4 COSTS AND OPERATIONS

4.1 INTRODUCTION

This chapter summarizes the estimated capital and operations and maintenance (O&M) costs for each HST Alignment Alternative evaluated in this Program EIR/EIS.

4.2 CAPITAL COSTS

Capital costs for HST Alignment Alternatives and station location options were estimated in 2006 dollars. The costs are associated with HST-related infrastructure improvements and do not include the costs associated with the No Project Alternative. The programmed and funded improvements included under the No Project Alternative are assumed to have been implemented by 2020, regardless of proposed HST implementation.

Capital costs were estimated for all proposed HST Alignment Alternatives and station location options evaluated in this Program EIR/EIS (Tables 4.2-1 and 4.2-2). Costs also were aggregated for each representative network alternative, as identified in Chapter 2 and compared in Chapter 7. Some alignments (horizontal and vertical) and station configurations previously considered have evolved since preparation of the statewide program EIR/EIS, and therefore costs also have changed. The proposed alignment alternatives and station location options selected in this program review would be further evaluated at the project level to identify cost savings through application of value engineering practices.

The capital costs are representative of all aspects of implementation of the proposed HST system, including construction, right-of-way, environmental mitigation, and design and management services. The construction costs include procurement and installation of line infrastructure (e.g., tracks, bridges, tunnels, grade separations, and power distribution); facilities (e.g., passenger stations and storage and maintenance facilities); systems (e.g., communications and train control); and removal or relocation of existing infrastructure (e.g., utilities and rail tracks). The right-of-way costs include the estimated costs to acquire properties needed for construction of the HST infrastructure. The environmental mitigation costs include a rough estimate of the proportion of the capital cost required for mitigating environmental impacts, based on similar completed highway and rail line construction projects. No specific mitigation costs are identified at this program level of review. Agency costs associated with administration of the program (e.g., design, environmental review, and management) are estimated in terms of add-on percentages to construction costs.

The estimated total capital costs for each individual alignment alternative are presented in Appendix 4-A. The individual station location costs are presented in Appendix 4-B.

Table 4.2-1
High-Speed Train Alignment Alternatives Capital Cost (in 2006 dollars), Including Contingencies and Program Implementation Cost

Alignment Alternative by Corridor and Segment	Length		Average Cost (in dollars)		
	Km	Miles	Per Km	Per Mile	Cost (in dollars)
San Francisco to San Jose Corridor: Caltrain					
San Francisco to Dumbarton	**44.58**	**27.70**	**49,175,138**	**79,139,713**	**2,192,227,640**
Transbay Transit Center to 4th/Townsend (Caltrain 1)	2.50	1.55	159,522,378	256,726,381	398,805,944
4th/Townsend to Millbrae/SFO (Caltrain 2)	22.58	14.03	45,352,477	72,987,737	1,024,058,938
Millbrae/SFO to Redwood City (Caltrain 3)	18.75	11.65	37,489,586	60,333,640	702,929,734
Redwood City to Caltrain (Caltrain 4)	0.75	0.47	88,577,366	142,551,453	66,433,025
Dumbarton to San Jose	**34.40**	**21.38**	**39,358,880**	**63,341,977**	**1,353,945,475**
Caltrain Dumbarton Wye (Caltrain 5)	1.62	1.01	24,593,435	39,579,297	39,865,958
Dumbarton Wye to Palo Alto (Caltrain 6)	5.23	3.25	49,783,239	80,118,357	260,316,558
Palo Alto to Santa Clara (Caltrain 7)	22.55	14.01	26,212,143	42,184,355	591,083,820
Santa Clara to Diridon Station (Caltrain 8)	5.00	3.11	92,535,828	148,921,979	462,679,139
Station Location Options					
Transbay Transit Center (Terminal Option)					786,262,418
4th and King (Caltrain) (Terminal Option)					791,939,278
Millbrae/SFO					29,076,600
Redwood City (Caltrain)					67,516,558
Palo Alto (Caltrain)					67,516,558
Oakland to San Jose Corridor: Niles/I-880					
West Oakland to Niles Junction	**44.64**	**27.74**	**35,744,748**	**57,525,595**	**1,595,717,028**
West Oakland to Jack London Square (Niles/I-880 1A)	6.72	4.18	77,055,201	124,008,325	517,810,948
Jack London Square to Oakland Coliseum (Niles/I-880 2)	3.95	2.45	55,088,733	88,656,721	217,600,493
Oakland Coliseum to Union City (BART) (Niles/I-880 3A)	10.52	6.54	76,504,832	123,122,593	804,983,844
Union City (BART) to Niles Junction (Niles/I-880 4A)	23.45	14.57	2,359,136	3,796,662	55,321,742
12th Street/City Center to Niles Junction	**43.02**	**26.73**	**34,949,176**	**56,245,246**	**1,503,583,436**
12th Street/City Center to Jack London Square (Niles/I-880 1B)	5.10	3.17	83,466,148	134,325,745	425,677,356
Jack London Square to Oakland Coliseum (Niles/I-880 2)	3.95	2.45	55,088,733	88,656,721	217,600,493
Oakland Coliseum to Union City (BART) (Niles/I-880 3A)	10.52	6.54	76,504,832	123,122,593	804,983,844

Alignment Alternative by Corridor and Segment	Length		Average Cost (in dollars)		Cost (in dollars)
	Km	Miles	Per Km	Per Mile	
Union City (BART) to Niles Junction (Niles/I-880 4A)	23.45	14.57	2,359,136	3,796,662	55,321,742
Niles Junction to San Jose via Trimble (Structure)	**27.43**	**17.04**	**66,893,831**	**107,655,186**	**1,834,964,679**
Niles Junction to Niles Wye (S) (Niles/I-880 5A)	3.65	2.27	45,726,749	73,590,069	166,902,634
Niles Wye (S) to Warm Springs (Niles/I-880 5B)	8.45	5.25	16,691,618	26,862,555	141,044,170
Warm Springs to Trimble Rd (Niles/I-880 6)	2.33	1.45	214,189,581	344,704,717	499,275,914
Trimble Rd. Option (Structure) (Niles/I-880 7B)	8.00	4.97	70,632,853	113,672,558	565,062,822
Santa Clara to Diridon Station (Caltrain 8)	5.00	3.11	92,535,828	148,921,979	462,679,139
Niles Junction to San Jose via Trimble (Tunnel)	**29.95**	**18.61**	**65,132,060**	**104,819,890**	**1,950,900,589**
Niles Junction to Niles Wye (S) (Niles/I-880 5A)	3.65	2.27	45,726,749	73,590,069	166,902,634
Niles Wye (S) to Warm Springs (Niles/I-880 5B)	8.45	5.25	16,691,618	26,862,555	141,044,170
Warm Springs to Trimble Rd (Niles/I-880 6)	2.33	1.45	214,189,581	344,704,717	499,275,914
Trimble Rd. Option (Tunnel) (Niles/I-880 7B)	10.52	6.54	64,721,415	104,159,021	680,998,732
Santa Clara to Diridon Station (Caltrain 8)	5.00	3.11	92,535,828	148,921,979	462,679,139
Niles Junction to San Jose via I-880	**26.10**	**16.22**	**48,553,043**	**78,138,548**	**1,267,234,412**
Niles Junction to Niles Wye (S) (Niles/I-880 5A)	3.65	2.27	45,726,749	73,590,069	166,902,634
Niles Wye (S) to Warm Springs (Niles/I-880 5B)	8.45	5.25	16,691,618	26,862,555	141,044,170
Warm Springs to Trimble Rd (Niles/I-880 6)	2.33	1.45	214,189,581	344,704,717	499,275,914
I-880—Trimble Rd. to Diridon (Niles/I-880 7A)	11.67	7.25	39,421,689	63,443,059	460,011,694
Niles Junction to Altamont	**13.13**	**8.16**	**55,263,716**	**88,938,329**	**725,723,114**
Niles Junction to Niles Wye (S) (Niles/Dumbarton XN)	4.25	2.64	35,018,018	56,356,037	148,966,648
Niles Wye (S) to Warm Springs (Niles/Dumbarton XS)	8.88	5.52	64,964,684	104,550,525	576,756,466
Station Location Options					
West Oakland/7th Street					611,197,055
12th Street/City Center					611,197,055
Coliseum/Airport					61,735,853
Union City (Bart)					69,853,070
Fremont (Warm Springs)					156,875,180

