

September 4, 2009

The following information has been excerpted from the Metropolitan Transportation Commission (MTC) study entitled, *Bay Area High Occupancy Toll (HOT) Network Study, December 2008 Update*

Additional information can be found at: <http://www.mtc.ca.gov/>

Appendix 3: Cost Analysis

Because it is a first-order analysis, this study takes a conservative approach to estimating costs and revenues. The following steps are taken to ensure conservative cost estimates:

- Low, medium, and high unit costs were applied to estimate HOT lane capital costs. The low cost was applied in very few locations
- Capital cost estimates include a large contingency ranging from 40% where low unit costs were applied to 60% high unit costs were applied.
- Capital cost factors were checked against the cost for the 95% design of the I-680 Sunol HOT lane.

Because of the large contingencies, the analysis did not make the additional, explicit assumption that construction costs would grow faster than inflation, as has been the case in the past few years.

Cost Estimating Assumptions

HOT lane costs are estimated based on previous work conducted by Caltrans, ACCMA, and VTA as well as commonly accepted unit costs. All cost figures are in 2006 dollars. Design assumptions influencing the capital cost estimates are listed below. (See the Task 4 paper for this study for a more detailed discussion of HOT lane design features and tolling equipment.)

- HOT lanes would be separated from the adjacent general-purpose lanes by painted double yellow lines and four-foot buffer.
- Where right-of-way permits, HOT lanes would be a standard 12-foot lane width and existing lanes would not be narrowed to accommodate the HOT lane. A 14-foot median shoulder would be provided, though this width could be used to accommodate enforcement zones and weave lanes at spot locations if needed.
- Widening may be needed in spot locations to accommodate electronic toll pricing gantries, CHP enforcement areas and weaving lanes at ingress and egress locations; these costs are captured in the contingency for this initial assessment.
- The average distance between ingress locations, and, thus, toll tag readers and variable message signs would be four miles. Readers would be located immediately downstream of each entrance on same sign pedestal as a variable message sign posting the price and travel time in the opposite direction, thus there are two such installations in each direction for access openings in each direction. At each ingress location there are one variable message sign installation advertising the price and travel time and two redundant readers and enforcement cameras.
- Communication along the freeway is not assumed to be shared with any existing fiber telecommunications ITS infrastructure that may already exist. This assumption will be revisited when more corridor detail is developed.

Capital Costs

The regional HOT network has two major capital cost components: (1) The cost to convert HOV lanes to HOT lanes or is funded; (2) The cost to add new HOT lanes where no HOV lane exists.

Cost to Convert HOV Lanes to HOT Lanes

The extent of facility modifications required to convert an HOV lane to a HOT lane differs from corridor to corridor and within a given corridor depending on the age of the freeway, number of structures and paved right-of-way. Thus, high, medium and low unit costs were developed to reflect the range of modifications likely to be required⁵:

- Low Range – No widening needed; no structures to be replaced; 40% contingency; \$1.6 million per lane-mile
- Mid Range – Some widening needed; 1.5 bridges per lane mile to be modified; 50% contingency; \$2.7 million per lane-mile
- High Range – More widening needed; 2.5 bridges per lane mile to be modified; 60% contingency; \$4.4 million per lane-mile

Where a Caltrans project study report (PSR) documented corridor-specific engineering features or constraints, this information was used to evaluate whether the cost to convert that corridor would fall in the low-, mid- or high-range unit cost. Where no PSR was available, the unit cost ranges were selected based on an engineer's inspection of Google™ Earth photos and, in some cases, review with local agencies. Where no project study report was available, the unit costs above were considered for the HOT lane corridors and applied based on engineers' inspection of Google™ Earth photos and, in some cases, review with local agencies. Segments with sufficient right-of-way and very few structures were costed at the low level. Depending on right-of-way availability, extent of structures, and other factors, higher unit costs were applied in other segments.

Cost to Add New HOT Lanes

Where the cost of HOV widening has already been estimated in PSR, that cost estimate is reflected in the HOT network cost. Where no cost estimate exists, the cost to add a new travel lane is estimated to be \$8 million per lane mile. This cost for the additional travel lane is added to the unit costs for HOT lane elements described above. It is likely that developing the HOV and HOT elements simultaneously will lead to cost savings. At this early stage, accounting for both costs with no assumption of economies or savings results in a conservative capital cost assumption.

