due to their uncertainty and the high degree of complexity associated with realizing such revenues.

Table 36 Ancillary Revenue Benchmarks for Silicon Valley to Central Valley Line Scenario

Benchmark Until 2060	Low Ridership (%)	Low Ridership (2023 \$ in millions)	Medium Ridership (%)	Medium Ridership (2023 \$ in millions)	High Ridership (%)	High Ridership (2023 \$ in millions)
Cumulative Farebox Revenues	N/A	20,051	N/A	25,873	N/A	28,122
Low Cumulative Ancillary Revenue Benchmark	1.9%	373	1.4%	373	1.3%	373
Medium Cumulative Ancillary Revenue Benchmark	4.2%	849	3.3%	849	3.0%	849
High Cumulative Ancillary Revenue Benchmark	6.6%	1,319	5.1%	1,319	4.7%	1,319

Table 37 Ancillary Revenue Benchmarks for Phase 1 Scenario

Benchmark Until 2060	Low Ridership (%)	Low Ridership (2023 \$ in millions)	Medium Ridership (%)	Medium Ridership (2023 \$ in millions)	High Ridership (%)	High Ridership (2023 \$ in millions)
Cumulative Farebox Revenues	N/A	56,253	N/A	76,661	N/A	83,090
Low Cumulative Ancillary Revenue Benchmark	1.3%	747	1.0%	747	0.9%	747
Medium Cumulative Ancillary Revenue Benchmark	2.6%	1,450	1.9%	1,450	1.7%	1,450
High Cumulative Ancillary Revenue Benchmark	3.9%	2,207	2.9%	2,207	2.7%	2,207

Please note that cumulative ancillary revenue estimates vary by low, medium and high scenario assumptions. These assumptions do not include changes in ridership, as they are not expected to have a material impact on the current ancillary revenue categories used in the 2024 Business Plan.

The analysis yielded a range of ancillary revenues from 1.3 percent to 6.6 percent of farebox revenues in the Silicon Valley to Central Valley scenario, and from 0.9 percent to almost 4 percent of farebox revenues in the Phase 1 scenario. Based on these results and consistent with the medium ancillary revenue benchmarks, a flat 3.3 percent of farebox revenues in the Silicon Valley to Central Valley scenario and a flat 1.9 percent of farebox revenues in the Phase 1 scenario will be applied as the ancillary revenue estimate in each year of operations for the high, medium and low ridership scenarios in the 2024 Business Plan.

APPENDIX G: ILLUSTRATIVE ORGANIZATION CHART

Below are illustrative, preliminary and indicative organization charts that incorporate all positions currently included in the model. At the current stage of design, a fully developed organizational chart is not feasible, as procurement and other decisions are yet to be made. The examples below are meant to depict the levels of the organization currently included in the model. The actual organization structure will be determined at a future date. The first organization chart shows the overall corporate organization structure at a very high level. The subsequent charts look at the operations and personnel included under the senior vice president of operations.

