

6 PROJECT COSTS AND OPERATIONS

6.1 Introduction

This chapter discusses the estimated costs for building, operating, and maintaining the Palmdale to Burbank Project Section of the California High-Speed Rail (HSR) System based on a preliminary level of design used in preparing this Draft Environmental Impact Report/Environmental Impact Statement (EIR/EIS). Information about the approach and additional details in preparing the construction and operation cost estimates are provided in Volume 2 of this document and include:

- Appendix 2-C, *Operations and Service Plan Summary*, provides background information on the intended service and operations of the California HSR System to provide sufficient detail for the environmental evaluation of proposed HSR operations.
- Appendix 6-A, *High-Speed Rail Operating and Maintenance Cost for Use in EIR/EIS Project-Level Analysis* (Authority and FRA 2017), summarizes the assumptions used to estimate full-system HSR operations and maintenance (O&M) costs.
- Appendix 6-B, *Palmdale to Burbank Project Section: Preliminary Engineering for Project Definition (PEPD) Record Set Capital Costs Estimate Report* (Authority 2022), presents the capital cost estimating methodology and summary of capital cost estimates. As stated in the report, the construction cost estimates were developed for each alternative based on the PEPD design plans, which are the same plans used in the environmental impact analysis in this EIR/EIS.

The sections below discuss both capital costs and O&M costs estimating methodology, assumptions, and costs. Additionally, vehicle and O&M costs are based on the Authority's 2016 Business Plan for consistency with the environmental impact analysis.¹

6.2 Capital Costs

Capital costs represent the total cost associated with the design, management, land acquisition, and construction of the California HSR System. The estimated long-term costs include both train operations and infrastructure maintenance. Operations consist of labor costs, electrical power, and other factors required to keep the California HSR System in service, whereas maintenance includes routine servicing of vehicles, maintenance of the tracks, signals, communications, and other systems needed to keep the system safe and reliable.

6.2.1 Standardized Capital Cost Categories

To help evaluate and compare project construction costs, the California High-Speed Rail Authority (Authority) and the Federal Railroad Administration developed 10 main standardized capital cost categories. Each standard cost category is briefly described below:

- **10 Track Structures and Track**—Includes elevated structures (bridges and viaducts), embankments and open cuts, retaining-wall systems, tunnels, culverts and drainage structures, track (ballasted and nonballasted), and special trackwork.

¹ The analysis presented in this Draft EIR/EIS was initiated using the 2016 Business Plan. Given that there are minimal differences between the Authority's 2016 Business Plan, 2018 Business Plan, and 2020 Business Plan, the costs included in this document rely on the 2016 Business Plan. The Authority released a Draft 2020 Business Plan in February 2020 for public review and comment. The plan's final adoption was expected at the December 2020 Board meeting for submittal to the Legislature by December 15, 2020. However, in coordination with the Legislature, the deadline for adoption of a Final Business Plan was extended. A Revised Draft 2020 Business Plan was released for public review on February 9, 2021, adopted by the Authority Board of Directors on March 25, 2021, and submitted to the Legislature on April 12, 2021. The Revised 2020 Business Plan forecasts were developed using the same travel forecasting model as the 2016 and 2018 Business Plans, updated for population and employment forecasts. The Phase 1 medium ridership forecast for 2040 is 38.6 million, and the high ridership forecast is 50.0 million. The Authority's 2018 Business Plan, adopted in June 2018, includes updated O&M costs. It states that "operations and maintenance costs in all scenarios are minimally impacted by the changes made since the 2016 Business Plan" (2018 Business Plan, Chapter 7, p. 96).

