

6 PROJECT COSTS AND OPERATIONS

6.1 Introduction

This chapter discusses the estimated costs for building, operating, and maintaining the Bakersfield to Palmdale Project Section (B-P) of the California High-Speed Rail (HSR) System, including the César E. Chávez National Monument Design Option (CCNM Design Option), the Refined CCNM Design Option, and the portion of the Fresno to Bakersfield Locally Generated Alternative (F-B LGA) alignment from the intersection of 34th Street and L Street to Oswell Street. This discussion is based on a preliminary level of design used in preparing this environmental impact report/environmental impact statement (EIR/EIS). The approach and details used to prepare the construction and operation cost estimates are provided in Volume 2 of this document and include:

- Appendix 2-C, Operations and Service Plan, provides background information on the intended service and operations of the 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, summarizes the assumptions used to estimate full system HSR operations and maintenance (O&M) costs.
- Appendix 6-B, Bakersfield to Palmdale Project Section: Cost Estimate Report, 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 preliminary engineering for project definition design plans, which are the same plans used in the environmental analysis in this EIR/EIS.

The sections below discuss capital costs and O&M costs.

6.2 Capital Costs

Capital costs represent the total cost associated with the design, management, land acquisition, and construction of the HSR system. To evaluate and compare project construction costs, the Federal Railroad Administration and the California HSR Authority (Authority) developed 10 main standardized capital cost categories. Each standardized capital 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, track (ballasted and non-ballasted), and special trackwork.
- **20 Stations, Terminals, Intermodal**—includes rough grading, excavation, station structures, architecture, enclosures, finishes, and equipment; mechanical and electrical components, including heating, ventilation, and air conditioning, station power, lighting, and public address/customer information systems; station site elements, such as pedestrian/bike access and accommodation; landscaping for parking lots; 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, and storage through use of a light maintenance facility; heavy maintenance and overhaul facilities; and storage, equipment, associated yard tracks, and electrification. This category also includes maintenance-of-way facilities.
- **40 Sitework, Right-of-Way, Land, Existing Improvements**—includes cost of demolition, hazardous materials removals, environmental mitigation, utility relocations, noise mitigation, intrusion protection, grade separations, roadway improvements, acquisition of real estate, and temporary facilities and other indirect costs.

- **50 Communications and Signaling**—includes all costs of implementing automatic train control systems, including positive train control and intrusion detection where it is applicable.
- **60 Electric Traction**—includes costs of traction power supply system, including supply, paralleling, and switching substations as well as connections to the power utilities; and traction power distribution system in the form of 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 on an annual basis). Acquisition of trainsets is considered a systemwide cost and is not included as part of the cost of individual B-P Build Alternatives or design options.
- **80 Professional Services**—includes all professional, technical, and managerial services related to the design and construction of infrastructure (Categories 10 through 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).

6.2.1 Bakersfield to Palmdale Project Section Build Alternatives

The Authority developed the conceptual cost estimates prepared for each of the alternatives using recent bid data from large transportation projects in the western U.S., followed by the development of specific, bottom-up unit pricing to reflect common HSR elements and construction methods with an adjustment for labor and material costs for the Bakersfield to Palmdale Project Section. The engineers estimated all material quantities for the project based on a preliminary level of design. This Authority generally defines this level of design as encompassing at-grade or elevated profiles, structure types, placement of retaining walls, and earth fill. Stations are still 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 and materials necessary to construct the Bakersfield to Palmdale Project Section, including utility relocations, upgrades, and modifications to roadways required to accommodate HSR grade-separated guideways. The capital cost estimates reflect related infrastructure improvements and do not include costs associated with the No Project Alternative.

Right-of-way costs were estimated based on the preliminary design and are documented in Appendix 6-B, Cost Estimate Report. 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, and rural and by population-density level) and based on local land values rather than relying on a parcel-by-parcel assessment at this phase of project development. Right-of-way costs include the estimated cost to acquire properties needed for the future right-of-way and include costs associated with temporary easements for construction that are assumed to be part of the construction contractor's responsibility to negotiate use.

The capital cost estimates do not include the cost of acquiring HSR vehicles because the vehicles would be part of the statewide system and are therefore not associated with construction of individual project sections. Consistent with the 2016 Business Plan (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”¹ requirements. Vehicle procurement cost is estimated at \$3.4 billion in 2015 dollars for the complete Phase 1 system. The 2016 Business Plan (Authority 2016) does not include cost estimates for Phase 2.

Professional services are estimated at 24.5 percent of the construction costs divided between final design (6 percent), construction management (4 percent), program management (3 percent), preliminary engineering and environmental (2 percent), startup and testing (6 percent), and third-party agency reviews and permits (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 (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 (i.e., 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, and unallocated contingency (i.e., project reserves intended to cover unknown risks) is estimated at 5 percent of the construction and right-of-way acquisition costs.

