

Chapter 6

Operating and Maintenance Costs

Introduction

In addition to the cost to build the high-speed rail (HSR) system, other expenditures will include on-going operating and maintenance (O&M) and capital asset renewal costs. The O&M costs comprise the cost of running the trains and maintaining the infrastructure and rolling stock in a state of good repair. Capital asset renewal is the cost of replacing worn out components at the end of their useful lives.

In developing this Revised Plan, the Authority has refined its operations planning and cost estimating process consistent with the greater emphasis on the phased implementation approach discussed in Chapter 2, The Implementation Strategy: Blending, Phasing, Investing in Early Benefits. Specifically, cost estimates have been updated to show the O&M costs associated with the Phase 1 Blended system.

The O&M costs include the costs of train operations, which include a large labor element for train operators, station personnel, and the administrative staff required to provide full passenger services, including sales and services marketing. They also include the cost of maintaining the infrastructure (e.g., track, signaling, and stations), which includes both the labor and materials required to regularly maintain the system. The O&M costs included in this chapter are fully comprehensive and include allowances for necessary system power and operator insurance. Finally, the system will require capital asset renewal expenditures over its life, reflecting the need to renew or replace assets over time.

This chapter describes the methodology and assumptions used to develop the O&M cost projections and the O&M cost projections associated with the implementation of the system from the initiation of HSR service on the Initial Operating Section (IOS), to Bay to Basin, and through Phase 1 Blended. This is followed by similar projections of the cost to replace HSR capital assets as they wear out.

Additional information on the O&M cost estimates in this Revised Plan is available in *Estimating High-Speed Train Operating & Maintenance Cost for the CA HSRA 2012 Business Plan*, which can be found at www.cahighspeedrail.ca.gov/business_plan_reports.aspx.

O&M methodology

The O&M cost projections were developed by defining an operating plan that can accommodate the anticipated level of annual ridership presented in Chapter 5, Ridership and Revenue. The operating plan provides the number and frequency of trains required to serve the projected riders, as well as the



O&M costs include costs for train operations as well as infrastructure maintenance.

number of employees and resources required to operate and maintain the system. Unit prices are developed and applied to calculate the cost for each activity included in the operating plan.

While many of California's HSR O&M unit costs are similar to 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 costs from comparable HSR operations were applied to planned California operations levels and HSR technology. Where appropriate, adjustments were made for local unit cost levels and labor costs.

International O&M information was derived from 2009 data generated by the International Union of Railways;¹ separate HSR analyses for Spain² and Brazil;³ a review of O&M costs by the Japan Railway Construction, Transport, and Technology Agency;⁴ and a comparison with Amtrak's Next-Gen published HSR operating costs.

In addition, the Authority has validated its operations and maintenance plans and assumptions through discussions and comparison with international high-speed rail operators. In October 2010, the Authority compiled an abstract of its current operations and maintenance strategies, including a network overview, detailed service plans, rolling stock/infrastructure maintenance concepts, and staffing levels and sent it to eight international HSR operators. Seven respondents—Belgium, China, France, Italy, Japan, Korea, and Spain—provided the Authority with comprehensive commentary that helped shape and validate the Authority's methodologies.

“JR East has provided frequent input to the Authority regarding HSR planning, engineering, and funding. Recently it provided a Review on Operations and Maintenance.

*Masaki Ogata, Vice Chairman,
East Japan Railway Company*

Exhibit 6-1 summarizes the major operating and maintenance categories on which the international operators were consulted (note that where there is no check mark, the respondents did not comment). The Authority continues to consult with these and other members of the international high-speed rail community, especially within the European Union, Japan, and Taiwan, to learn from their experience and to help ensure that California's system is based on sound, proven technology and operating principles.

The O&M cost projections include data for a wide range of service levels and ridership, using 2011 dollars. The 2011 cost estimate was escalated to produce annual O&M cost projections in year-of-expenditure (YOE) dollars for use in the funding and financial analyses developed for the Revised Plan. Inflation for 2012 is assumed to be 1 percent, 2013 through 2015 is 2 percent per year, and 3 percent per year is used for 2016 forward. These rates have been estimated based on multiple sources, including the California inflation forecast data provided by California Department of Finance, ENR Construction Cost Index historical and forecast indexes, and medium/long-term federal inflation targets.

