

5.0 Project Costs and Operations

5.1 Introduction

This chapter discusses the estimated costs for building, operating, and maintaining the Merced to Fresno Section of the California HST System, based on a 15% level of design used in preparing this EIR/EIS. The approach and the details used to prepare the construction cost estimate are provided in the Merced to Fresno Section Cost Estimate Report (Authority 2011), which is available upon request from the Authority. Appendix 5-A to this EIR/EIS is the Operations and Service Plan Summary and Appendix 5-B is a memorandum regarding HST operations and maintenance (O&M) costs.

5.2 Capital Costs

Capital costs represent the total cost associated with the design, management, land acquisition, and construction of the HST System. The estimate of long-term O&M costs includes both train operations and infrastructure maintenance. Operations consists of labor costs, electrical power, and other factors required to keep the HST 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.

To help evaluate and compare project construction costs, FRA has developed 10 main Standard Capital Cost Categories. Each 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, enclosures, finishes, and equipment; mechanical and electrical components including heating, ventilation, and air conditioning (HVAC), station power, lighting, and public address/customer information systems; and safety systems such as fire detection and prevention, security surveillance, access control, life safety systems, etc.
- **30 Support Facilities: Yards, Shops, and Administration Buildings** – Includes rolling stock service, inspection, storage, and heavy maintenance and overhaul facilities and equipment, as well as associated yard tracks and electrification. 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 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** – Covers all costs of implementing Automatic Train Control (ATC) systems, inclusive of Positive Train Control (PTC) and intrusion detection where applicable.
- **60 Electric Traction** – Covers costs of traction power supply system, including supply, paralleling and switching substations, and connections to the power utilities; and traction power distribution system in the form of Overhead Contact System (OCS).
- **70 Vehicles** – Includes costs for acquisition of the trainsets (design, prototype unit, and production and delivery of trainsets to the project site on annual basis). The cost of acquiring trainsets was not included in the capital cost estimate prepared for this document.

- **80 Professional Services** – Includes all professional, technical, and management 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 project 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 FRA funding commitment, whichever occurs later in time. Finance charges are not included in the capital cost estimate prepared for this document.

5.2.1 High-Speed Train Alternatives

The conceptual HST cost estimate prepared for each of the study alternatives was developed by utilizing recent bid data from large transportation projects in the western United States and by developing specific, bottom-up unit pricing to reflect common HST elements and construction methods with an adjustment for Central Valley labor and material costs. All material quantities are estimated based on a 15% level of design for the Merced to Fresno Section. This level of design has generally defined at-grade or elevated profiles, structure types, placement of retaining walls, and earth fill. HST stations are still conceptual, but roadway and utility relocations have been designed, and power substations have been sized and located.

The costs include the total effort and materials required to construct the Merced to Fresno Section, including modifications to roadways required to accommodate HST grade-separated guideways. It should be noted that the capital cost estimate reflects only HST-related infrastructure improvements and does not include costs associated with the No Project Alternative.

Detailed right-of-way needs are included in the 15% design drawings (see Volume III of this 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 by land use types (agricultural, commercial, industrial, etc.) and by estimated areas of partial and full parcel acquisitions for each land use type rather than by 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 HST right-of-way but do not include costs associated with temporary easements for construction that are assumed to be part of allocated contingencies added to right-of-way acquisition costs.

These costs do not include acquiring HST vehicles because they are part of the statewide HST System and are not associated with constructing individual sections. Consistent with the *2009 Business Plan Report to the Legislature* (Authority 2009), the cost of vehicles was determined by using publicly available data regarding recent sales of comparable equipment to other HST projects around the world and by informally consulting with manufacturers. The systemwide cost of vehicle procurement is divided into two parts: Opening Day demand (assumes 60 trainsets in 2020) and Optional Orders, which accommodate the demand associated with increases in ridership (assumes 40 trainsets between 2025 and 2035). Total vehicle costs, including vehicles needed for Opening Day service and Optional Orders, are estimated at \$3.3 billion in year-of-expenditure dollars.

Professional services are estimated at 13.5% of the construction costs and include final design (6%), construction management (4%), program management (3%), and agency costs (0.5%). Environmental mitigation costs are based on similar estimates, with approximately 3% of the capital cost required to mitigate environmental impacts, considering potential project impacts and typical mitigation costs in the region.