Alignment Alternative by Corridor and Segment	Length		Average Cost (in dollars)		Cost (in dollars)
	Km	Miles	Per Km	Per Mile	
San Jose to Central Valley Corridor: Pacheco Pass					
Pacheco	**92.50**	**57.48**	**38,800,727**	**62,443,717**	**3,589,067,255**
Diridon to Morgan Hill (Pacheco 1)	32.50	20.19	20,366,713	32,777,047	661,918,165
Morgan Hill to Gilroy (Pacheco 2)	16.00	9.94	23,730,117	38,189,921	379,681,864
Gilroy to San Luis Reservoir (Pacheco 3)	44.00	27.34	57,896,982	93,176,161	2,547,467,226
Henry Miller (UPRR Connection)	**100.89**	**62.69**	**13,489,349**	**21,709,003**	**1,360,872,958**
San Luis Reservoir to Valley Floor (Pacheco 4)	15.45	9.60	27,554,846	44,345,226	425,722,369
Western Valley to Henry Miller UP Wye (HM-1)	58.05	36.07	10,870,134	17,493,785	630,967,784
Henry Miller UP North Wye to UP South Wye (HM-2)	8.19	5.09	11,200,428	18,025,342	91,720,307
Henry Miller Wye North to UPRR (HM/UP-XN)	11.25	6.99	11,845,555	19,063,573	133,262,493
Henry Miller Wye South to UPRR (HM/UP-XS)	7.95	4.94	9,962,265	16,032,711	79,200,005
Henry Miller (BNSF Connection)	**104.70**	**65.06**	**13,324,586**	**21,443,843**	**1,395,030,861**
San Luis Reservoir to Valley Floor (Pacheco 4)	15.45	9.60	27,554,846	44,345,226	425,722,369
Western Valley to Henry Miller UP Wye (HM-1)	58.05	36.07	10,870,134	17,493,785	630,967,784
Henry Miller UP North Wye to UP South Wye (HM-2)	8.19	5.09	11,200,428	18,025,342	91,720,307
Henry Miller UP South Wye to BNSF Wyes (HM-3)	4.62	2.87	11,920,369	19,183,975	55,012,505
Henry Miller Wye North to BNSF (HM/BN-XN)	8.70	5.40	13,137,656	21,143,007	114,245,054
Henry Miller Wye South to BNSF (HM/BN-XS)	9.70	6.03	7,975,551	12,835,405	77,362,843
GEA North	**80.25**	**49.87**	**16,775,455**	**26,997,477**	**1,346,230,241**
San Luis Reservoir to Atwater Wye (GEA-1A)	47.70	29.64	12,125,069	19,513,408	578,365,814
GEA Wye to Atwater (GEA-1B)	9.30	5.78	7,483,268	12,043,153	69,594,395
GEA Wye to Arena (SR-99) (GEA XN-1)	10.85	6.74	13,768,794	22,158,725	149,350,104
Arena (SR-99) to Ballico West (GEA XN-2)	8.57	5.33	10,530,597	16,947,353	90,247,214
Arena (SR-99) to Ballico North (GEA XN-3)	9.40	5.84	22,965,148	36,958,823	215,941,283
GEA Atwater Wye South to Merced UP (GEA-UPRR XS)	11.10	6.90	27,186,344	43,752,180	301,768,423
Station Location Options					
San Jose (Diridon)					185,051,790
Morgan Hill (Caltrain)					284,985,295
Gilroy (Caltrain)					148,256,045

Alignment Alternative by Corridor and Segment	Length		Average Cost (in dollars)		Cost (in dollars)
	Km	Miles	Per Km	Per Mile	
East Bay to Central Valley Corridor: Altamont Pass					
I-680/580/UPRR	**49.43**	**30.71**	**48,015,427**	**77,273,339**	**2,373,258,499**
Niles Canyon to Sunol (UPRR-2A/2B)	6.27	3.90	99,895,152	160,765,663	626,342,602
Sunol to Dublin/Pleasanton BART (I-680/580/UPRR-1)	11.72	7.28	43,125,032	69,403,012	505,382,254
Dublin/Pleasanton BART to El Charo Road (I-680/580/UPRR-2)	4.09	2.54	37,877,905	60,958,579	154,996,386
El Charo Road to Livermore (I-580) (I-680/580/UPRR-3)	5.32	3.31	37,708,288	60,685,606	200,608,090
Livermore (I-580) to Greenville (I-680/580/UPRR-4)	8.11	5.04	36,480,045	58,708,941	295,853,163
Greenville to Altamont Pass (I-680/580/UPRR-5)	8.66	5.38	61,995,084	99,771,416	536,567,450
Altamont Pass to County Line (UPRR-9)	5.26	3.27	10,170,795	16,368,308	53,508,554
I-580/UPRR	**43.96**	**27.32**	**45,493,874**	**73,215,293**	**1,999,973,946**
Niles Canyon to Sunol (UPRR-2A/2B)	6.27	3.90	99,895,152	160,765,663	626,342,602
Sunol to Pleasanton (UPRR-3)	3.30	2.05	44,840,606	72,163,960	147,876,695
Pleasanton to El Charo (UPRR-4)	2.59	1.61	26,405,269	42,495,161	68,510,055
UPRR to I-580 Connector (Pleasanton X)	4.45	2.77	15,878,585	25,554,105	70,707,337
El Charo Road to Livermore (I-580) (I-680/580/UPRR-3)	5.32	3.31	37,708,288	60,685,606	200,608,090
Livermore (I-580) to Greenville (I-680/580/UPRR-4)	8.11	5.04	36,480,045	58,708,941	295,853,163
Greenville to Altamont Pass (I-680/580/UPRR-5)	8.66	5.38	61,995,084	99,771,416	536,567,450
Altamont Pass to County Line (UPRR-9)	5.26	3.27	10,170,795	16,368,308	53,508,554
Patterson Pass/UPRR	**41.19**	**25.60**	**41,847,512**	**67,347,043**	**1,723,804,068**
Niles Canyon to Sunol (UPRR-2A/2B)	6.27	3.90	99,895,152	160,765,663	626,342,602
Sunol to Pleasanton (UPRR-3)	3.30	2.05	44,840,606	72,163,960	147,876,695
Pleasanton to El Charo (UPRR-4)	2.59	1.61	26,405,269	42,495,161	68,510,055
El Charo to Livermore (UPRR-5)	6.41	3.98	7,350,429	11,829,368	47,082,729
Livermore to Patterson Pass cut off (UPRR-6)	3.55	2.21	20,957,133	33,727,236	74,412,071
Patterson Pass	19.07	11.85	39,822,791	64,088,570	759,579,915
UPRR	**41.62**	**25.86**	**40,377,726**	**64,981,651**	**1,680,501,168**
Niles Canyon to Sunol (UPRR-2A/2B)	6.27	3.90	99,895,152	160,765,663	626,342,602
Sunol to Pleasanton (UPRR-3)	3.30	2.05	44,840,606	72,163,960	147,876,695
Pleasanton to El Charo (UPRR-4)	2.59	1.61	26,405,269	42,495,161	68,510,055
El Charo to Livermore (UPRR-5)	6.41	3.98	7,350,429	11,829,368	47,082,729