Figure 2 Illustrative Overall Corporate Organizational Structure

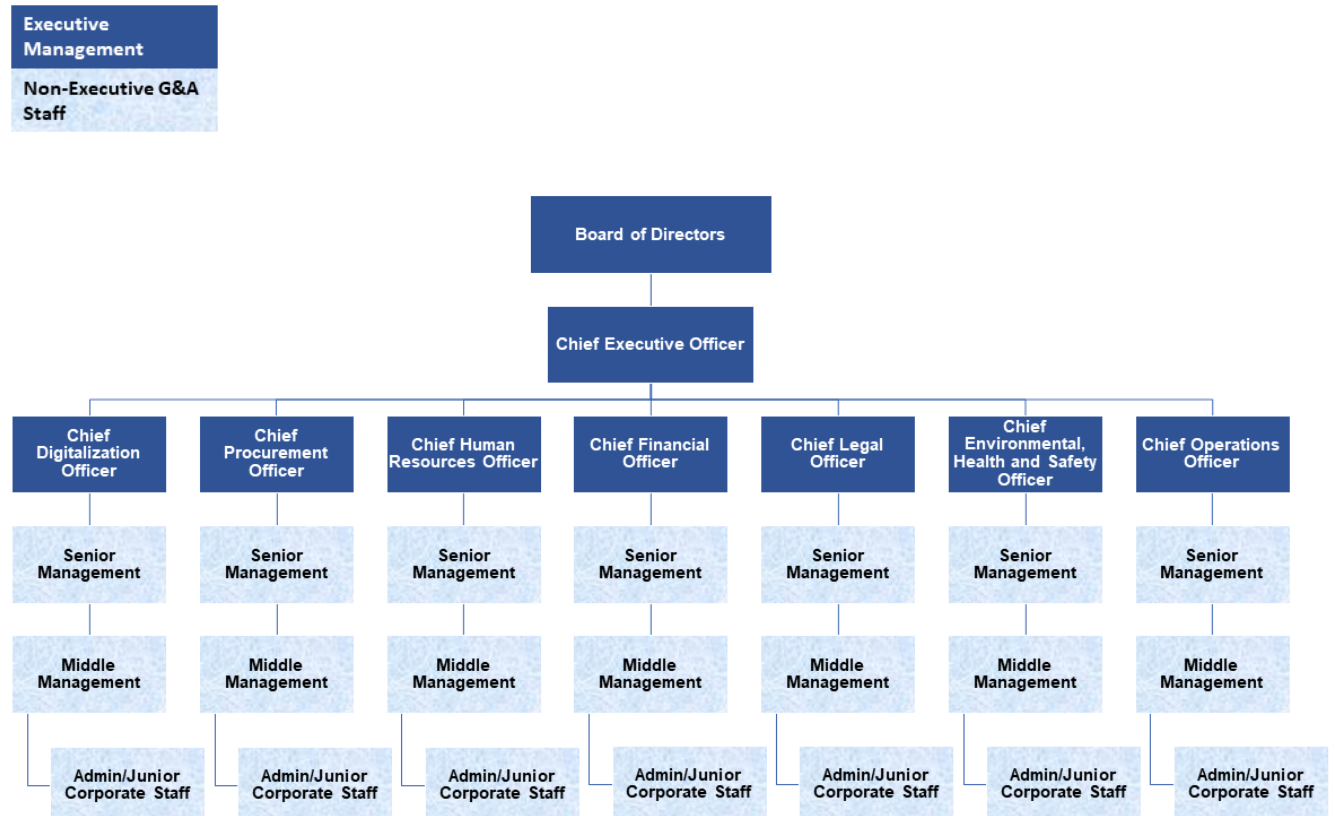


Figure 3 Illustrative Operations and Maintenance Staff Structure—On-board Personnel and Dispatching