The total capital cost of the Bay Area HOT network is estimated to be \$4.8 billion. This includes \$1.4 billion to convert HOV lanes to HOT lanes and \$3.4 billion to add new HOT-equipped travel lanes, where HOV lanes do not currently exist or are not otherwise funded. Attachment A includes a more detailed breakdown of the unit costs. Attachments B through D present the capital cost estimate for each corridor: those that can be developed by converting HOV lanes and those that require widening.

Operating and Maintenance Cost

Operations and maintenance (O&M) costs are estimated at \$70,000 per lane-mile per year. This estimate is based on planning by ACCMA for the I-680 HOT lane. It includes the following costs

⁵ These unit cost are higher than those used in Phase 1 and documented in the Task 3 report. Unit costs were increased by 20% following further review of the 95% design capital cost for the I-680 Sunol HOT lane to allow for greater contingency.

proportional to corridor distance: a) maintenance of toll equipment; b) supplies; c) utilities; d) lease of communications system; and, e) enforcement. Enforcement unit costs for the system, however, may differ from those for a single corridor. Administrative costs and a 25% contingency are added to these items resulting in the \$70,000 operations and maintenance cost per lane-mile. This estimate cost does not include the cost of roadway maintenance.

The annual operations and maintenance cost for the entire Bay Area HOT network is about \$55 million per year (in 2006 dollars).

Centralized Costs

Centralized system costs are a factor of HOT lane usage and are not proportional to corridor length. These include: the cost to BATA for processing a tolling transaction, estimated to be \$0.16 per transaction; 2.2% of transaction costs for bank or financial institution processing fees; and \$18 each for purchase and replacement of a transponder. In addition, the centralized system costs include a one time start up cost of \$1 million to expand BATA operations from the current scale, designed to handle traffic on the seven state-owned toll bridges, to one capable of handling traffic on a regional HOT lane network.

Over 20 years (2015 – 2035), the total operating and maintenance cost and centralized system cost for the phased plan described in the final report (and shown in Attachment E) is \$1.6 billion.

Roadway Maintenance Costs

At Caltrans' request, this study enumerates the cost of roadway maintenance for the Bay Area HOT network. Under current policy, the state of California covers roadway maintenance costs for all portions of state-owned roadways, including all HOV lanes, the existing HOT lanes in San Diego (30 miles) and the Orange County toll roads (51 miles). The SR 91 HOT lane does pay for pavement maintenance under the terms by which the state acquired the HOT lane from the private owner.

Caltrans provided a statewide average unit cost for roadway maintenance of \$93,700 per lane mile per year. This cost includes maintenance of pavement, signs, barriers, guardrails and other design features. At this rate, the annual cost to maintain the region's existing HOV system (350 lane miles) is approximately \$33 million per year. The roadway maintenance cost for the full Bay Area HOT network (approximately 800 lane miles) would be approximately \$74 million per year.

The estimated 20-year cost (2015 – 2035) to maintain the HOT network roadway, based on the phased plan described in the final report is \$1.2 billion. Because the phased plan calls for converting existing HOV lanes to HOT lanes before closing gaps and extending the system, the bulk of this (\$800 million) is the cost of roadway maintenance for HOT lanes associated with existing HOV lanes that Caltrans currently maintains. This estimate does not include the cost to bring current pavement up to standards, which would likely be desirable before converting an existing HOV lane to a HOT lane.

A refined estimate of roadway maintenance cost would reflect the average cost in the Bay Area, which might differ from the statewide average. It also would be useful to understand whether the unit cost for HOV/HOT lanes would be lower than the average unit cost due to less vehicle usage and exclusion of heavy trucks. And further whether full-time HOT lanes might have a less robust cross section, resulting in lower capital costs.