Alignment Alternative by Corridor and Segment	Length		Average Cost (in dollars)		Cost (in dollars)
	Km	Miles	Per Km	Per Mile	
Livermore to Patterson Pass cutoff (UPRR-6)	3.55	2.21	20,957,133	33,727,236	74,412,071
Patterson Pass cut off to Greenville (UPRR-7)	2.99	1.86	18,265,628	29,395,678	54,614,227
Greenville to Altamont Pass (UPRR-8)	11.25	6.99	54,058,154	86,998,166	608,154,234
Altamont Pass to County Line (UPRR-9)	5.26	3.27	10,170,795	16,368,308	53,508,554
Tracy Downtown (BNSF Connection)	**86.22**	**53.58**	**17,787,134**	**28,625,617**	**1,533,677,808**
County Line to Tracy Downtown (UPRR-10)	12.84	7.98	23,802,574	38,306,529	305,553,641
Tracy Downtown to I-205 (UPRR-11	7.34	4.56	15,988,833	25,731,533	117,358,035
I-205 to S. UPPRR (UPRR-12)	8.31	5.16	14,955,715	24,068,890	124,281,993
I-205 to Lathrop—Northern (UPRR-13)	13.14	8.16	18,113,361	29,150,629	238,009,562
Southwestern Manteca (MC-1)	1.46	0.91	27,687,372	44,558,506	40,340,501
Southeastern Manteca (MC-2)	1.83	1.14	25,102,875	40,399,161	45,963,364
Northern Escaton Wye to BNSF (MC-5)	4.30	2.67	23,422,722	37,695,217	100,717,704
Southern Escaton Wye to BNSF (part 1) (MC-6)	22.84	14.19	8,972,327	14,439,561	204,945,893
Southern Escaton Wye to BNSF (part 2) (MC-7)	14.17	8.80	25,164,616	40,498,524	356,507,116
Tracy ACE Station (BNSF Connection)	**86.87**	**53.98**	**18,877,113**	**30,379,768**	**1,639,835,922**
County Line to South of Tracy (S UPRR-1)	2.09	1.30	13,128,290	21,127,935	27,398,741
South of Tracy to Tracy ACE Station (S UPRR-2)	15.51	9.64	25,499,265	41,037,089	395,493,599
Tracy ACE Station to I-205 (S UPRR-3)	7.14	4.44	11,856,678	19,081,474	84,656,684
I-205 to Southeast of Manteca (S UPRR-4)	6.46	4.02	15,269,787	24,574,340	98,673,364
I-205 to Lathrop—Southern (S UPRR-5)	11.07	6.88	25,750,831	41,441,946	285,138,957
Southwestern Manteca (MC-1)	1.46	0.91	27,687,372	44,558,506	40,340,501
Southeastern Manteca (MC-2)	1.83	1.14	25,102,875	40,399,161	45,963,364
Northern Escaton Wye to BNSF (MC-5)	4.30	2.67	23,422,722	37,695,217	100,717,704
Southern Escaton Wye to BNSF (part 1) (MC-6)	22.84	14.19	8,972,327	14,439,561	204,945,893
Southern Escaton Wye to BNSF (part 2) (MC-7)	14.17	8.80	25,164,616	40,498,524	356,507,116
Tracy ACE Station (UPRR Connection)	**47.93**	**29.78**	**29,956,447**	**48,210,228**	**1,435,902,370**
County Line to South of Tracy (S UPRR-1)	2.09	1.30	13,128,290	21,127,935	27,398,741
South of Tracy to Tracy ACE Station (S UPRR-2)	15.51	9.64	25,499,265	41,037,089	395,493,599
Tracy ACE Station to I-205 (S UPRR-3)	7.14	4.44	11,856,678	19,081,474	84,656,684
I-205 to Southeast of Manteca (S UPRR-4)	6.46	4.02	15,269,787	24,574,340	98,673,364

Alignment Alternative by Corridor and Segment	Length		Average Cost (in dollars)		Cost (in dollars)
	Km	Miles	Per Km	Per Mile	
Southwestern Manteca (MC-1)	1.46	0.91	27,687,372	44,558,506	40,340,501
Southeastern Manteca (MC-2)	1.83	1.14	25,102,875	40,399,161	45,963,364
Eastern Manteca UPRR South to BNSF (MC-3)	9.17	5.70	74,962,364	120,640,230	687,254,951
Manteca to Escaton Wye (MC-4)	4.28	2.66	13,118,552	21,112,263	56,121,166
Tracy Downtown (UPRR Connection)	**58.36**	**36.26**	**27,670,588**	**44,531,495**	**1,614,883,212**
County Line to Tracy Downtown (UPRR-10)	12.84	7.98	23,802,574	38,306,529	305,553,641
Tracy Downtown to I-205 (UPRR-11)	7.34	4.56	15,988,833	25,731,533	117,358,035
I-205 to S. UPPRR (UPRR-12)	8.31	5.16	14,955,715	24,068,890	124,281,993
I-205 to Lathrop—Northern (UPRR-13)	13.14	8.16	18,113,361	29,150,629	238,009,562
Southwestern Manteca (MC-1)	1.46	0.91	27,687,372	44,558,506	40,340,501
Southeastern Manteca (MC-2)	1.83	1.14	25,102,875	40,399,161	45,963,364
Eastern Manteca UPRR South to BNSF (MC-3)	9.17	5.70	74,962,364	120,640,230	687,254,951
Manteca to Escaton Wye (MC-4)	4.28	2.66	13,118,552	21,112,263	56,121,166
East Bay Connections	**13.13**	**8.16**	**55,263,716**	**88,938,329**	**725,723,114**
Niles to Union City—Niles Wye (E) to Niles Wye (N) (Dumbarton/Niles XN)	4.25	2.64	35,018,018	56,356,037	148,966,648
Niles to Fremont—Niles Wye (E) to Niles Wye (S) (Dumbarton/Niles XS)	8.88	5.52	64,964,684	104,550,525	576,756,466
Station Location Options					
Pleasanton (I-680/Bernal Rd)					72,639,578
Pleasanton (BART)					316,675,328
Livermore (Downtown-At Grade)					73,297,263
Livermore (Downtown-Aerial)					314,667,658
Livermore (I-580)					151,769,468
Livermore (Greenville Road/UPRR)					72,639,578
Livermore (Greenville Road/I-580)					160,180,913
Tracy (Downtown)					310,150,400
Tracy (ACE)					314,667,658

Alignment Alternative by Corridor and Segment	Length		Average Cost (in dollars)		Cost (in dollars)
	Km	Miles	Per Km	Per Mile	
San Francisco Bay Crossings Corridor					
Transbay Crossing—Transbay Transit Center	**11.71**	**7.28**	**338,317,199**	**544,468,754**	**3,961,694,398**
Transbay Transit Center tube to SF Bay (TB-1)	2.48	1.54	252,855,279	406,931,126	627,081,091
SF Bay to West Oakland (TB-3)	9.23	5.74	361,279,882	581,423,610	$3,334,613,307
Transbay Crossing—4th & King	**11.06**	**6.87**	**343,054,247**	**552,092,294**	**3,794,179,969**
4th/Townsend tube to SF Bay (TB-2)	1.83	1.14	251,129,323	404,153,470	459,566,662
SF Bay to West Oakland (TB-3)	9.23	5.74	361,279,882	581,423,610	3,334,613,307
Dumbarton (High Bridge)	**30.67**	**19.06**	**63,990,228**	**102,982,290**	**1,962,452,322**
Dumbarton Wye North to Caltrain (Dumbarton-XN)	2.20	1.37	73,361,640	118,064,116	161,395,609
Dumbarton Wye South to Caltrain (Dumbarton-XS)	0.96	0.60	13,082,432	21,054,134	12,559,135
Dumbarton Bay Crossing to Don Edwards (Dumbarton-1 [High Bridge])	10.01	6.22	88,615,763	142,613,246	886,866,552
Dumbarton Bay Crossing to Don Edwards (Dumbarton-2 [High Bridge])	13.00	8.08	60,644,584	97,597,998	788,379,595
Shinn to Niles Canyon (UPRR-1)	4.50	2.80	25,166,985	40,502,336	113,251,431
Dumbarton (Low Bridge)	**32.21**	**20.01**	**47,523,861**	**76,482,241**	**1,530,743,565**
Dumbarton Wye North to Caltrain (Dumbarton-XN)	2.20	1.37	73,361,640	118,064,116	161,395,609
Dumbarton Wye South to Caltrain (Dumbarton-XS)	0.96	0.60	13,082,432	21,054,134	12,559,135
Dumbarton Bay Crossing to Don Edwards (Dumbarton-1 [Low Bridge])	11.55	7.18	53,574,758	86,220,216	618,788,460
Dumbarton Bay Crossing to Don Edwards (Dumbarton-2 [Low Bridge])	13.00	8.08	48,057,610	77,341,226	624,748,930
Shinn to Niles Canyon (UPRR-1)	4.50	2.80	25,166,985	40,502,336	113,251,431
Dumbarton (Tube)	**30.67**	19.06	**75,782,552**	**121,960,196**	**2,324,099,311**
Dumbarton Wye North to Caltrain (Dumbarton-XN)	2.20	1.37	73,361,640	118,064,116	161,395,609
Dumbarton Wye South to Caltrain (Dumbarton-XS)	0.96	0.60	13,082,432	21,054,134	12,559,135
Dumbarton Bay Crossing to Don Edwards (Dumbarton-1 [Tube])	10.01	6.22	100,498,996	161,737,456	1,005,793,953
Dumbarton Bay Crossing to Don Edwards (Dumbarton-2 [Tube])	13.00	8.08	79,315,322	127,645,637	1,031,099,183
Shinn to Niles Canyon (UPRR-1)	4.50	2.80	25,166,985	40,502,336	113,251,431
Fremont Central Park (High Bridge)	**32.36**	**20.11**	**84,449,717**	**135,908,645**	**2,732,623,930**
Dumbarton Wye North to Caltrain (Dumbarton-XN)	2.20	1.37	73,361,640	118,064,116	161,395,609
Dumbarton Wye South to Caltrain (Dumbarton-XS)	0.96	0.60	13,082,432	21,054,134	12,559,135