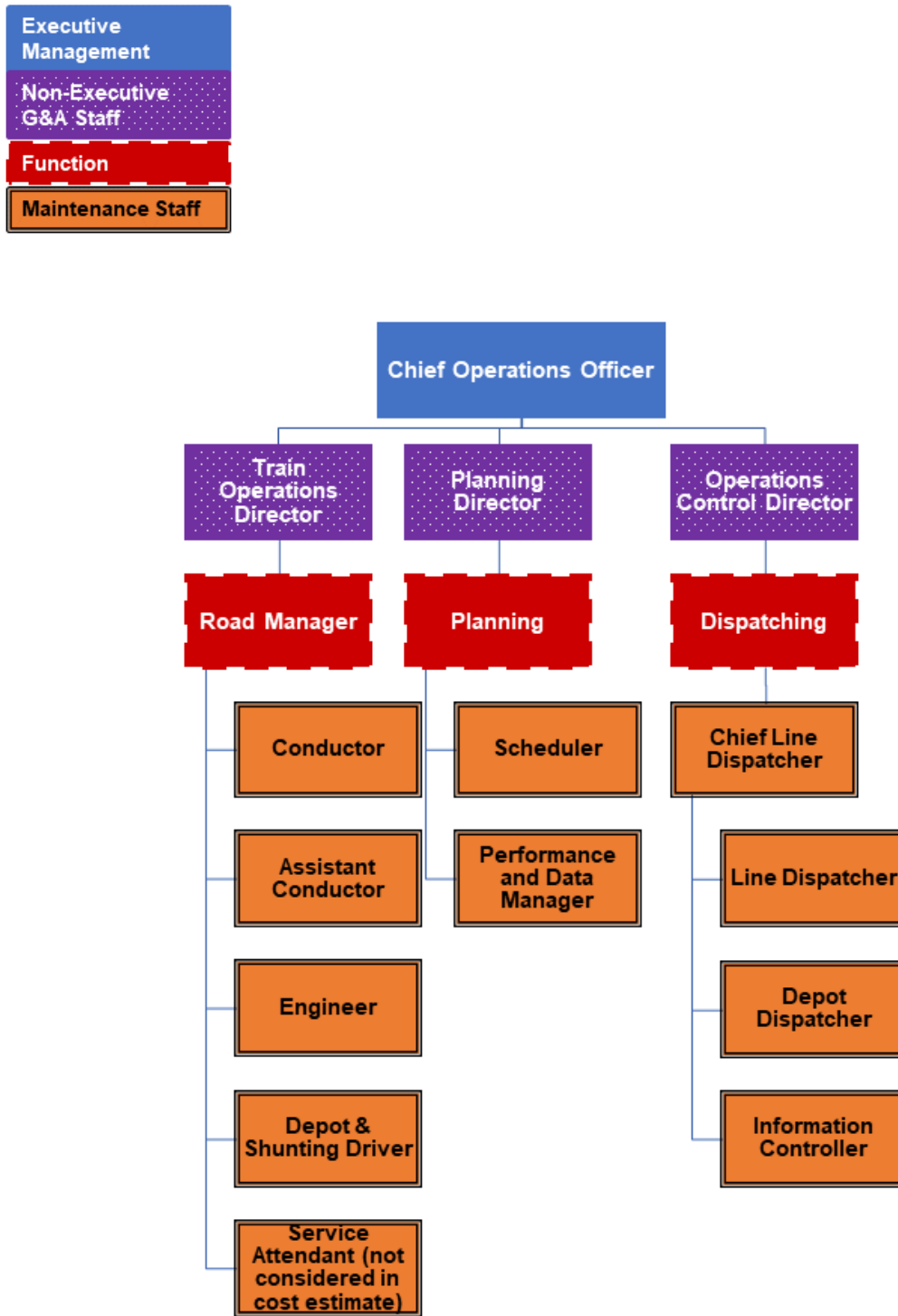
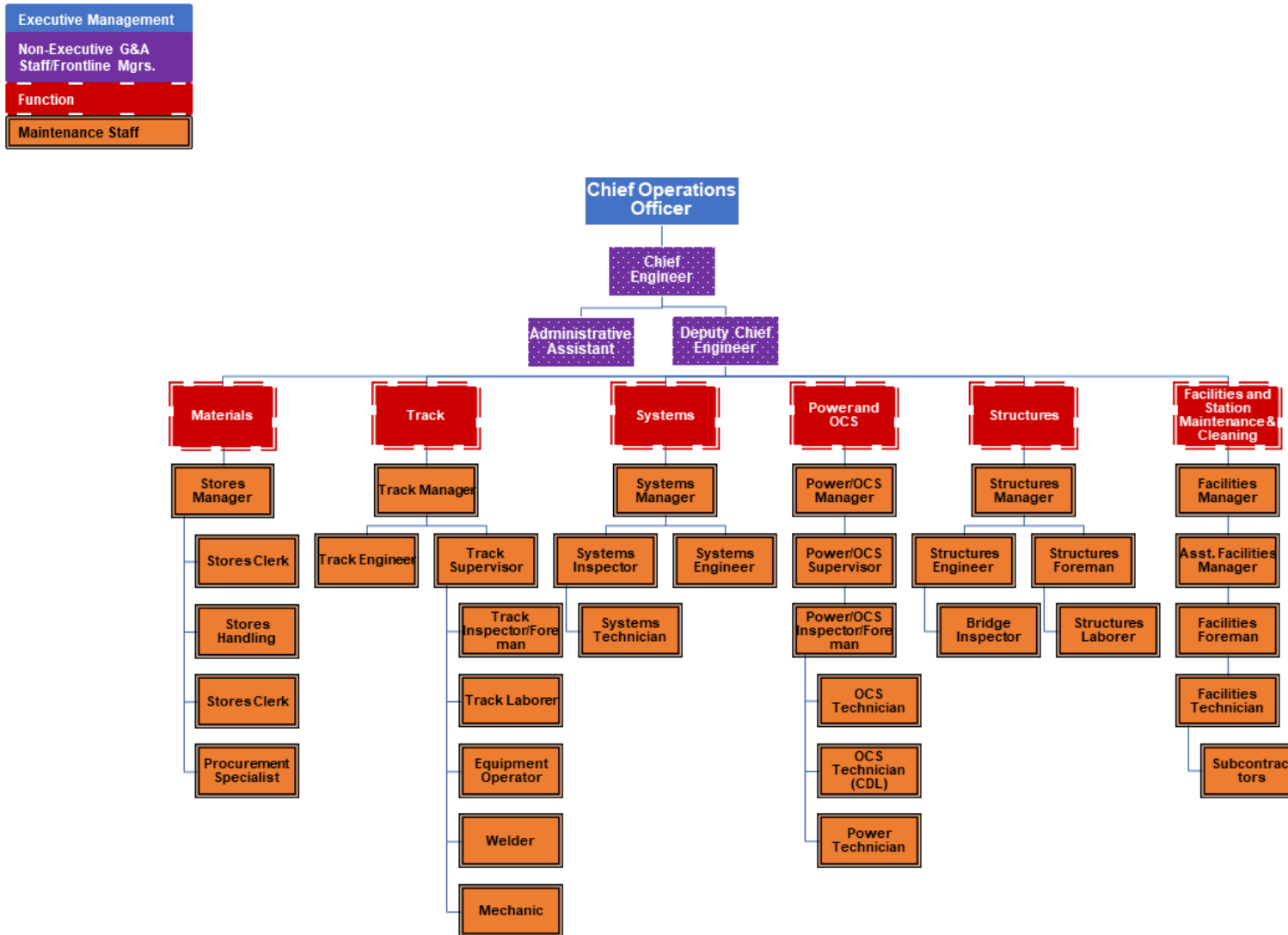


Figure 4 Illustrative Operations and Maintenance Staff Structure—Maintenance of Rolling Stock



Figure 5 Illustrative Operations and Maintenance Staff Structure—Maintenance of Infrastructure Facility Staff



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