- **20 Stations, Terminals, Intermodal**—Includes rough grading; excavation; station structures; enclosures; finishes; equipment; mechanical and electrical components, including heating, ventilation and air conditioning; station power; lighting; public address/customer service information systems; station site elements, such as pedestrian/bike access and accommodation, landscaping for parking lots, and automobile, bus, and van access ways, including roads; and safety systems, such as fire detection and prevention, security surveillance, access control, and life safety systems.
- **30 Support Facilities: Yards, Shops, Administration, Buildings**—Includes rolling stock service, inspection, storage; heavy maintenance, overhaul facilities and equipment, and associated yard tracks and electrification. In addition, maintenance-of-way facilities are also included in this cost category.
- **40 Sitework, Right-of-Way, Land, Existing Improvements**—Includes cost of demolition, hazardous materials removal, environmental mitigation, utility relocations, noise mitigation, intrusion protection, grade separations, roadway improvements, acquisition of real estate, temporary facilities, and other indirect costs.
- **50 Communications and Signaling**—Includes all costs associated with implementing automatic train control systems, inclusive of positive train control and intrusion detection, where applicable.
- **60 Electric Traction**—Includes costs of the traction-power supply system, including supply, paralleling, and switching substations as well as connections to the power utilities and the traction power distribution system in the form of the overhead contact system.
- **70 Vehicles**—Includes costs for acquisition of the trainsets (design, prototype unit, and production and delivery of trainsets to the project site[s] on an annual basis). Acquisition of trainsets is considered a systemwide cost and is not included as part of the cost of individual HSR study alternatives.
- **80 Professional Services**—Includes all professional, technical, and management services related to the design and construction of infrastructure (Categories 10–60) during the preliminary engineering, final design, and construction phases of the project/program (as applicable).
- **90 Unallocated Contingency**—Includes program reserves.
- **100 Finance Charges**—Includes finance charges expected to be paid by the project/program/sponsor/grantee prior to either the completion of the project or the fulfillment of the Federal Railroad Administration funding commitment, whichever occurs later in time (not included in the estimate).

6.2.2 Palmdale to Burbank Project Section Build Alternatives

The cost estimate prepared for the HSR Build Alternatives was developed by using recent bid data from large transportation projects in the western United States and by developing specific, bottom-up unit pricing to reflect common HSR elements and construction methods with an adjustment for regional labor and material costs. All material quantities for the Palmdale to Burbank Project Section are estimated based on a preliminary level of design. This level of design has generally been defined as encompassing at-grade, retained-fill, or below-grade profiles; structure types; placement of retaining walls; and earth fill. Stations are conceptual, but roadway and utility relocations have been identified and power substations have been sized and located.

The capital cost estimates include the total labor effort and materials to build the Palmdale to Burbank Project Section, including track structures, stations, support facilities, communications and signaling, electric traction and any necessary utility relocations, upgrades, and road modifications. Support facilities associated with the project, including equipment yards, shops, and administration buildings, are not included in the capital cost estimates. It should also be

noted that the capital cost estimates only reflect project-related infrastructure improvements; planned infrastructure improvements from which the project would benefit that would occur regardless of project implementation are not included in capital cost estimates.

Right-of-way costs were estimated based on the preliminary design and are provided in Appendix 6-B, *Palmdale to Burbank Project Section PEPD Set Capital Cost Estimate Report*, in Volume 2 of this Draft EIR/EIS. However, as the design of the project evolves, the right-of-way limits will be reassessed to reflect refined property acquisition needs. As a result, property acquisition costs are estimated in broad categories (i.e., urban, suburban, rural and by land use density level), based on local land values rather than on a parcel-by-parcel assessment at the current phase of project development. Right-of-way acquisitions include the estimated cost to acquire properties needed for the future real estate needs of the Palmdale to Burbank Project Section and costs associated with temporary easements for construction that are assumed to be part of the design-build contractor’s responsibilities to negotiate use.

The capital cost estimates for the Build Alternatives do not include the cost of acquiring HSR vehicles because they are part of the statewide system and are not associated with construction of individual sections. It should be noted, however, that consistent with the *2016 Business Plan: Connecting and Transforming California* (Authority 2016), the cost of vehicles was determined using publicly available data regarding recent sales of comparable equipment to other HSR projects around the world. Additional costs are included for adaptation of existing trainset designs to meet U.S. safety regulations and to comply with “Buy America”² requirements. The systemwide cost of vehicle procurement is divided into two milestones: Silicon Valley to the Central Valley Line, and Phase 1, which extends from San Francisco to Anaheim. Total vehicle procurement cost is estimated at \$3.4 billion in 2015 dollars. The 2016 Business Plan does not include cost estimates for Phase 2.