At this stage of design, many project features have not been fully developed; therefore, early 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 between 10% and 25% of the estimated construction

and right-of-way acquisition costs, while unallocated contingency (project reserve intended to cover unknown risks) is estimated at 5% of the construction and right-of-way acquisition costs.

Table 5-1 shows estimates for each study alternative. The estimates are detailed by project cost item to help identify where the alternatives differ and why.

Table 5-1
Capital Cost of the HST Alternatives (2010 \$Thousands)

FRA Standard Cost Categories	UPRR/ SR 99 Alternative with Ave 24 Wye	UPRR/ SR 99 Alternative with Ave 21 Wye	UPRR/SR 99 Alternative West Chowchilla Design Option with Ave 24 Wye	BNSF Alternative with Ave 24 Wye	BNSF Alternative with Ave 21 Wye	Hybrid Alternative with Ave24 Wye	Hybrid Alternative with Ave 21 Wye
10 Track Structures & Track	\$3,485,000	\$3,008,000	\$2,629,000	\$1,961,000	\$1,844,000	\$1,383,000	\$2,059,000
20 Stations, Terminals, Intermodal	\$170,000	\$170,000	\$170,000	\$170,000	\$170,000	\$170,000	\$170,000
30 Support Facilities: Yards, Shops, Admin. Bldgs	\$12,000	\$12,000	\$27,000	\$12,000	\$12,000	\$27,000	\$27,000
40 Sitework, Right Of Way, Land, Existing Improvements	\$1,416,000	\$1,348,000	\$1,205,000	\$1,325,000	\$1,138,000	\$1,218,000	\$1,318,000
50 Communications & Signaling	\$151,000	\$129,000	\$116,000	\$156,000	\$140,000	\$117,000	\$135,000
60 Electric Traction	\$486,000	\$417,000	\$374,000	\$504,000	\$452,000	\$378,000	\$440,000
70 Vehicles	Considered a systemwide cost and not included as part of individual HST study alternatives						
80 Professional Services (applies to Cats. 10-60)	\$723,000	\$637,000	\$561,000	\$511,000	\$461,000	\$393,000	\$509,000
90 Unallocated Contingency	\$251,000	\$222,000	\$197,000	\$178,000	\$162,000	\$141,000	\$180,000

FRA Standard Cost Categories	UPRR/ SR 99 Alternative with Ave 24 Wye	UPRR/ SR 99 Alternative with Ave 21 Wye	UPRR/SR 99 Alternative West Chowchilla Design Option with Ave 24 Wye	BNSF Alternative with Ave 24 Wye	BNSF Alternative with Ave 21 Wye	Hybrid Alternative with Ave 24 Wye	Hybrid Alternative with Ave 21 Wye
100 Finance Charges	Estimate to be developed prior to project construction						
Total	\$6,694,000	\$5,943,000	\$5,279,000	\$4,817,000	\$4,379,000	\$3,827,000	\$4,838,000

All HST alternatives in the Merced to Fresno Section reflect costs of the Fresno Kern Street Station Alternative. Another Fresno station alternative being considered is the Mariposa Street Station Alternative, estimated at approximately the same cost.

The BNSF Alternative design options would allow the HST to connect from the UPRR in Merced to the BNSF corridor near the community of Le Grand. These design options were developed to parallel Mission Avenue or Mariposa Way and to travel through Le Grand or east of Le Grand. The design options that travel east of Le Grand are substantially more expensive. The least costly design option is the Mission Ave design option. The primary difference in the cost is attributed to the longer length of the guideway and the additional elevated guideway required for the design options that travel east of Le Grand compared with those that go through Le Grand.

5.2.2 Heavy Maintenance Facilities

Another project component of the Central Valley portion of the HST System is the construction and operation of an HMF. Five sites are under consideration for the HMF between the cities of Merced and Fresno. Table 5-2 lists the projected costs for these design options, including connecting tracks and infrastructure. The costs for the HMF alternatives are estimated based on conceptual site and functional layouts and the unit costs for comparable rail equipment, maintenance, and storage facilities.