Alignment Alternative by Corridor and Segment	Length		Average Cost (in dollars)		Cost (in dollars)
	Km	Miles	Per Km	Per Mile	
Dumbarton Bay Crossing to Don Edwards (Dumbarton-1 [High Bridge])	10.01	6.22	88,615,763	142,613,246	886,866,552
Fremont Central Park (Fremont Central Park [High Bridge])	19.19	11.92	87,118,428	140,203,519	1,671,802,634
Fremont Central Park (Low Bridge)	**34.94**	**21.71**	**64,246,458**	**103,394,652**	**2,244,771,247**
Dumbarton Wye North to Caltrain (Dumbarton-XN)	2.20	1.37	73,361,640	118,064,116	161,395,609
Dumbarton Wye South to Caltrain (Dumbarton-XS)	0.96	0.60	13,082,432	21,054,134	12,559,135
Dumbarton Bay Crossing to Don Edwards (Dumbarton-1 [Low Bridge])	11.55	7.18	53,574,758	86,220,216	618,788,460
Fremont Central Park (Fremont Central Park [Low Bridge])	20.23	12.57	71,775,978	115,512,240	1,452,028,043
Fremont Central Park (Tube)	**34.94**	**21.71**	**88,556,605**	**142,518,041**	**3,093,990,660**
Dumbarton Wye North to Caltrain (Dumbarton-XN)	2.20	1.37	73,361,640	118,064,116	161,395,609
Dumbarton Wye South to Caltrain (Dumbarton-XS)	0.96	0.60	13,082,432	21,054,134	12,559,135
Dumbarton Bay Crossing to Don Edwards (Dumbarton-1)	10.01	6.22	100,498,996	161,737,456	1,005,793,953
Don Edwards to Niles Wye (E) via Fremont Central Park (Fremont Central Park [Tube])	21.77	13.53	87,930,269	141,510,051	1,914,241,964
Station Location Option					
Union City (Shinn)					310,150,400
Central Valley Corridor					
BNSF—UPRR	**149.65**	**92.99**	**15,891,685**	**25,575,188**	**2,378,190,686**
North Stockton South to UPRR Connection (BNSF N/S-1)	17.50	10.87	8,362,619	13,458,330	146,345,827
BNSF Parallel to UPRR Tracks (BNSF N/S-2)	3.50	2.17	8,090,264	13,020,018	28,315,925
Parallel tracks South through Escaton (BNSF N/S-3)	13.55	8.42	13,929,771	22,417,794	188,748,403
Escaton South to Amtrak Briggsmore (BNSF N/S-4)	13.85	8.61	18,871,199	30,370,251	261,366,107
Amtrak Briggsmore to UPRR/BNSF Connection (BNSF N/S-5)	39.85	24.76	15,645,491	25,178,977	623,472,816
UPRR/BNSF Connection to Atwater (BNSF N/S-6)	6.30	3.91	16,322,332	26,268,248	102,830,695
Atwater to Downtown Merced (BNSF N/S-7)	17.00	10.56	25,661,185	41,297,674	436,240,142
Merced South to BNSF Connection (BNSF N/S-8)	4.75	2.95	32,162,740	51,760,913	152,773,015
BNSF Connection South to Henry Miller Wye (BNSF N/S-9)	17.45	10.84	8,686,037	13,978,822	151,571,352
BNSF Henry Miller Wye (BNSF N/S-10)	15.90	9.88	18,020,529	29,001,230	286,526,405
BNSF	**161.55**	**100.38**	**15,203,210**	**24,467,194**	**2,456,078,506**
North Stockton South to UPRR Connection (BNSF N/S-1)	17.50	10.87	8,362,619	13,458,330	146,345,827
BNSF Parallel to UPRR tracks (BNSF N/S-2)	3.50	2.17	8,090,264	13,020,018	28,315,925

Alignment Alternative by Corridor and Segment	Length		Average Cost (in dollars)		Cost (in dollars)
	Km	Miles	Per Km	Per Mile	
Parallel tracks South through Escaton (BNSF N/S-3)	13.55	8.42	13,929,771	22,417,794	188,748,403
Escaton South to Amtrak Briggsmore (BNSF N/S-4)	13.85	8.61	18,871,199	30,370,251	261,366,107
Amtrak Briggsmore to UPRR/BNSF Connection (BNSF N/S-5)	39.85	24.76	15,645,491	25,178,977	623,472,816
UPRR/BNSF Connection to Atwater (BNSF N/S-6)	6.30	3.91	16,322,332	26,268,248	102,830,695
Atwater to Downtown Merced (BNSF N/S-7)	17.00	10.56	25,661,185	41,297,674	436,240,142
Merced South to UPRR Connection (BNSF N/S-8)	8.00	4.97	32,682,285	52,597,039	261,458,279
UPRR Connection East to Castle Connection (BNSF N/S-9)	17.66	10.97	9,825,892	15,813,240	173,495,771
Castle Connection to Henry Miller Wye (BNSF N/S-10)	13.44	8.35	10,838,922	17,443,554	145,707,628
Henry Miller Wye (BNSF N/S-11)	10.90	6.77	8,082,286	13,007,178	88,096,913
UPRR N/S	**134.95**	**83.85**	**18,862,722**	**30,356,608**	**2,545,524,294**
French Camp to Lathrop (UPRR N/S-1)	8.00	4.97	13,627,270	21,930,965	109,018,159
Lathrop through Manteca (UPRR N/S-2)	8.70	5.41	21,359,159	34,374,234	185,824,683
Manteca South to BNSF/UPRR (UPRR N/S-3)	3.30	2.05	7,761,402	12,490,765	25,612,626
BNSF/UPRR South to Modesto (UPRR N/S-4)	18.50	11.50	15,559,246	25,040,179	287,846,051
UPRR Modesto South—Western Option (UPRR N/S-5a*)	4.20	2.61	84,115,056	135,370,061	353,283,237
South Modesto to BNSF Connection (UPRR N/S-6)	20.90	12.99	21,150,677	34,038,714	442,049,140
BNSF Connection South to Merced (UPRR N/S-7)	33.25	20.66	16,572,019	26,670,079	551,019,624
Merced South to BNSF Connection (UPRR N/S-8)	4.75	2.95	32,162,740	51,760,913	152,773,015
BNSF Connection South to Henry Miller Wye (UPRR N/S-9)	17.45	10.84	8,686,037	13,978,822	151,571,352
BNSF Henry Miller Wye (UPRR N/S-10)	15.90	9.88	18,020,529	29,001,230	286,526,405
BNSF Castle	**148.74**	**92.42**	**14,323,359**	**23,051,212**	**2,130,413,453**
North Stockton South to UPRR Connection (BNSF N/S-1)	17.50	10.87	8,362,619	13,458,330	146,345,827
BNSF Parallel to UPRR tracks (BNSF N/S-2)	3.50	2.17	8,090,264	13,020,018	28,315,925
Parallel tracks South through Escaton (BNSF N/S-3)	13.55	8.42	13,929,771	22,417,794	188,748,403
Escaton South to Amtrak Briggsmore (BNSF N/S-4)	13.85	8.61	18,871,199	30,370,251	261,366,107
Amtrak Briggsmore to UPRR/BNSF Connection (BNSF N/S-5)	39.85	24.76	15,645,491	25,178,977	623,472,816
From BNSF Southeast to Castle AFB (BNSF Castle-1)	17.60	10.94	9,100,491	14,645,821	160,168,647
Castle AFB South to BNSF Connect (BNSF Castle-2)	10.52	6.54	22,904,277	36,860,860	240,998,798
BNSF South of Castle to UPRR Connect (BNSF Castle-3)	8.02	4.98	30,814,309	49,590,824	247,192,389
Castle Connection to Henry Miller Wye (BNSF N/S-10)	13.44	8.35	10,838,922	17,443,554	145,707,628