Again, using cost information collected from large transportation projects and adjusting for regional labor and material costs, professional services are estimated at 18.5 percent of the construction costs. These costs are divided among preliminary engineering (2 percent), program management (3 percent), final design (6 percent), construction management (4 percent), and agency costs (0.5 percent). Environmental mitigation costs are estimated at approximately 3 percent of the capital cost, given potential project impacts and typical mitigation costs in the region (see Appendix 6-B).

At this early stage of design, the capital cost estimates include contingencies to account for changes in material costs and changes during project design. Currently, allocated contingencies (money reserves assigned to each cost category to cover risks associated with design uncertainty) are assumed to be between 10 percent and 25 percent of the estimated construction and right-of-way acquisition costs. Unallocated contingency (project reserves intended to cover unknown risks) is estimated at 5 percent of the construction costs (see Appendix 6-B).

Table 6-1 shows the estimate for each Palmdale to Burbank Project Section Build Alternative. The alignments range in distance from approximately 35 to 41 miles and are estimated to have capital costs between \$22,400 million and \$24,075 million (2018 dollars). Differences in each Build Alternative cost are a result of track length and relevant site work variations. Each Build Alternative cost estimate includes the costs of the Palmdale Station and the Maintenance Facility, which overlap with both the project section to the north (Bakersfield to Palmdale) and the Burbank Airport Station, which overlaps with the project section to the south (Burbank to Los Angeles). Refer to Chapter 2, Alternatives, for additional information.

² “Buy America” requirements apply to mass transit projects and give preference to the use of domestically produced materials on any procurements funded at least in part by federal funds. Administered by the Federal Transit Administration, the requirements are described at 49 Code of Federal Regulations 661.

Table 6-1 Estimated Capital Costs of the Palmdale to Burbank Project Section Build Alternatives (2018\$ in millions)

Authority Cost Category	Refined SR14 Build Alternative	SR14A Build Alternative	E1 Build Alternative	E1A Build Alternative	E2 Build Alternative	E2A Build Alternative
10 Track structures and track	\$12,723	\$13,568	\$13,267	\$13,867	\$13,526	\$14,086
20 Stations, terminal, intermodal ^{1,2}	\$556	\$560	\$573	\$532	\$661	\$624
30 Support facilities: yards, shops, administration buildings ³	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable
40 Sitework, right-of-way, land, existing improvements	\$4,946	\$5,472	\$4,459	\$4,607	\$4,074	\$4,139
50 Communications and signaling	\$175	\$189	\$173	\$182	\$164	\$159
60 Electric traction	\$249	\$256	\$237	\$238	\$213	\$214
70 Vehicles	Considered a systemwide cost and not included as part of the Build Alternatives within individual project sections.					
80 Professional services	\$2,950	\$3,169	\$2,985	\$3,110	\$3,036	\$3,138
90 Unallocated contingency ⁴	\$801	\$861	\$803	\$834	\$799	\$824
100 Finance charges	Estimate to be developed prior to project construction.					
Total⁵	\$22,400	\$24,075	\$22,497	\$23,370	\$22,473	\$23,184

Source: Appendix 6-B, Palmdale to Burbank Project Section: PEPD Record Set Capital Costs Estimate Report

¹ Station costs overlap. The Palmdale Station and the Maintenance Facility are also included in the Bakersfield to Palmdale project section costs. The Burbank Station costs are also included in the Burbank to Los Angeles project section costs.

² Roadway modifications and accesses to the alignment are accounted for under station cost estimates. The SR14A, E1A, and E2A Build Alternatives would require significantly fewer roadway modifications due to more tunneling and through avoidance of the Pearblossom Interchange, resulting in lower station construction cost estimates compared to the Refined SR14, E1, and E2 Build Alternatives.

³ The Palmdale to Burbank Project Section cost information does not include support facilities due to the limited level of design information available for these project features.

⁴ All cost categories include unallocated contingencies. Category SCC 90 is only unallocated monies.