Table 5-2
Costs for Heavy Maintenance Facility Alternatives
(2010 \$Thousands)

FRA Standard Cost Categories	Heavy Maintenance Facility (Adjacent Site Alternatives)	Heavy Maintenance Facility (Castle Commerce Center)
10 Track Structures & Track	\$32,000	\$348,000
20 Stations, Terminals, Intermodal	\$—	\$—
30 Support Facilities: Yards, Shops, Admin. Bldgs.	\$383,000	\$383,000
40 Sitework, Right Of Way, Land, Existing Improvements	\$77,000	\$108,000
50 Communications & Signaling	\$3,000	\$11,000
60 Electric Traction	\$37,000	\$63,000
70 Vehicles	\$—	\$—
80 Professional Services (applies to Cats. 10-60)	\$66,000	\$116,000
90 Unallocated Contingency	\$22,000	\$39,000

FRA Standard Cost Categories	Heavy Maintenance Facility (Adjacent Site Alternatives)	Heavy Maintenance Facility (Castle Commerce Center)
100 Finance Charges	\$—	\$—
Total	\$620,000	\$1,068,000

Except for the Castle Commerce Center HMF site, all of the HMF sites would be adjacent to one or more of the HST alternative alignments, and their costs include relatively similar components. For instance, each potential HMF site (except the Castle Commerce Center site) would require approximately the same length of lead guideway. The site plan is standard, so there is no major difference at this level of design. The sites were screened to eliminate major resource conflicts and difficult site constraints. The proposed HMF sites would generally require relatively low land costs; as a result, there are no noticeable cost differences between the sites (except the Castle Commerce Center site). The Castle Commerce Center site would require a longer lead guideway from the Downtown Merced Station, which would not follow the future HST guideway extension toward Sacramento for two reasons:

- The Authority has not decided whether the UPRR or the BNSF route would be the route between Merced and Sacramento.
- A guideway designed for operation at 220 mph in accordance with the design criteria for the future northbound extension would bypass the Castle Commerce Center, which would require a lead guideway traveling in reverse from the north to enter the proposed HMF site; therefore, the lead guideway would be a separate and unique guideway from the Merced HST station to the Castle Commerce Center HMF.

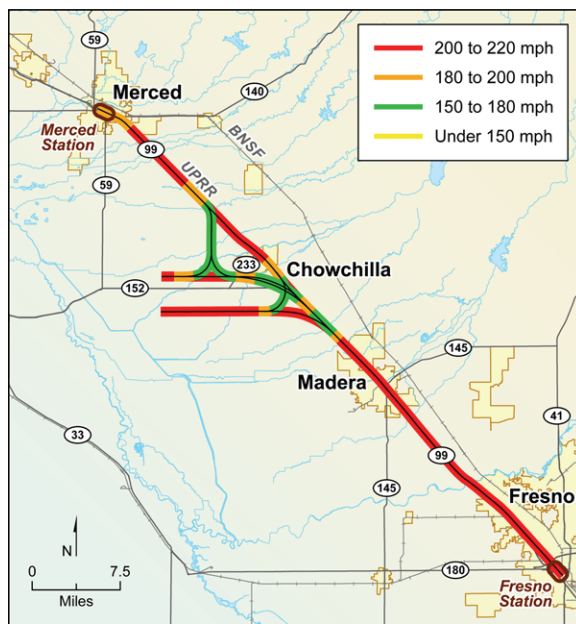
5.3 Operation and Maintenance Costs

Chapter 2, Alternatives, describes O&M activities in greater detail. HST service during Phase 1 would connect San Francisco with Los Angeles via the Central Valley by 2020. HST service during Phase 2 would extend to Sacramento and San Diego beginning in 2027. The plan is to offer express, limited-stop, and all-stop services, depending on the time of the day and projected needs. For Phases 1 and 2 there would be 24 HST stations, with 2 HST stations located within the Merced to Fresno Section. Multiple facilities would be required for overnight storage, inspection, and routine maintenance of over 200 trainsets, each 656 feet long, by 2035. An HMF serving the entire HST system would be needed and could be located in the Merced to Fresno Section. If so, it would serve as a facility to store and maintain a portion of the trainsets. One maintenance-of-way facility would also be required approximately every 100 miles.