Exhibit 6-1. International counterparts the Authority consulted to improve O&M costs

Issue	Belgium	China	France	Italy	Japan	Korea	Spain
Shared use of tracks in congested urban corridors	✓	✓	✓	✓	✓	✓	✓
Trainset length/coupling multiple trains	✓		✓				✓
Schedule with clock-face operation	✓	✓	✓	✓	✓		✓
Number of trains per hour during the peak	✓		✓	✓	✓		✓
Dwell time at stations	✓				✓		
Hours of service operations	✓		✓	✓	✓	✓	✓
Approach for maintaining the rail line	✓	✓	✓	✓	✓	✓	

Assumptions

Exhibit 6-2 shows the base unit cost for each major cost item and the basis for each assumption. These assumptions were developed based on operating experience in France and a review of energy costs, labor rates, station requirements, and insurance costs in the U.S.

As noted, the costs shown in Exhibit 6-2 were developed in 2009 and, in order to compare them to costs for the international systems consulted in 2010, as shown in Exhibit 6-3, they are still shown in 2009 dollars.

As noted, the maintenance unit cost estimates were primarily based on international HSR data and applied to California's planned HSR operations. Exhibit 6-3 compares the California unit values for infrastructure and equipment maintenance to published costs for overseas systems. As highlighted below, this Revised Plan assumes a conservative (higher) infrastructure and equipment maintenance unit cost of \$200,000 per route mile and \$8.60 per trainset mile, respectively.

Exhibit 6-2. Cost categories and unit cost assumptions (2009\$)

Category of Cost	Unit Cost	Basis
Train operations and maintenance	\$20 per trainset mile, plus \$83.33 per revenue service hour for feeder coach service	Operating crew costs from comparable U.S. operations and labor practices, electricity cost from power demand simulations and California large user rates with green surcharge, and train maintenance cost from French HSR experience. Feeder service cost based on review of similar systems in California and elsewhere in the U.S.
Maintenance of infrastructure	\$200,000 per route mile	French HSR experience adapted to California requirements and benchmarked against other HSR systems
Stations	\$4,100,000 per station per year	U.S. staffing for high-volume, access-controlled stations and reserved seating ticketing practices
Administration and support	10% of O&M costs excluding contingency	Standard industry allowance to cover management, accounting, sales, marketing, and control center
Insurance	\$25,000,000 per year	Review of insurance costs for rail passenger service in the U.S. Costs include necessary indemnities
Contingency	10% of total O&M costs	Contingency applied to account for unknowns
Inflation	3% per year, price base date of 2010	Long-term year-over-year percentage increase for the Consumer Price Index in the region

Exhibit 6-3. Comparison of California HSR maintenance costs with international HSR costs (2009\$)

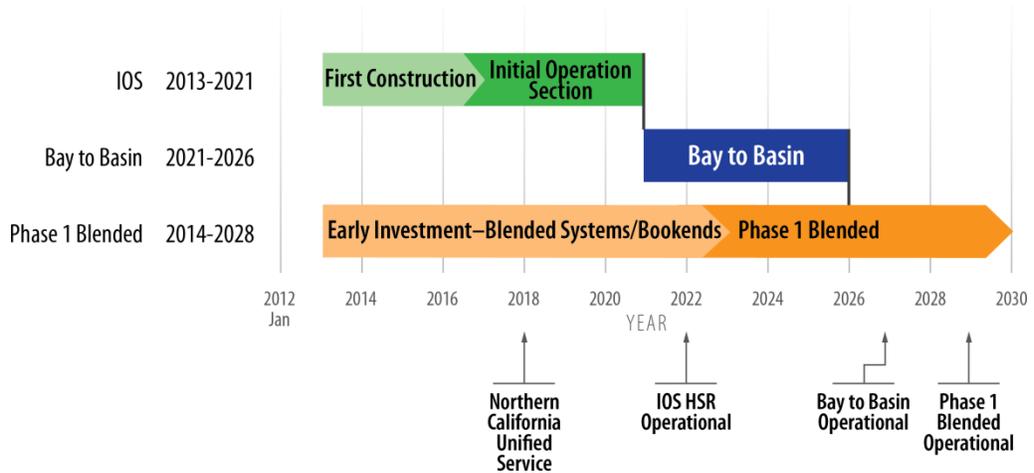
Cost Type	Unit	France ¹	Spain	JR Central	UIC Europe	Halcrow/Sinergia	CAHSR 2009
Infrastructure	Per route mile	\$175,000	\$177,000	n/a	\$145,000	\$200,000	\$200,000
Equipment	Per trainset mile	n/a	n/a	\$7.20	\$4.16	\$5.75	\$8.60