⁵ Totals may not sum correctly due to rounding

SCC = standard capital cost; SR = State Route

6.3 Operating and Maintenance Costs

Chapter 2, Alternatives, describes O&M activities in detail. This analysis assumes that HSR service during Phase 1 would connect San Francisco with Los Angeles via the southern Central Valley by 2029. The plan is to offer express, limited-stop, and all-stop services, depending on time of day and projected needs. For Phase 1, there would be 13 HSR stations. By 2040, multiple facilities would be required for overnight storage, inspection, and routine maintenance of more than 78 trainsets, each 655 feet long. The heavy maintenance facility serving the California HSR System would be between Merced and Bakersfield. The heavy maintenance facility would store and maintain a portion of the trainsets. A maintenance of infrastructure facility would be located approximately every 150 miles, while a maintenance of infrastructure siding facility would be needed approximately every 75 miles.

O&M costs account for staff, labor, and material supplies required to run the California HSR System and to perform required maintenance. O&M costs are estimated based on daily rail miles, operating speeds, HSR station configurations, maintenance and storage facilities, and operating frequencies in accordance with the 2016 Business Plan (Authority 2016).

6.3.1 Assumptions

The O&M cost forecasts for the Palmdale to Burbank Project Section Build Alternatives are based on assumptions included in the *High-Speed Rail Operating and Maintenance Cost for Use in EIR/EIS Project Level Analysis Memorandum* (Authority and FRA 2017). The Authority developed the assumptions based on refinements to the HSR plan over time and aspects specific to the Palmdale to Burbank Project Section. Assumptions used in this analysis include the following:

- The apportionment of systemwide O&M cost estimates to the Palmdale to Burbank Project Section is proportional to the cost per route mile in the project section.
- The Phase 1 system will open in 2029 and will cover approximately 520 miles.
- The Phase 1 system will serve 13 stations: San Francisco, Millbrae, San Jose, Gilroy, Merced, Fresno, Kings/Tulare, Bakersfield, Palmdale, Burbank, Los Angeles Union Station, Norwalk/Santa Fe Springs or Fullerton, and the Anaheim Regional Transportation Intermodal Center.
- The Phase 1 system will include 196 revenue service train runs per day with varying stopping patterns between San Francisco and Anaheim, San Francisco and Los Angeles, San Jose and Los Angeles, Merced and Los Angeles, and Merced and Anaheim.
- The Phase 1 system assumes 6 hours of peak service and 10 hours of off-peak service daily. Phase 1 will include eight round-trip revenue service trains per hour during peak service and five round-trip trains per hour during off-peak service.
- The California HSR System will include connecting bus service between Sacramento and Merced during Phase 1 operations.
- After full operational ramp-up, HSR operations will include 78 trainsets including spares, 34.5 million total trainset miles, and 2.2 million bus miles per year.

To support the Phase 1 HSR service outlined above, total O&M costs include additional assumptions related to maintenance and train operations. The system will include one operations control center and three terminal control facilities to manage dispatching. A heavy maintenance facility would be in the southern Central Valley, with three light maintenance facilities dispersed across the rest of the system, including one near Gilroy, one in Northern California along the Peninsula Corridor at Brisbane, and one in Southern California near Los Angeles. O&M support activities would also be provided at five maintenance of infrastructure facilities.

6.3.2 Operating Speeds

The HSR trains would operate at high speeds (up to 220 miles per hour) along fully grade-separated dedicated track, and lower speeds in some areas with blended operations. Certain segments in the corridor may require lower speeds due to limiting track geometry.

6.3.3 Development of Operations and Maintenance Costs

An important goal of the Authority's business plans is to achieve a balance between O&M costs and projected farebox revenue as proof of the requirements mandated by Proposition 1A, the *Safe, Reliable, High-Speed Passenger Train Bond Act*, adopted by California voters in November 2008. The Authority has continued to refine its O&M cost model to reflect a more accurate cost basis for the program's current level of design.

O&M costs estimates include operations activities to serve and carry the forecast train service for Phase 1 in 2040 for the medium and high ridership forecasts as described in Chapter 2, Alternatives; the maintenance costs necessary to keep the system in a state of good repair; and

the administrative costs (Appendix 6-A). For consistency with the environmental impacts analysis, estimated O&M costs in this chapter are based on the Authority's 2016 Business Plan. The current HSR O&M model, where applicable, is based on cost categories defined in the U.S. Department of Transportation Inspector General's *High-Speed Intercity Passenger Rail Best Practices: Operating Cost Estimation* report (Office of the Inspector General 2011), where applicable. The report defines the general parameters for estimating the preliminary, intermediate, final, and commercial closeout stages of a program. No program falls neatly into all these parameters, and there is usually some overlap between the stages. In this context, large parts of the Authority's O&M cost model fall into the intermediate stage, while still others might be classified as preliminary or have advanced to the final stage (Office of the Inspector General 2011).