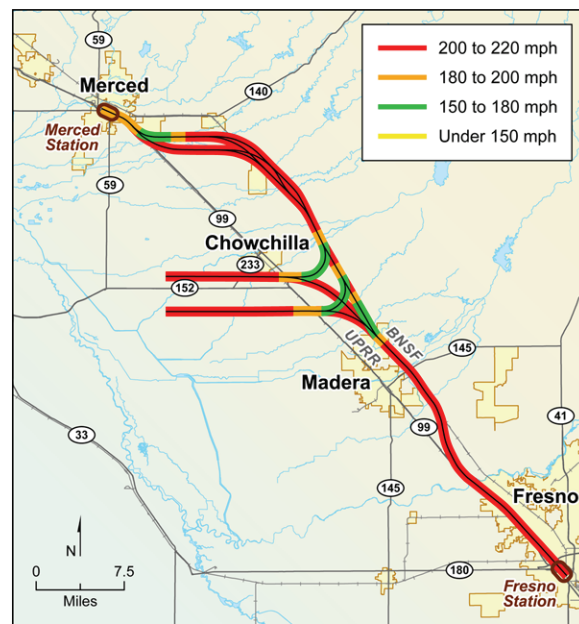
O&M costs account for staff and supplies required to run the HST system and keep it properly maintained. O&M costs are estimated based on daily train miles, operation speeds, travel times, HST station configurations, maintenance and storage facilities, and assumed operating frequencies (Parsons Brinckerhoff 2011). The apportionment of systemwide O&M cost estimates to the Merced to Fresno Section is proportional to the O&M activity and facilities within the section.

5.3.1 Operating Speeds

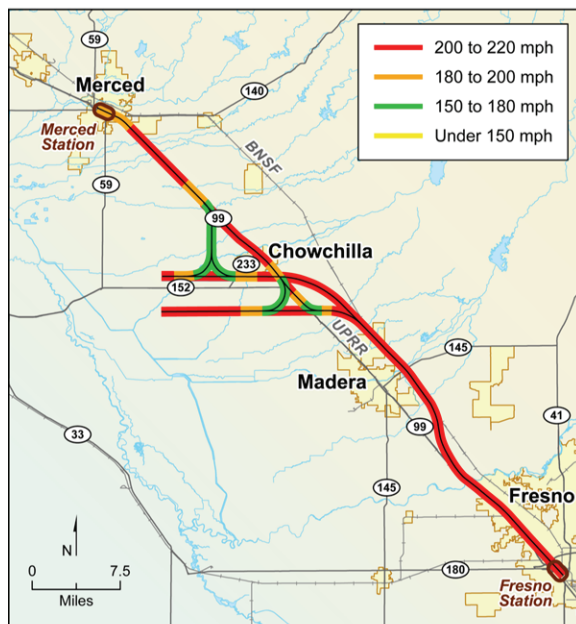
The HSTs would operate at high speeds (150 to 220 miles per hour [mph]) within most of the Merced to Fresno Section. There are some curves, such as from the Bay Area toward Merced, where speeds may be limited to 150 mph. A few other curves would slow the trains to 180 mph; otherwise, the Merced to Fresno Section is designed to reach maximum speeds. Figure 5-1 illustrates general speeds for the HST alternatives.



(a) Speed Profile for the UPRR/SR 99 Alternative



(b) Speed Profile for the BNSF Alternative



(c) Speed Profile for the Hybrid Alternative

Figure 5-1

HST Speeds along the UPRR/SR 99,
BNSF, and Hybrid Alternatives

*Note: For all alternatives, the Fresno to
San Jose tracks have a minimum design
speed of 220 mph.*

5.3.2 Travel Times

Table 5-3 shows the optimal express train times between Merced, Fresno, and other destinations in the proposed statewide HST System. Merced and Fresno would connect to the Bay Area and Los Angeles in Phase 1. In Phase 2, the HST System would extend to Sacramento and San Diego by 2027.