¹ Infrastructure maintenance figure represents an average cost per route mile.

Scenarios

This section illustrates the projected operating and maintenance costs of the system, assuming the phased implementation schedule discussed in Chapter 2, The Implementation Strategy: Blending, Phasing, Investing in Early Benefits, and shown in Exhibit 6-4.

Exhibit 6-4. Schedule by section



For this analysis, the Revised Plan’s High, Medium, and Low Ridership Scenarios described in Chapter 5, Ridership and Revenue, were used to develop High, Medium, and Low Operating and Maintenance Cost Scenarios.

Operating and maintenance cost projections are shown in 2011 dollars to allow the reader to see the effect of real growth without the impact of inflation. These cost projections were then escalated to show year-of-expenditure costs that were used to calculate the impact of O&M costs on financial performance as presented in Chapter 7, Financial Analysis and Funding.

O&M projections—IOS

Exhibit 6-5 provides the projected operating and maintenance costs for the High, Medium, and Low Ridership Scenarios in 2011 dollars through Phase 1 Blended.

Exhibit 6-5. O&M costs, IOS through Phase 1 Blended (2011 dollars in millions)

Ridership	2025	2030	2035	2040	2045	2050	2055	2060
High	\$386	\$728	\$873	\$913	\$946	\$982	\$954	\$927
Medium	\$346	\$644	\$744	\$797	\$824	\$826	\$786	\$799
Low	\$261	\$533	\$627	\$672	\$724	\$727	\$690	\$674

Operations and maintenance forecasts were escalated using 2011 price levels. Exhibit 6-6 shows operating and maintenance costs in YOE dollars through Phase 1 Blended.

Exhibit 6-6. O&M costs, IOS through Phase 1 Blended (YOE dollars in millions)

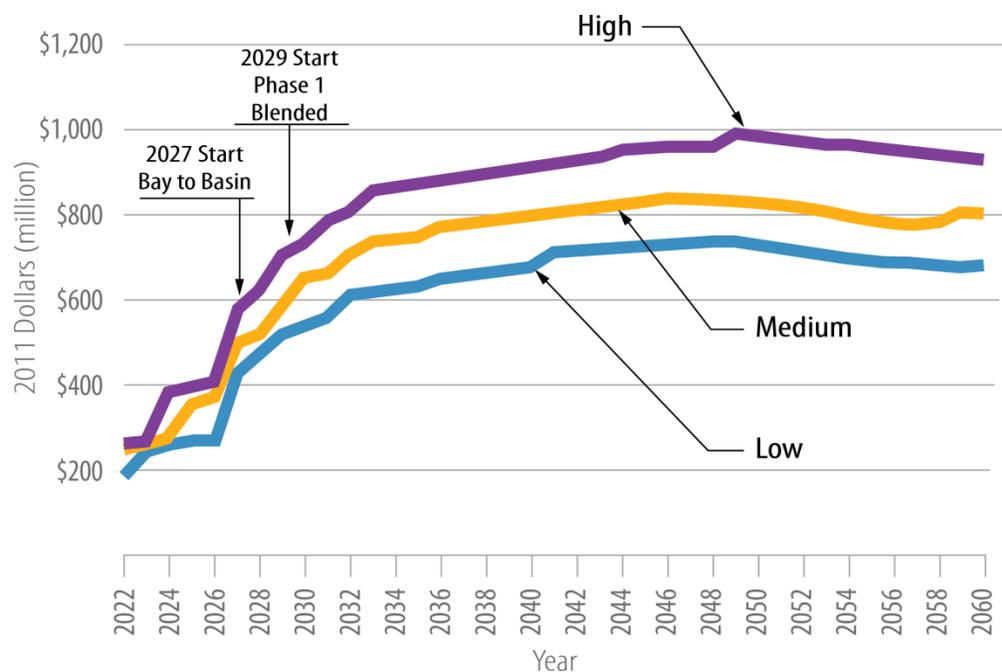
Ridership	2025	2030	2035	2040	2045	2050	2055	2060
High	\$556	\$1,216	\$1,691	\$2,048	\$2,462	\$2,961	\$3,336	\$3,758
Medium	\$499	\$1,075	\$1,440	\$1,789	\$2,143	\$2,492	\$2,749	\$3,240
Low	\$376	\$889	\$1,215	\$1,509	\$1,884	\$2,194	\$2,412	\$2,731