Alignment Alternative by Corridor and Segment	Length		Average Cost (in dollars)		Cost (in dollars)
	Km	Miles	Per Km	Per Mile	
Henry Miller Wye (BNSF N/S-11)	10.90	6.77	8,082,286	13,007,178	88,096,913
UPRR—BNSF Castle	**139.24**	**86.52**	**17,417,257**	**28,030,358**	**2,425,126,621**
French Camp to Lathrop (UPRR N/S-1)	8.00	4.97	13,627,270	21,930,965	109,018,159
Lathrop through Manteca (UPRR N/S-2)	8.70	5.41	21,359,159	34,374,234	185,824,683
Manteca South to BNSF/UPRR (UPRR N/S-3)	3.30	2.05	7,761,402	12,490,765	25,612,626
BNSF/UPRR South to Modesto (UPRR N/S-4)	18.50	11.50	15,559,246	25,040,179	287,846,051
UPRR Modesto South—Western Option (UPRR N/S-5a*)	4.20	2.61	84,115,056	135,370,061	353,283,237
South Modesto to BNSF Connection (UPRR N/S-6)	20.90	12.99	21,150,677	34,038,714	442,049,140
North South Connection East of Stockton (South Portion) (UPRR-BNSF X-2)	15.15	9.41	9,196,591	14,800,478	139,328,349
From BNSF Southeast to Castle AFB (BNSF Castle-1)	17.60	10.94	9,100,491	14,645,821	160,168,647
Castle AFB South to BNSF Connect (BNSF Castle-2)	10.52	6.54	22,904,277	36,860,860	240,998,798
BNSF South of Castle to UPRR Connect (BNSF Castle-3)	8.02	4.98	30,814,309	49,590,824	247,192,389
Castle Connection to Henry Miller Wye (BNSF N/S-10)	13.44	8.35	10,838,922	17,443,554	145,707,628
Henry Miller Wye (BNSF N/S-11)	10.90	6.77	8,082,286	13,007,178	88,096,913
UPRR—BNSF	**140.15**	**87.09**	**19,071,736**	**30,692,985**	**2,672,903,854**
French Camp to Lathrop (UPRR N/S-1)	8.00	4.97	13,627,270	21,930,965	109,018,159
Lathrop through Manteca (UPRR N/S-2)	8.70	5.41	21,359,159	34,374,234	185,824,683
Manteca South to BNSF/UPRR (UPRR N/S-3)	3.30	2.05	7,761,402	12,490,765	25,612,626
BNSF/UPRR South to Modesto (UPRR N/S-4)	18.50	11.50	15,559,246	25,040,179	287,846,051
UPRR Modesto South—Western Option (UPRR N/S-5a*)	4.20	2.61	84,115,056	135,370,061	353,283,237
South Modesto to BNSF Connection (UPRR N/S-6)	20.90	12.99	21,150,677	34,038,714	442,049,140
North South Connection East of Stockton (South Portion) (UPRR-BNSF X-2)	15.15	9.41	9,196,591	14,800,478	139,328,349
UPRR/BNSF Connection to Atwater (BNSF N/S-6)	6.30	3.91	16,322,332	26,268,248	102,830,695
Atwater to Downtown Merced (BNSF N/S-7)	17.00	10.56	25,661,185	41,297,674	436,240,142
Merced South to BNSF Connection (BNSF N/S-8)	4.75	2.95	32,162,740	51,760,913	152,773,015
BNSF Connection South to Henry Miller Wye (BNSF N/S-9)	17.45	10.84	8,686,037	13,978,822	151,571,352
BNSF Henry Miller Wye (BNSF N/S-10)	15.90	9.88	18,020,529	29,001,230	286,526,405

Alignment Alternative by Corridor and Segment	Length		Average Cost (in dollars)		Cost (in dollars)
	Km	Miles	Per Km	Per Mile	
Station Location Options					
Modesto (Downtown)					71,428,053
Briggsmore (Amtrak)					71,428,053
Merced (Downtown)					71,428,053
Castle Air Force Base					71,428,053
* *Option 5B more expensive by $26,806,470.*					

Table 4.2-2
High-Speed Train Passenger Station Cost Summary

Station	Terminal Station	Quantity	Cost (in 2006 dollars)
S1	4th & King Station (Caltrain1-2, Caltrain Urban Tunnel)	Each	791,939,278
S2	Transbay Transit Center Station (Caltrain1-TB1, Urban—Tunnel)	Each	786,262,418
S3	West Oakland/7th Street Station (Niles/I-880 1A, Urban—Tunnel)	Each	611,197,055
S4	12th Street/City Center Station (Niles/I-880 1B, Urban—Tunnel)	Each	611,197,055
	Intermediate Station		
S5	San Jose Diridon Station (Caltrain 8-Pacheco 1, Urban—Aerial)	Each	185,051,790
S6	Millbrae/SFO Station (Caltrain 2-3, Urban—At Grade)	Each	29,076,600
S7	Redwood City Station (Caltrain 3-4, Urban—At Grade)	Each	67,516,558
S8	Palo Alto (Caltrain 6-7, Urban—At Grade)	Each	67,516,558
S9	Coliseum/Airport Station (Niles/I-880 2-3, Urban—At Grade)	Each	61,735,853
S10	Union City (BART) Station (Niles/I-880 3-4, Urban—Aerial)	Each	69,853,070
S11	Union City (Shinn) Station (Niles/I-880 4-5, Urban—Aerial)	Each	310,150,400
S12	Fremont (Warm Springs) Station (Niles/I-880 5-6, Suburban—Aerial)	Each	156,875,180
S13	Newark Station (Caltrain 2-3, Suburban—Aerial)	Each	310,150,400
S14	Pleasanton (BART) Station (I-680/580/UPRR 1-2, Suburban—Aerial)	Each	316,675,328
S15	Pleasanton (I-680/Bernal) Station (UPRR 3-4, Suburban—At Grade)	Each	72,639,578
S16	Livermore 1 (I-580) Station (I-680/580/UPRR 3-4, Undeveloped—Aerial)	Each	151,769,468
S17	Livermore 2 (Downtown) Station (UPRR 5-6, Urban—At Grade)	Each	73,297,263
S18	Livermore 2 (Downtown) Station (UPRR 5-6, Urban—Aerial)	Each	314,667,658
S19	Livermore (Greenville Road/I-580) Station (I-680/580/UPRR 4-5, Undeveloped—Aerial)	Each	160,180,913
S20	Livermore (Greenville Road/UPRR) Station	Each	72,639,578
S21	Tracy 1 (Downtown) Station (UPRR 10-11, Urban—Aerial)	Each	310,150,400
S22	Tracy 2 (Existing ACE) Station (SUPRR 2-3, Suburban—Aerial)	Each	314,667,658
S23	Gilroy (Caltrain) Station (Pacheco 2-3, Urban—Aerial)	Each	148,256,045
S24	Morgan Hill (Caltrain) Station (Pacheco 1-2, Suburban—Aerial)	Each	284,985,295
S25	Modesto Downtown Station (UPRR N/S 4-5A/B, Urban—At Grade)	Each	71,428,053
S26	Briggsmore (Amtrak) Station (BNSF N/S 4-5, Suburban—At Grade)	Each	71,428,053
S27	Merced Downtown Station (UPRR N/S 7-8, BNSF N/S 7-8, Urban—At Grade)	Each	71,428,053
S28	Castle Air Force Base Station (BNSF N/S 6-7, BNSF Castle 1-2, Suburban—At Grade)	Each	71,428,053
	Intermediate Station (Local Service Option)		
S29	Union City (Shinn) Station (Niles/I-880 4-5, Urban—Aerial)	Each	300,146,665
S30	Newark Station (Caltrain 2-3, Suburban—Aerial)	Each	300,146,665
S31	Pleasanton (BART) Station (I-680/580/UPRR 1-2, Suburban—Aerial)	Each	297,325,543
S32	Pleasanton (I-680/Bernal) Station (UPRR 3-4, Suburban—At Grade)	Each	58,118,585
S33	Livermore 1 (I-580) Station (I-680/580/UPRR 3-4, Undeveloped—Aerial)	Each	132,402,375
S34	Livermore 2 (Downtown) Station (UPRR 5-6, Urban—At Grade)	Each	58,758,963
S35	Livermore 2 (Downtown) Station (UPRR 5-6, Urban—Aerial)	Each	300,146,665
S36	Livermore (Greenville Road/I-580) Station (I-680/580/UPRR 4-5, Undeveloped—Aerial)	Each	140,813,820
S37	Livermore (Greenville Road/UPRR) Station	Each	58,118,585
S38	Tracy 1 (Downtown) Station (UPRR 10-11, Urban—Aerial)	Each	300,146,665
S39	Tracy 2 (Existing ACE) Station (SUPRR 2-3, Suburban—Aerial)	Each	300,146,665

As defined in Chapter 2, the HST Network Alternatives represent different ways to combine HST Alignment Alternatives and station location options to implement the HST system in the study region. The estimated capital costs for each network alternative are presented in Table 4.2-3. The breakdown of these costs by the alignment alternatives and alignment segments that comprise each network alternative are presented in Appendix 4-C.