ATTACHMENT A: UNIT COST COMPARISON FOR HOT LANE NETWORK - Low, Medium, and High Range Costs Per Lane Mile

Item	Low Range		Medium Range		High Range	
	Lane Mile Cost	Comments/Assumptions	Lane Mile Cost	Comments/Assumptions	Lane Mile Cost	Comments/Assumptions
Pavement Demolition	\$ 50,000		\$ 50,000		\$ 50,000	
Haul Debris	\$ 25,000		\$ 25,000		\$ 25,000	
Aggregate Base	\$ 20,000		\$ 20,000		\$ 20,000	
Subgrade	\$ 4,000		\$ 4,000		\$ 4,000	
Asphalt Concrete	\$ 41,000		\$ 41,000		\$ 41,000	
Drainage Modifications	\$ 65,000	Inlet modifications etc. along shoulder	\$ 65,000	Inlet modifications etc. along shoulder	\$ 65,000	Inlet modifications etc. along shoulder
Metal Beam Guardrailing	\$ 42,000	Replace 25% per lane mile	\$ 42,000	Replace 25% per lane mile	\$ 42,000	Replace 25% per lane mile
Concrete Barrier	\$ 50,000	Replace 20% per lane mile	\$ 50,000	Replace 20% per lane mile	\$ 50,000	Replace 20% per lane mile
Shoulder reconstruction	\$ 78,000		\$ 78,000		\$ 78,000	
Asphalt Concrete- Shoulder	\$ 20,000		\$ 20,000		\$ 20,000	
Temporary K-rail	\$ 22,500	0.25 mile of placement per mile	\$ 45,000	0.5 mile of placement per mile	\$ 45,000	0.5 mile of placement per mile
Temporary Striping	\$ 3,000		\$ 3,000		\$ 3,000	
Permanent Striping	\$ 7,000		\$ 7,000		\$ 7,000	
Traffic Markings for HOT lanes	\$ 3,000		\$ 3,000		\$ 3,000	
HOT Lane Striping	\$ 15,000		\$ 15,000		\$ 15,000	
Enforcement Area	\$ -	None Assumed	\$ 40,000	Use of median structure every 1/4 mile	\$ 86,250	Standard enforcement & Weaving Lanes
Misc. Sign Allowance	\$ 10,000	Small signs posted on median barrier	\$ 10,000	Small signs posted on median barrier	\$ 10,000	Small signs posted on median barrier
Guide Sign Allowance	\$ 22,500	3 prior to start of each HOT every 10 miles	\$ 22,500	3 prior to start of each HOT every 10 Miles	\$ 22,500	3 prior to start of each HOT every 10 miles
CMS/VMS	\$ 37,500	1 per 4 lane mile @ 150,000 ea.	\$ 75,000	2 per 4 lane miles @ 150,000 ea.	\$ 75,000	2 per 4 lane miles @ 150,000 ea.
Utility Relocation Allowance	\$ 25,000		\$ 50,000		\$ 50,000	
Structure Modification	\$ -	None Assumed	\$ 300,000	1.5 bridge per lane mile, \$500/sq.ft due to addition of substructure, assume 100 foot long bridge	\$ 500,000	2.5 bridges per lane mile, \$500/sq.ft due to addition of substructure, assume 100 foot long bridge
Sound wall Modification	\$ -	None Assumed	\$ -	None Assumed	\$ 396,000	10% replacement per lane mile
ITS Elements	\$ 300,000		\$ 300,000.00		\$ 300,000	
Sub-total	\$ 840,500		\$ 1,265,500		\$ 1,907,750	
Mobilization 10%	84,050		126,550		190,775	
Contingency	\$ 184,910	Assume 20%	\$ 417,615.00	Assume 30%	\$ 839,410	40% Contingency; greater uncertainty with ROW acquisition and structure replacement
Total	\$ 1,109,480		\$ 1,808,665.00		\$ 2,937,935	
Traffic Management	33,284	Assume 3% of total	72,387	Assume 4% of total	149,897	Assume 5% of total
Design and Construction Management	221,892	Assume 20% of total	361,933	Assume 20% of total	587,587	Assume 20% of total
	272,927	Added 20% for overall contingency	448,797	Added 20% for overall contingency	734,484	Added 20% for overall contingency
Grand Total	\$ 1,637,563		\$ 2,692,762		\$ 4,406,903	

Note: Shaded rows indicate cost items where assumptions differ for the low, medium and high range cost estimates.