As operations and maintenance costs are closely aligned with ridership, they trend in a similar manner to revenues. Operations and maintenance costs will have a similar ramp-up as revenues as ridership demand and service expands in early years.

As each section becomes operational, the O&M costs for that section are phased in according to the ramp-up periods. For example, when the Bay-to-Basin system opens in 2027, the O&M costs increase quickly in the first five years and more slowly after operations reach a steady state on that section.

Exhibit 6-7 compares the O&M costs shown above and how those costs would change for the High, Medium, and Low Ridership Scenarios.

Exhibit 6-7 . O&M cost ranges, IOS through Phase 1 Blended (2011 dollars in millions)



Capital asset renewal

An important element of O&M analysis is the rate at which assets—the trains, rail infrastructure, stations, and systems—wear out and must be renewed or replaced. This section discusses the methodology and assumptions used to develop the capital asset renewal cost projections.

Assumptions

Incremental capital asset renewal cost projections were developed for each HSR section. The need to replace an asset depends on when it is placed into service, the asset's useful life, and the extent to which the asset is used or consumed in train operations. Minor component replacement activities will be performed during the first five years of each segment's operating period and have been accounted for in the O&M cost projections discussed above. Incremental annual capital asset renewal activities begin for certain components in each section after about five years, consistent with U.S. and international HSR experience.

In general, each component's design life determines the magnitude of incremental annual capital asset renewal activities. Exhibit 6-8 shows the track structures and system components and their respective design lives based on design standards.

Exhibit 6-8. Component design life—track structures and systems

Component	Years
Civil structures	100
Track system	30–60
Facilities/yards/sidings	30–60
Signal/communication system	15
Traction power system	30
Catenary system	30
Stations	50

A similar analysis was performed for the capital asset renewal activities for replacing trainsets based on their useful lives. Trainsets will be put into operation for the IOS in 2022, for the Bay-to-Basin section in 2027, and for Phase 1 Blended in 2020. Phased replacement will begin based on a 25-year useful life, and replacement expenditures are expected to occur based on progress payments through the delivery, testing, and warranty periods for the new trainsets. Exhibit 6-9 shows the timing that was assumed for trainset replacement for those trains placed into service for the IOS. Exhibit 6-10 shows the trainset replacement timeline for those additional trains placed into service for the Bay-to-Basin section. Trainsets to operate Phase 1 and the Phase 2 extensions will be replaced under similar assumptions.