Because of the variations in alignment alternatives and station location options being considered in the Program EIR/EIS process, there is a potential range of capital costs associated with any given network alternative.

The capital costs have been categorized into discrete cost elements. In general, the capital costs were estimated by determining the appropriate unit costs for the identified cost elements and the cost element quantities from conceptual alignment alternative and station location option plans prepared for each alignment alternative (Appendices 2-E, 2-F, and 2-G). Each cost element is defined in Appendix 4-D, along with the methods, assumptions, and description of the unit cost applied in each case.

The unit costs were reviewed as part of previous studies by HST owners, operators, and manufacturers, various agencies, and consultants. Formal peer reviews of the Authority's Corridor Evaluation were also conducted. Application of these unit costs and assumptions is consistent with past studies for the HST, including the Business Plan, and provides sufficient detail for the comparison of alignment alternatives and station location options at this program level. The unit costs for all individual elements are presented in Table 4.2-4. The unit costs were adjusted to account for inflation from September 2003 to November 2006, based on the *Engineering News Record Construction Cost Index Report* (McGraw-Hill Construction ENR 2007). Unit costs for the Oakland to San Francisco transbay tube, Dumbarton rail bridge (high-bridge and low-bridge options), and Dumbarton tube were obtained from MTC as part of the *Regional Rail* planning studies.

Table 4.2-3
High-Speed Train Network Alternatives Cost Summary (in 2006 dollars)

		Stations	Segment Length		Average Total Cost (dollars)		Cost (dollars)		
No.	Network Alternative		Km	Miles	Per Km	Per Mile	Segment	Station	Total
A	ALTAMONT PASS								
1	San Francisco and San Jose Termini	S2, S5, S6, S7, S12, S15, S21, S25, S27	327.24	203.34	38,880,394	62,571,929	10,972,862,793	1,750,428,628	12,723,291,421
2	Oakland and San Jose Termini	S3, S5, S9, S10, S15, S21, S25, S27	293.17	182.16	34,208,979	55,054,015	8,575,425,642	1,453,483,850	10,028,909,492
3	San Francisco, Oakland, and San Jose Termini	S2, S3, S5, S6, S7, S9, S10, S15, S21, S25, S27	388.12	241.16	38,787,079	62,421,753	12,717,546,470	2,336,339,425	15,053,885,895
4	San Jose Terminus	S5, S12, S15, S21, S25, S27	257.78	160.18	29,863,432	48,060,536	6,830,741,966	867,573,053	7,698,315,019
5	San Francisco Terminus	S2, S6, S7, S11, S15, S21, S25, S27	308.27	191.55	35,729,340	57,500,799	9,295,774,550	1,718,652,058	11,014,426,607
6	Oakland Terminus	S3, S9, S10, S15, S21, S25, S27	274.97	170.86	29,700,584	47,798,456	6,898,337,399	1,268,432,060	8,166,769,459
7	Union City Terminus	S10, S15, S21, S25, S27	254.16	157.93	23,423,990	37,697,258	5,357,942,113	595,499,153	5,953,441,266
8	San Francisco, and San Jose—via SF Peninsula	S2, S5, S6, S8, S11, S15, S21, S25, S27	343.27	213.30	36,606,277	58,912,092	10,662,279,160	1,903,703,848	12,565,983,007
9	San Francisco, San Jose, and Oakland—with no San Francisco Bay Crossing	S2, S3, S5, S6, S7, S9, S10, S15, S21, S25, S27	393.81	244.70	36,713,165	59,084,112	12,121,598,757	2,336,339,425	14,457,938,182
10	Oakland, and San Francisco—via Transbay Tube	S2, S3, S9, S10, S15, S21, S25, S27	289.11	179.64	44,670,632	71,890,413	10,860,031,797	2,054,694,478	12,914,726,275
11	San Jose, Oakland and San Francisco—via Transbay Tube	S2, S3, S5, S9, S10, S15, S21, S25, S27	320.44	199.11	46,114,588	74,214,235	12,537,120,041	2,239,746,268	14,776,866,308
P	PACHECO PASS								
1	San Francisco and San Jose Termini	S2, S5, S6, S8, S23, S26, S27	430.55	267.53	28,771,881	46,303,853	11,028,569,783	1,359,019,515	12,387,589,298
2	Oakland and San Jose Termini	S3, S5, S9, S10, S23, S26, S27	413.40	256.87	27,973,967	45,019,736	10,345,348,109	1,218,949,918	11,564,298,026

		Stations	Segment Length		Average Total Cost (dollars)		Cost (dollars)		
No.	**Network Alternative**		**Km**	**Miles**	**Per Km**	**Per Mile**	**Segment**	**Station**	**Total**
3	San Francisco, Oakland and San Jose Termini	S2, S3, S5, S6, S8, S9, S10, S23, S26, S27	498.26	309.60	32,098,678	51,657,815	13,891,521,223	2,101,805,493	15,993,326,716
4	San Jose Terminus	S5, S23, S26, S27	343.04	213.15	23,200,433	37,337,478	7,482,396,668	476,163,940	7,958,560,608
5	San Jose, San Francisco and Oakland—via Transbay Tube	S2, S3, S5, S6, S7, S23, S26, S27	444.69	276.31	38,140,438	61,381,085	14,990,264,181	1,970,216,570	16,960,480,751
6	San Jose, Oakland and San Francisco—via Transbay Tube	S2, S3, S5, S9, S10, S23, S26, S27	427.54	265.66	38,154,198	61,403,229	14,307,042,507	2,005,212,335	16,312,254,842
PA	PACHECO PASS WITH ALTAMONT PASS (LOCAL SERVICE)								
1	San Francisco and San Jose Termini	S2, S5, S6, S8, S23, S25, S27, S29, S32, S38	545.83	339.16	33,558,079	54,006,494	16,299,474,324	2,017,431,430	18,316,905,754
2	Oakland and San Jose Termini	S3, S5, S9, S10, S23, S25, S27, S32, S38	512.50	318.45	31,135,039	50,106,988	14,379,523,442	1,577,215,168	15,956,738,609
3	San Francisco, Oakland and San Jose Termini (with Dumbarton Bridge)	S2, S3, S5, S6, S8, S9, S10, S23, S25, S27	629.32	391.04	34,942,461	56,234,439	19,888,148,879	2,101,805,493	21,989,954,371
4	San Francisco, Oakland and San Jose Termini (without Dumbarton Bridge)	S2, S3, S5, S6, S8, S9, S10, S23, S25, S27, S32, S38	580.81	360.90	35,098,797	56,486,038	17,925,696,556	2,460,070,743	20,385,767,299
5	San Jose Terminus	S5, S12, S23, S25, S27, S32, S38	460.34	286.04	29,237,801	47,053,679	12,467,937,131	991,304,370	13,459,241,501

Table 4.2-4
High-Speed Train Unit Cost (in November 2006 Dollars)