Unit prices were developed and applied to calculate the cost for each activity included in the operating plan. Although many of the O&M unit costs for the California HSR System would be similar to the costs of U.S. conventional rail operations and can be reliably estimated from U.S. practices and costs, the unit cost to maintain high-speed trainsets and dedicated high-speed rail infrastructure has no close analogy in the U.S. Therefore, international O&M unit cost projections from comparable HSR operations were applied to planned California operations, HSR technology, and local cost levels and labor practices.

The O&M costs of HSR equipment includes the cost of (1) crew, administration, and supplies to operate and dispatch the HSR services; (2) electric power for traction, onboard systems, stations, and maintenance/other facilities; and (3) cleaning, inspection, maintenance, and overhaul of the trainsets. Maintenance of infrastructure covers the costs of patrolling, inspecting, and maintaining the right-of-way, fencing, structures, bridges, tunnels, roadbed, track, signaling, overhead contact systems, substations and similar electric facilities, communications, intrusion detection, and other facilities.

Station O&M costs include the day-to-day operations of the station, ticket sales and machine maintenance, public safety, passenger handling, and cleaning. The O&M cost model includes the following categories of O&M costs:

- Train operations
- Dispatching
- Maintenance of equipment
- Maintenance of infrastructure
- Station and train cleaning
- Commercial
- General and administrative
- Insurance
- Unallocated contingencies

The upgrades made to the 2016 O&M model have improved the detail and flexibility of the model to allow for more precise estimations and easier validation of source materials.

Table 6-2 outlines the medium and high ridership forecast O&M costs by cost category estimated for Phase 1 of the California HSR System for the year 2040. For more information on the O&M cost model used for cost forecasting, please refer to Appendix 6-A.

Table 6-2 Annual Operation and Maintenance Costs for Phase 1 (2015\$ in millions)

O&M Activity	2040 Medium Ridership Forecast	2040 High Ridership Forecast
Train operations	\$285	\$311
Dispatching	\$30	\$33
Maintenance of equipment	\$134	\$146
Maintenance of infrastructure	\$122	\$133

O&M Activity	2040 Medium Ridership Forecast	2040 High Ridership Forecast
Station and train cleaning	\$71	\$77
Commercial costs and functions	\$94	\$103
General and administrative	\$53	\$58
Insurance	\$52	\$57
Unallocated contingency	\$35	\$38
Total	\$874	\$956

Source: Appendix 6-A, High-Speed Rail Operating and Maintenance Cost for Use in EIR/EIS Project-Level Analysis

Totals may not sum due to rounding.

O&M = operating and maintenance

O&M costs in 2015 dollars as apportioned to the Palmdale to Burbank Project Section are shown in Table 6-3 and are based on total cost per route mile for Phase 1 of the California HSR System. The costs associated with O&M are apportioned based on trainset miles operated in the Palmdale to Burbank Project Section. The costs associated with the maintenance of infrastructure are apportioned as a ratio of 40 miles to the 520 total route miles in Phase 1.

Accordingly, the Palmdale to Burbank Project Section is expected to cost \$70 million annually under the 2040 medium ridership forecast and \$76 million annually under the 2040 high ridership forecast (Appendix 6-A).

Table 6-3 Annual Operation and Maintenance Costs Apportioned to the Palmdale to Burbank Project Section (2015\$ in millions)

O&M Activity	2040 Medium Ridership Forecast	2040 High Ridership Forecast
Train operations	\$22	\$24
Dispatching	\$3	\$3
Maintenance of equipment	\$11	\$12
Maintenance of infrastructure	\$10	\$11
Station and train cleaning	\$6	\$6
Commercial costs and functions	\$7	\$8
General and administrative	\$4	\$5
Insurance	\$4	\$4
Unallocated contingency	\$3	\$3
Total¹	\$70	\$76

Source: Appendix 6-A, High-Speed Rail Operating and Maintenance Cost for Use in EIR/EIS Project-Level Analysis

¹Totals may not sum due to rounding.

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