Exhibit 6-9. Trainset replacement assumptions—IOS

Year	Percent of total	Description
2043	20%	Notice to proceed to the manufacturer of initial delivery and two years in advance of Year 2045 to allow for testing and commissioning
2045	55%	Initial delivery date
2048	20%	Final delivery date
2051	5%	Upon completion of the warranty period

Exhibit 6-10. Trainset replacement assumptions—Bay to Basin

Year	Percent of total	Description
2050	20%	Notice to proceed to the manufacturer of initial delivery
2052	75%	Final delivery date
2055	55%	Upon completion of the warranty period

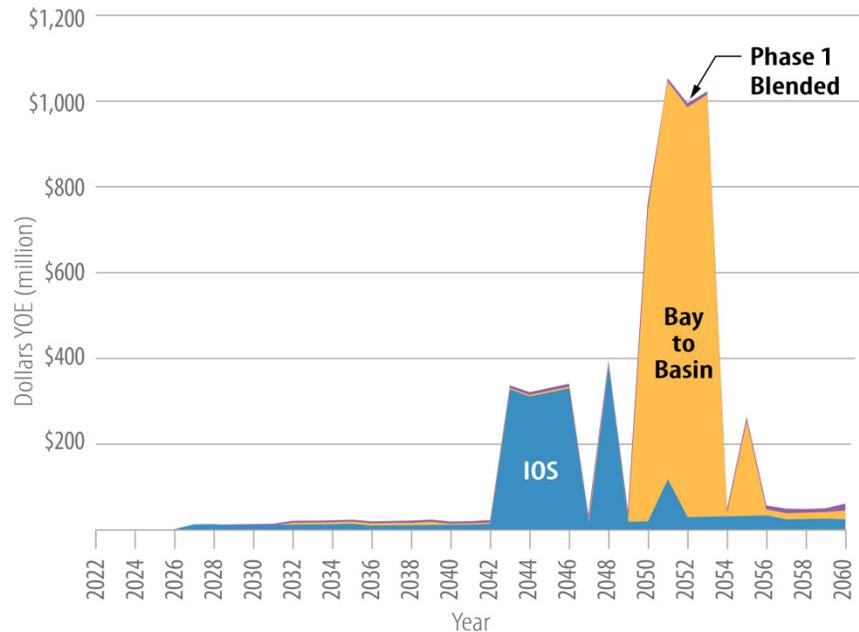
Exhibit 6-11. Trainset replacement assumptions IOS through Phase 1 Blended (2011 dollars in millions)

Segment	Opening	2022–2025	2026–2030	2031–2035	2036–2040	2041–2045	2046–2050	2051–2055	2056–2060
IOS	2022	—	—	—	—	\$364	\$246	\$32	—
Bay to Basin	2027	—	—	—	—	—	\$239	\$954	—
Phase 1 Blended	2029	—	—	—	—	—	—	—	—
Total		—	—	—	—	\$364	\$485	\$986	—

Capital renewal costs

Capital renewal costs have been estimated to reflect the long-term asset management required for the system. The estimated capital renewal cost profile over time for the incremental sections from IOS through to Phase 1 Blended is illustrated in Exhibit 6-12.

Exhibit 6-12. Annual capital renewal profile through Phase 1 Blended



End notes

¹ Source: Union International des Chemins-de-Fer. 2010. *High-Speed Rail—Fast Track to Sustainability*. Paris, France. www.uic.org/IMG/pdf/20101124_uic_brochure_high_speed.pdf

² Source: Campos, J., G. de Rus, I. Barrón. October 2006. “Some Stylized Facts about High-Speed Rail around the World: An Empirical Approach.” Paper presented at 4th Annual Conference on Railroad Industry Structure, Competition and Investment, Universidad Carlos III de Madrid (cited in Halcrow/Sinergia, 2009).

³ Source: Halcrow/Sinergia Consortium. June 2009. “Brazil TAV Project—Volume 4, Rail Operations and Technology, Part 1: Rail Operations.” www.tavbrasil.gov.br/Documentacao/Ingles/VOL4-OPERATIONS&TECHNOLOGY/OPERATIONS/VOL_4_Pt_1_Operations_Final_Report.pdf

⁴ Source: Kikuchi, K. Japan Railway Construction, Transport, and Technology Agency. 2011. “About the California High Speed Rail Reviews for O&M (California High-Speed Rail O&M Review).” Attachment to e-mail Kikuchi to Hanakura, Yu, September 2, 2011 (translated by Hanakura).