Regional HOT Lanes Network Feasibility Study

Phase 2, Task 10.1 – COMPARISON OF CAPITAL AND OPERATING & MAINTENANCE COST ESTIMATES FOR I-680

Prepared for:

Metropolitan Transportation Commission

and

California Department of Transportation

Prepared by:

PB

with

ECONorthwest

September, 2007

Introduction

PB compared capital cost estimates for the I-680 HOT lane (14.2 miles southbound from Calaveras to SR 84 in Alameda County) prepared by the ACCMA consultant team and those developed by PB using the same method as used for the overall network in Phase 1. ACCMA's estimates are based on greater project detail and greater depth of engineering than applied in the Phase 1 regional network review. The method used in Phase 1 involved consideration of corridor characteristics based on either a Project Study Report (where available) or an engineer's review of a corridor using GoogleEarth aerial photography and low, medium, or high costs depending on presence of structures needing to be modified and other factors.

In Phase 1, PB used ACCMA's capital cost estimates for the I-680 southbound HOT Lane based on ACCMA's greater level of engineering at that stage. For this Phase 2 review, the key capital cost questions are whether the regional capital costing approach produces results similar to those of ACCMA and, to the extent there are differences, what characterizes them.

In this review, PB considered I-680 capital costs developed by ACCMA's consulting team through June 14, 2007. These costs are listed in Table 1 alongside estimates made by the PB team.

PB reviewed the corridor using GoogleEarth as was done for other corridors in Phase 1. This review took into account cost estimates developed for other corridors (including I-680 northbound) and considered the same factors as included in Phase 1. The capital cost estimate for the southbound lanes of I-680 from Calaveras to SR84 was developed using the mid-range unit cost based on the inspection of Google Earth photos. This unit cost includes 30% contingencies and structure widening.

The resulting costs in 2006 \$s were compared side by side with the ACCMA cost estimate as shown in table 1. ACCMA's escalation costs were not included for the capital costs, support costs or electronic toll system so that all costs could be kept in 2006 \$s. In addition the risk contingency and the funds for first year operating reserve were deducted from the electronic toll system costs in ACCMA's estimate.

As shown in tables 2 and 3, a further adjustment was the reclassification of \$2.53 million in ACCMA-estimated costs for centralized tolling services, essentially functions associated with BATA. These centralized tolling services costs include:

- ETS software

- Documentation
- Test bench simulator
- ETS contract project management
- Contingency associated with these costs

Clearly, such investments will be needed. However, to keep the capital cost basis similar to Phase 1 costing, these items are assumed to be spread across all corridors and are not considered to be “capital costs.” The centralized services costs were estimated in Phase 1 to include: 1) \$1 million in BATA start-up for HOT lane tolling; 2) the cost to BATA for processing a tolling transaction, estimated to be \$0.16 per transaction; (i.e., charging a toll); 3) 2.2% of transaction costs for bank or financial institution processing fees; and, 4) \$18 each for purchase and replacement of a transponder. These costs are included later in this working paper under the section on centralized services costs.

Based on these assumptions, the total capital cost estimates from the two approaches are similar (\$26.3 million for the regional network approach and \$24.0 million for the ACCMA project estimate).

Roadway costs are very similar under the two approaches (\$12.1 million for the regional approach and \$12.9 for ACCMA).

The regional network approach leads to higher structures modification costs than did ACCMA’s assessment (\$4.2 million vs. \$1.9 million). This difference represents the preliminary estimates used in the regional approach compared with the greater depth of engineering applied by ACCMA which reflects a more detailed understanding of corridor conditions.

ITS elements (electronic toll collection and related elements) under the regional approach are estimated to be lower than the more detailed ACCMA assessment (when the centralized services costs are excluded). The regional approach yields an estimate of \$4.2 million whereas the ACCMA estimate is \$6.1 million.