	Cost Elements	Unit	Unit Cost (dollars)
Alignment Cost			
Track Items			
	Double Track Section—Total	Kilometers	
1	Double Track Section—At Grade	Kilometers	993,167
2	Double Track Section—On Structure	Kilometers	1,878,243
3	Double Track Section—In Tunnel or Subway	Kilometers	1,878,243
4	Double Track Section—In Trench	Kilometers	1,878,243
	Single Track Section—Total	Kilometers	
5	Single Track Section—At Grade	Kilometers	496,583
6	Single Track Section—On Structure	Kilometers	939,121
7	Single Track Sections—In Tunnel or Subway	Kilometers	939,121
8	Single Track Section—In Trench	Kilometers	939,121
9	Freight Double Track—At Grade	Kilometers	993,167
10	Freight Single Track—At Grade	Kilometers	496,583
Earthwork Items			
1	Site Preparation—Undeveloped	Hectares	12,081
2	Total Cut	Meters^3	9
3	Total Fill	Meters^3	9
4	Borrow	Meters^3	13
5	Spoil	Meters^3	0
4	Landscape/Erosion Control	Hectares	8,075
5	Security Fencing (Both Sides of R/W)	Kilometers	101,733
6	Special Drainage Facilities	5% of Earthwork Cost	
Structures, Tunnels, Walls			
1	Standard Structure	Kilometers	13,733,933
2	High Structure	Kilometers	16,480,720
3	Long Span Structure	Kilometers	37,577,568
4	Waterway Crossing—Primary	Kilometers	28,876,734
5	Waterway Crossing—Secondary (Irrigation/Canal Crossing)	Kilometers	23,119,226
6	Twin Single Track Drill & Blast (<6 Miles)	Kilometers	75,040,254
7	Twin Single Track TBM (<6 Miles)	Kilometers	55,464,535
8	Twin Single Track TBM w/3rd Tube (>6 Miles)	Kilometers	78,846,643
9	Double Track Drill & Blast	Kilometers	83,740,573
10	Double Track Mined (Soft Soil)	Kilometers	96,247,282
11	Seismic Chamber (Drill & Blast/Mined)	Each	94,803,899
12	Crossovers	Each	94,803,899
13	Cut & Cover Double Track Tunnel	Kilometers	48,123,641
14	Trench Short	Kilometers	49,668,587
15	Trench Long	Kilometers	39,272,836
16	Mechanical & Electrical for Tunnels	Kilometers	1,931,362
17	Retaining Walls	Kilometers	4,399,945
18	Containment Walls	Kilometers	1,500,559
19	Single Track Cut and Cover Subway	Kilometers	30,077,276
Grade Separations			
1	Street Overcrossing HSR—(Urban)	Each	17,167,417
2	Street Overcrossing HSR—(Suburban)	Each	6,485,469
3	Street Overcrossing HSR—(Undeveloped)	Each	1,093,628
4	Street Undercrossing HSR—(Urban)	Each	17,930,413
5	Street Undercrossing HSR—(Suburban)	Each	6,866,967

	Cost Elements	Unit	Unit Cost (dollars)
6	Street Undercrossing HSR—(Undeveloped)	Each	1,157,211
7	Street Bridging HSR Trench	Each	
8	Minor crossing closures	Each	178,032
Rail and Utility Relocation			
1	Single Track Relocation (Temporary)	Kilometers	1,271,661
2	Single Track Relocation (Permanent)	Kilometers	1,271,661
3	Single Track Removal	Kilometers	63,372
4	Major Utility Relocations—Dense Urban	Kilometers	890,162
5	Major Utility Relocations—Urban	Kilometers	680,338
6	Major Utility Relocations—Dense Suburban	Kilometers	476,873
7	Major Utility Relocations—Suburban	Kilometers	273,407
8	Major Utility Relocations—Undeveloped	Kilometers	13,988
Right–of-Way Items			
1	Right-of-Way Required for Each Segment		
	Dense Urban	Hectares	4,106,412
	Urban	Hectares	2,737,608
	Dense Suburban	Hectares	1,368,804
	Suburban	Hectares	479,081
	Undeveloped	Hectares	342,201
Environmental Mitigation			
Environmental Mitigation		3% of Line Cost	
System Elements			
1	Signaling (ATC)	Kilometers	845,654
2	Communications (w/Fiber Optic Backbone)	Kilometers	699,413
3	Wayside Protection System	Kilometers	67,144
Electrification Items			
1	Traction Power Supply	Kilometers	432,365
2	Traction Power Distribution	Kilometers	806,233
Program Implementation Costs (per screening)			
Program Implementation Costs		25.5% of Total Cost and Procurement	
Contingencies (per screening)			
Contingencies		25% of Total Construction Cost	
Total Construction			
Total Construction and Right-of-Way (includes environmental mitigation)			
Grand Total			

4.3 OPERATIONS AND MAINTENANCE COSTS

O&M costs were developed for each of the HST Network Alternatives for comparative purposes. The annual O&M costs of the HST Alignment Alternatives and Network Alternatives are based on daily train miles, operating speed, travel time, station configuration, maintenance and storage facilities, and assumed operating frequencies. Daily train miles, operating speeds, and travel times are all outputs of the California high-speed rail simulation model as documented in the operations report prepared as part of the statewide Program EIR/EIS. (Parsons Brinckerhoff 2003.)

A. OPERATING SPEEDS

For the HST system, higher operating speed (150–220 mph [241–354 kph]) are proposed for areas where the alignment is less constrained, and lower operating speeds (less than 125 mph [201 kph]) are proposed in the more heavily developed areas. Local and semi-express services would not necessarily reach the maximum speeds on a given segment. Figure 4.3-1 shows the maximum speeds that could be attained on the various alignment alternatives.

B. TRAVEL TIMES

Table 4.3-1 shows the optimal express trip times between several example city pairs. These times represent the estimated travel times between city pairs without interference from other trains or stops at intermediate stations. A complete listing of station-to-station travel times is included as Appendix 4-E. Express travel times are possible on the proposed HST system because all intermediate stations would have four tracks, with two through-tracks for express service.

Table 4.3-1
Optimal Express Trip Times between City Pairs (220 mph [350 kph] maximum speed)

ALTAMONT Travel Time (hh:mm) / PACHECO Travel Time (hh:mm)	SAN FRANCISCO	OAKLAND	SAN JOSÉ	SACRAMENTO	FRESNO	LOS ANGELES	SAN DIEGO	
San Francisco	N/A	N/A	N/A	01:06	01:18	02:36	03:54	San Francisco
Oakland	N/A	N/A	N/A	00:53	01:04	02:23	03:40	Oakland
San José	00:30	00:22	N/A	00:49	01:01	02:19	03:37	San José
Sacramento	01:47	01:38	01:18	N/A	00:59	02:17	03:35	Sacramento
Fresno	01:20	01:12	00:51	00:53	N/A	01:24	02:42	Fresno
Los Angeles	02:38	02:30	02:09	02:11	01:24	N/A	01:18	Los Angeles
San Diego	03:56	03:48	03:27	03:29	02:42	01:18	N/A	San Diego
	San Francisco	Oakland	San Jose	Sacramento	Fresno	Los Angeles	San Diego	N/A

N/A Not Applicable — Altamont Pass Test Alignment — Pacheco Pass Test Alignment

Note: Based on Altamont Pass Test Alignment B (I-580/UPRR) and Pacheco Pass Test Alignment B (Caltrain/Gilroy/Henry Miller/UPRR).

C. MAINTENANCE FACILITIES AND STORAGE YARDS

The train sets used for the HST system would need to be maintained at several points along the HST corridor. To estimate maintenance costs, it was assumed that the overall statewide HST system would have four maintenance facilities. Three of these facilities would be the primary locations for cleaning, servicing, inspecting, and maintaining the vehicles, as well as storing the trains overnight. A fourth facility would serve as a heavy maintenance facility. In addition to these maintenance facilities, each of the terminal stations would have some light maintenance and cleaning capabilities. The cost of these support facilities is not included in specific segments or network alternatives. These costs are considered in total for the HST system.

D. CONCEPTUAL OPERATING PLAN

The service levels tested in the ridership demand model were 124 trains per day in each direction (i.e., north and south) (248 total), assuming 1,175 seats per train. The service type and stopping patterns are summarized below.

- Express (16 trains per day in each direction): Trains running from Sacramento, San Jose, or San Francisco to Los Angeles and San Diego with one intermediate stop between origin and destination.
- Semi-Express (34 trains per day in each direction): Trains running between similar endpoints as the express, with a limited number of intermediate stops.
- Suburban-Express (33 trains per day in each direction): Trains running express between major metropolitan regions but stopping frequently in these regions.
- Local (36 trains per day in each direction): Trains stopping at all intermediate stops, with potential for skipping stops to improve service, depending on demand.
- Regional (5 trains per day in each direction): Trains running locally that begin or end in the Central Valley, operating mostly during commute hours.

Many HST Network Alternatives studied in this document involve dividing points, such as just north of San Jose for the Pacheco route to serve both sides of the Bay Area, or east of Pleasanton for the Altamont route to serve San Francisco, San Jose, and/or Oakland. Other dividing points exist in the HST system, including one in the Merced area and one south of Los Angeles Union Station. The conceptual HST operating plan assumes separate and distinct trains operating on all defined routes. This would mean that some trains from Los Angeles or Sacramento would go to San Francisco and some to San Jose, while others might go to Oakland. Although it is possible to create long multiunit trains and physically separate the units at specific points on the route to serve more than one terminus from a single origin, this is considered undesirable for the reasons discussed below. Additionally, it is unlikely that the application of such operational practices would benefit one alignment alternative over another.