Table 6-1 shows the capital cost estimates for each alternative from the Bakersfield Station to the Palmdale Station (including the F-B LGA alignment from the intersection of 34th Street and L Street to Oswell Street), as well as for the CCNM Design Option and the Refined CCNM Design Option. Alternatives 1, 2, 3, and 5 range in distance from 82.77 to 82.79 miles and are estimated to have construction costs between approximately \$18.1 billion and \$19.0 billion (2016\$). The CCNM Design Option would cost an additional \$47 million to construct and the Refined CCNM Design Option would cost an additional \$534 million to construct. All B-P Build Alternatives reflect costs of the Bakersfield and Palmdale stations, as well as maintenance facilities discussed in Section 6.2.2.

Table 6-1 Capital Costs of the B-P Build Alternatives from Bakersfield Station to Palmdale Station¹ (2016\$ in millions)

Cost Category	Alternative 1 ¹	Alternative 2 ¹	Alternative 3 ¹	Alternative 5 ¹	CCNM Design Option ²	Refined CCNM Design Option ³
10 Track structures and track	\$9,308	\$9,516	\$9,880	\$9,262	+\$35	+422
20 Stations, ⁴ terminals, intermodal	\$745	\$675	\$745	\$760	\$0	+\$7
30 Support facilities: yards, shops, administration buildings	\$490	\$490	\$490	\$482	\$0	\$0
40 Site work, right-of-way, land, existing improvements	\$3,668	\$3,487	\$3,731	\$3,638	\$4	-\$24
50 Communications and signaling	\$247	\$248	\$248	\$248	\$0	\$0
60 Electric traction	\$614	\$615	\$615	\$614	\$0	\$0

¹ “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 in 49 Code of Federal Regulations 661.

Cost Category	Alternative 1 ¹	Alternative 2 ¹	Alternative 3 ¹	Alternative 5 ¹	CCNM Design Option ²	Refined CCNM Design Option ³
70 Vehicles	Considered a systemwide cost and not included as part of individual B-P Build Alternatives or design options					
80 Professional services	\$2,239	\$2,182	\$2,303	\$2,165	+\$6	+\$80
90 Unallocated contingency ⁵	\$933	\$933	\$965	\$930	+\$2	+\$24
100 Finance Charges	Estimate to be developed prior to project construction					
Total	\$18,244	\$18,146	\$18,977	\$18,099	+\$47	+\$509

Sources: Appendix 6-B, Cost Estimate Report; Simon 2020

¹ Includes costs from Bakersfield Station to Palmdale Station, including the portion of the F-B LGA alignment from the intersection of 34th Street and L Street to Oswell Street and Avenue O to Spruce Court in Palmdale.

² Numbers reflect changes brought by the addition of the CCNM Design Option to any of the B-P Build Alternatives.

³ Numbers reflect changes brought by the addition of the Refined CCNM Design Option to any of the B-P Build Alternatives.

⁴ Station costs overlap with Bakersfield to Palmdale and Palmdale to Burbank project sections, respectively.

⁵ All cost categories include allocated contingencies. Category 90 is only unallocated monies.

6.2.2 Maintenance Facilities

O&M of the HSR system would require construction of maintenance facilities along the alignment. For systemwide operations, terminal station locations would be supported by a light rolling-stock maintenance facility (LMF) to supply inspected and serviced trainsets at the start of operation each day. In addition, maintenance-of-way facilities (MOWF) would provide dispatch, maintenance, and repair of rail-mounted equipment and would include support quarters for maintenance personnel. A maintenance of infrastructure siding (MOIS) facility would provide sufficient storage for on-track equipment required to be placed prior to the beginning of overnight maintenance.

The Bakersfield to Palmdale Project Section would include construction of an LMF, an MOWF, and two MOIS facilities. The LMF and MOWF would be located in the Antelope Valley, while the two MOIS facilities would be located in Edison and in Tehachapi. The locations of these facilities are anticipated to be generally the same regardless of the B-P Build Alternative selected. Planning for these facilities is based on the current implementation phases of the HSR project as described in the 2016 Business Plan (Authority 2016).