Table 5-3
Optimal Express Travel Times from Merced to Fresno and Other Cities
(hours:minutes)

	San Francisco	San Jose	Bakersfield	Los Angeles	Anaheim	Sacramento (Phase 2)	San Diego (Phase 2)	Fresno/Merced
Merced	1:14	0:45	0:52	1:40	1:58	0:43	2:57	0:21
Fresno	1:20	0:51	0:37	1:24	1:43	0:59	2:42	0:21

5.3.3 Development of Operation and Maintenance Costs

O&M costs were estimated for the operations needed to serve and carry the forecast traffic of Phases 1 and 2, as described in Chapter 2, Alternatives, the maintenance necessary to keep the entire system in a state of good repair, and administrative activities and costs. Unit prices were developed and applied to calculate the cost for each activity included in the operating plan. While many of California's HST O&M unit costs are similar to 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 HST operations were applied to planned California operations, HST technology, and local cost levels and labor practices (Authority 2011).

5.3.4 Development of Operation and Maintenance Costs

O&M costs were estimated for the operations needed to serve and carry the forecast traffic of Phases 1 and 2, as described in Chapter 2, Alternatives, the maintenance necessary to keep the entire system in a state of good repair, and administrative activities and costs. Unit prices were developed and applied to calculate the cost for each activity included in the operating plan. While many of California's HST O&M unit costs are similar to 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 United States. Therefore, international O&M unit cost projections from comparable HST operations were applied to planned California operations, HST technology, and local cost levels and labor practices (Authority 2011).

O&M of equipment costs include the cost of crew administration and supplies to operate and dispatch the HST services, electric traction, onboard systems, and stations, as well as other facilities' power requirements, and cleaning, inspection, maintenance and overhaul of trainsets.

Maintenance of infrastructure covers the costs 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 costs include the day-to-day operations of the station, ticket sales and machine maintenance, public safety, passenger handling, and cleaning. Insurance, administration, and contingency costs round out the categories of costs presented.

At the higher level of activity associated with HST fares at 50% of airfares, maintenance of equipment activities around the state would employ 4,800 persons, transportation operations 4,100 people, maintenance of infrastructure 800 employees, and all other activities 1,600 employees. At the lower level of riders and operations associated with HST fares at 83% of airfares, employment would be roughly a third lower in the three categories, except maintenance of infrastructure, which would be similar to the estimated employment with 50% airfare.

Table 5-4 lists the total annual O&M costs estimated for the full system, upon completion of Phases 1 and 2, of the California HST Project for the year 2035.

Table 5-4
Annual Phase Full System O&M Cost, Year 2035
(2010 \$Millions)

O&M Activity	HST Fares at 50% of Airfare	HST Fares at 83% of Airfare
Operations & Maintenance of Equipment	\$1,973	\$1,316
Maintenance of Infrastructure	\$165	\$165
Stations	\$101	\$101
Insurance	\$25	\$25
Administration (10% of above)	\$226	\$161
Contingency (10% of above)	\$249	\$177
Total	\$2,739	\$1,944

O&M costs in 2010 dollars apportioned to the Merced to Fresno Section are shown in Table 5-5, based on the levels of activity associated with the section as a proportion of full system costs. O&M of equipment costs are apportioned on the basis of trainset miles operated within the Merced to Fresno Section, with and without the system's HMF. Maintenance of infrastructure cost is apportioned as a ratio of the average midpoint mileage of the three alternatives (88 route miles) to the 800 total route miles. Station cost is apportioned based on 2 of the 24 stations being located in the Merced to Fresno Section. Insurance cost is apportioned on the basis of the sum of the first three cost categories of the Merced to Fresno Section to that of the full system costs. Administration and contingency are calculated as in the full system as a percentage of the full Merced to Fresno Section costs.

Table 5-5
Annual 2035 O&M Costs Apportioned to the Merced to Fresno Section
(2010 \$Millions)

Annual O&M Cost	HST Fares at 50% of Airfare		HST Fares at 83% of Airfare	
	Without HMF	With HMF	Without HMF	With HMF
Operations & Maintenance of Equipment	\$174	\$565	\$116	\$377
Maintenance of Infrastructure	\$18	\$18	\$18	\$18
Stations	\$8	\$8	\$8	\$8
Insurance	\$2	\$2	\$2	\$2
Administration (10% of above)	\$20	\$59	\$14	\$41
Contingency (10% of above)	\$22	\$65	\$16	\$45
Total	\$245	\$719	\$175	\$491