Some HST systems physically separate trainsets ("splitting and joining trains") at some point on the route. However, the percentage of HST trains actually using this practice worldwide is very small. In France, about 10% of the TGV trainsets are physically split, whereas in Japan the percentage is even smaller. HST trainsets generally are not split during peak hours or at peak traffic points. For example, the TGVs that split in southwest France have already served the major Paris-Bordeaux market, and do not add time to the passengers on this critical city-pair. The Paris-Bordeaux passengers in the other direction also do not lose time waiting for the trains to be combined into one, since they board after consolidation. The mini-Shinkansen that splits to Yamagata, does so after the major stations at Fukushima and Sendai. The Thalys HST does not split until after Brussels passengers get off. The HST splits are generally done in places where the traffic demands are low—not on the main trunk line between the major markets.

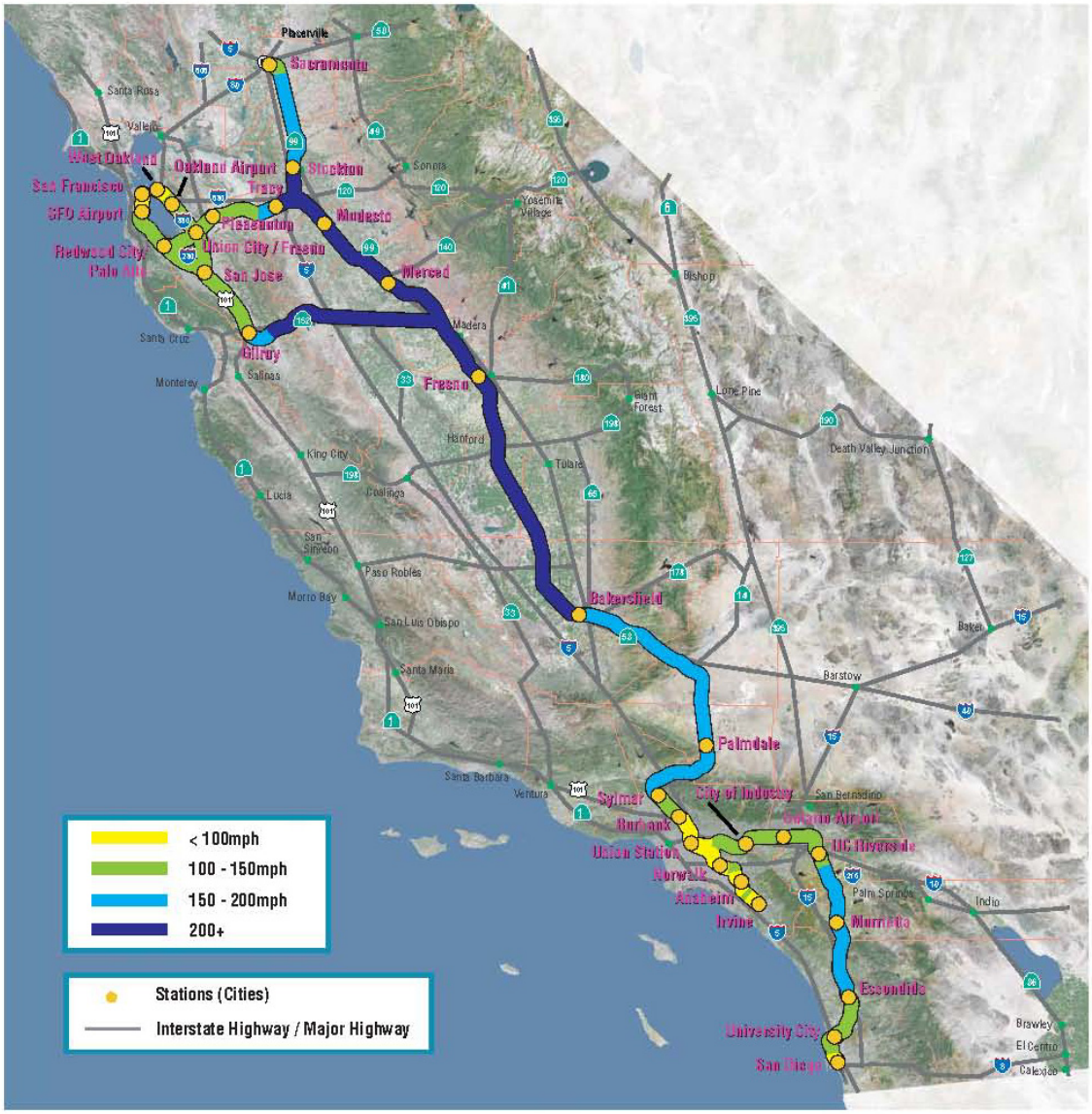

Figure 4.3-1
Maximum Speeds Attained on Alignment Alternatives

It is unlikely that the application of splitting and joining trains would benefit one alignment alternative over the other. Practically, only one such train split could be accomplished for each scheduled train operation. Limited and appropriate splitting of trainsets could be used for either the Altamont Pass or Pacheco Pass alternatives (at Fresno or Los Angeles for example). A key operational benefit of the Pacheco Pass is that it minimizes the number of HST network branches and splits.

E. OPERATIONS AND MAINTENANCE ANNUAL COSTS

The HST projected annual O&M costs are based on the train miles and frequencies assumed in the ridership forecasting analysis (as described in Chapter 2) (Cambridge Systematics 2007) and the unit costs applied in the statewide Program EIR/EIS (California High-Speed Rail Authority and Federal Railroad Administration 2005). A cost estimation method and unit costs were developed for the previous corridor evaluation study to provide an order of magnitude cost estimate for HST service on particular alignments. This method was peer reviewed by the operators of several HST systems, as discussed above in Section 4.2, and found to be adequate for this level of analysis. The same method has been applied in this analysis. Table 4.3-2 presents the operating and maintenance costs on a per-train-mile and per-train-kilometer basis summarized by each operating and maintenance cost element.

Table 4.3-3 summarizes the systemwide operations and maintenance costs according to the alignment alternatives and station location options included in each network alternative. The costs are based primarily on length and frequency of service.

Table 4.3-2
Annual Operating and Maintenance Costs (in 2006 dollars)

Item	Dollars per Train Mile	Annual Cost (million dollars)
Station Services	0.83	24.6
Insurance	2.02	60.1
General Support	1.45	43.3
Maintenance of Way	4.31	128.5
Train Operations	10.05	299.5
Equipment Maintenance	11.79	351.2
Marketing and Reservations	2.12	63.0
Power	7.11	211.9
Total per Year		1.182
Source: Parsons Brinckerhoff 2007.		

Table 4.3-3
Annual Costs of Operating and Maintaining High-Speed Train Infrastructure (in 2006 dollars)

		Network Alternative Length		Systemwide O&M Costs (dollars)
		Km	Miles	
A	**ALTAMONT PASS**			
1	San Francisco and San Jose Termini	327.24	203.34	1,099,301,000
2	Oakland and San Jose Termini	293.17	182.16	1,085,313,000
3	San Francisco, Oakland, and San Jose Termini	388.12	241.16	1,097,940,000
4	San Jose Terminus	257.78	160.18	1,076,391,000
5	San Francisco Terminus	308.27	191.55	1,124,271,000
6	Oakland Terminus	274.97	170.86	1,092,689,000
7	Union City Terminus	254.16	157.93	1,072,954,000
8	San Francisco and San Jose—via SF Peninsula	343.27	213.30	1,115,288,000
9	San Francisco, San Jose, and Oakland—with no San Francisco Bay Crossing	393.81	244.70	1,122,869,000
10	Oakland and San Francisco—via Transbay Tube	289.11	179.64	1,106,098,000
11	San Jose, Oakland and San Francisco—via Transbay Tube	320.44	199.11	1,092,654,000
P	**PACHECO PASS**			
1	San Francisco and San Jose Termini	430.55	267.53	1,182,186,000
2	Oakland and San Jose Termini	413.40	256.87	1,165,923,000
3	San Francisco, Oakland, and San Jose Termini	498.26	309.60	1,174,114,0000
4	San Jose Terminus	343.04	213.15	1,099,200,000
5	San Jose, San Francisco, and Oakland—via Transbay Tube	444.69	276.31	1,195,595,000
6	San Jose, Oakland, and San Francisco—via Transbay Tube	427.54	265.66	1,179,332,000
PA	**PACHECO PASS WITH ALTAMONT PASS (LOCAL SERVICE)**			
1	San Francisco and San Jose Termini	545.83	339.16	1,171,052,000
2	Oakland and San Jose Termini	512.50	318.45	1,139,579,000
3	San Francisco, Oakland, and San Jose Termini (without Dumbarton Bridge)	580.81	360.90	1,179,011,000
4	San Jose Terminus	460.34	286.04	1,130,210,000