Figure 2-54 in Chapter 2, Alternatives, shows the potential locations for the LMF and MOWF, or co-located LMF/MOWF in the Bakersfield to Palmdale Project Section. The Avenue M LMF in Antelope Valley would be sited on the west side of the HSR alignment, generally between W Avenue L and Avenue M-12. The MOWF would be sited at the Lancaster North B site, which is west of the Antelope Valley Freeway (State Route [SR] 14), generally between W Avenue C and W Avenue B. Chapter 2, Alternatives, describes the LMF, MOWF, and MOIS facilities in detail. A LMF co-located with an MOWF could be sited at the Lancaster North A site. This site would be located on the west side of the HSR alignment and to the west of SR 14, generally between W Avenue C and W Avenue B.

For the Bakersfield to Palmdale Project Section, an MOIS is proposed in Edison near the bottom of the Tehachapi Mountains and in Tehachapi near the top of the Tehachapi Mountains. Each MOIS facility is estimated to be approximately 5 acres and would require one siding track, one tail track, and stockpile areas (Authority 2016).

Table 6-1 includes project costs for the maintenance facilities for each alternative.

6.3 Operations and Maintenance Costs

The estimated long-term O&M costs include both train operations and infrastructure maintenance. Operations costs address labor, electrical power, and other aspects required to keep the HSR system

in service. Maintenance costs include routine servicing of vehicles and maintenance of the tracks, signals, communications, and other systems needed to keep the system safe and reliable.

Chapter 2, Alternatives, describes O&M activities in detail. The Phase 1 system would operate the HSR trains on approximately 520 miles of track by 2040. Phase 1 would include 15 HSR stations serving the system, 2 of which would be located in the Bakersfield to Palmdale Project Section. Multiple facilities would be required for overnight storage, inspection, and routine maintenance of more than 78 trainsets, each 656 feet long. A heavy maintenance facility, serving the entire HSR system, would be needed and would be located between Merced and Bakersfield. The HMF would store and maintain some of the trainsets. As described in Section 6.2.2, the Bakersfield to Palmdale Project Section would include an LMF, an MOWF, and two MOIS facilities.

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

6.3.1 Operating Speeds

The HSR system in the Bakersfield to Palmdale Project Section would operate at high speeds (up to 220 miles per hour).

6.3.2 Development of Operations and Maintenance Costs

O&M cost estimates include operations activities needed 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, the maintenance costs necessary to keep the system in a state of good repair, and administrative costs (Appendix 6-A). For consistency with the environmental impacts analysis, the estimated O&M costs in this chapter are based on the Authority's 2016 Business Plan.² 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 Costs Estimation* report (U.S. Department of Transportation 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 others might be classified as preliminary or have advanced to the final stage.

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 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 include 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.

² The Authority released a Draft 2020 Business Plan in February 2020 for public review and comment. The plan's final adoption is expected at the April 2020 Board meeting for submittal to the Legislature by May 1, 2020. The 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 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" (Authority 2018, chapter 7, p. 96).

Maintenance of infrastructure covers the expense of patrolling, inspecting, and maintaining the right-of-way, fencing, structures, bridges, tunnels, roadbed, track, signaling, overhead electric traction power system, substations and similar electrical facilities, communications, intrusion detection, and 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. Station staffing is based on the number of train turns at each terminal station and station size. Station staffing assumes the following job categories:

- Station manager
- Ticket clerk/customer service representative
- Sworn and unsworn security
- Station and train cleaning
- Frontline supervisors

Phase 1 HSR system operations would require approximately 25 individuals at the Bakersfield and Palmdale stations.

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 contingency

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

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 of this EIR/EIS.

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

Operations and Maintenance 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
Station and train cleaning	\$71	\$77
Commercial	\$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 of this EIR/EIS
Totals may not sum due to rounding.

O&M costs in 2015 dollars as apportioned to the Bakersfield to Palmdale Project Section are shown in Table 6-3 and are based on the Phase 1 HSR system, total cost per route mile. The costs associated with O&M are apportioned on the basis of trainset miles operated in the Bakersfield to Palmdale Project Section. The costs associated with maintenance of infrastructure are apportioned as a ratio of 80 route miles to the 520 Phase 1 total route miles.

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

Operations and Maintenance Activity	2040 Medium Ridership Forecast	2040 High Ridership Forecast
Train operations	\$46	\$50
Dispatching	\$5	\$5
Maintenance of equipment	\$21	\$23
Maintenance of infrastructure	\$20	\$21
Station and train cleaning	\$11	\$12
Commercial	\$15	\$16
General and administrative	\$8	\$9
Insurance	\$8	\$9
Unallocated contingency	\$6	\$6
Total	\$140	\$153

Source: Appendix 6-A, High-Speed Rail Operating and Maintenance Cost for Use in EIR/EIS Project-Level Analysis of this EIR/EIS
 Totals may not sum due to rounding.
 Total 2040 medium ridership forecast cost based on \$1.75/mile; and total 2040 high ridership forecast cost based on \$1.91/mile.

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