Contingency and supplemental work shown for the regional network approach is about twice the level estimated for the ACCMA assessment. This reflects a greater contingency considered in the regional network approach.

Estimates of support costs (right-of-way engineering, PS&E, and construction engineering) differ with the regional network estimate at \$5.1 million (or approximately 20% of the capital costs) and ACCMA's estimate at \$7.9 million (or approximately 30% of the capital costs).

Considered together, the contingency plus supplemental work and the support costs are similar under the two approaches (\$10.9 million for the regional network approach and \$10.8 million for the ACCMA approach).

With centralized services costs removed from the ACCMA capital cost estimates, the regional approach capital cost estimate and the ACCMA capital cost estimate are within 2% of each other. With ACCMA's (adjusted) capital cost very close to the regional approach estimate, this suggests that the regional approach is producing estimates that are reasonable. While having a greater contingency allowance in the regional estimates would be preferable, the comparison suggests that the regional estimates are acceptable for this stage of the analysis.

ACCMA's consultants advised MTC and PB on June 14, 2007 that they believed their contingency estimate could be reduced given the advanced stage of engineering. If that were to be done, the ACCMA (adjusted) capital costs would be lower than shown above, thus suggesting that the regional approach is providing a comparable capital cost and building in a slight contingency representing a measure of conservativeness in the regional estimates.

However, this overall review suggested to the PB team that the MTC unit costs should be increased by 10% to provide for greater contingency. With Caltrans' concurrence and request for an additional 10% increase, the Phase 1 unit costs were increased by 20% for the Phase 2 working papers.

Table 1: Unit Cost Comparison-Southbound I-680 HOT Lane in Alameda County (In 2006 \$s)

Item	Regional HOT Lane Feasibility Project Estimates (Based on Medium Range Cost Assumption)		ACCMA I-680 SB Cost Estimate (Source: ACCMA I-680 cost estimates)	
	Total Cost	Comments	Total Cost	Comments
Roadway Costs	\$ 12,102,112		\$ 12,876,827	Northern Segment Roadway, Southern Segment Roadway
Structure Modification	\$ 4,200,000		\$ 1,851,360	Northern Segment Structures
ITS Elements	\$ 4,200,000		\$ 6,067,688	System Integrator, Systems Engineering (not including escalation or risk contingency <i>and not including centralized system costs -- see tables 2 and 3 below</i>)
Contingency & Supplemental Work	\$ 5,846,610	30%	\$ 2,892,831	Northern Segment Contingency and Supplemental Work, Southern Segment Contingency
Right of Way Capital	\$ -	included contingencies in	\$ 352,800	Right of Way Capital
Total Capital Costs	\$ 26,348,722		\$ 24,041,506	
Total Support Costs RWE, PS&E, CE	\$ 5,067,062	20% of total	\$ 7,915,942	PS&E and CE for Smart Share of HOV PS&E; Scoping, PE/ENV, PS&E, CE, and Contingency for HOT Lane PS&E
Grand Total	\$ 31,415,784		\$ 31,957,448	

Table 2: ACCMA ITS Costs Likely Associated with BATA Centralized System

ETS Software	\$	1,440,000
Documentation	\$	200,000
Test Bench Simulator	\$	37,500
ETS Contract Project Management	\$	350,000
<i>Subtotal</i>	\$	<i>2,027,500</i>
25% Contingency	\$	506,875
Total	\$	2,534,375

Table 3: Adjustment of ACCMA ITS Costs to Remove Centralized System Costs

ACCMA ITS Costs	\$	8,602,063
Less centralized system (BATA-type) costs	\$	(2,534,375)
ITS costs apportionable to corridor (and entered in "ITS Elements" costs above)	\$	6,067,688

Operations and Maintenance Costs

The PB team considered the O&M costs developed by ACCMA and concluded that with greater depth of review having been completed by ACCMA, it would be appropriate to adapt that project's O&M estimate for the regional assessment. The team rounded the per mile cost to \$70,000 per lane mile per year.

Operations and Maintenance Elements	ACCMA Estimated Cost Per Lane Mile	O&M Estimate Used for MTC HOT Lane Assessment
Administration and marketing	\$28,520	
Oversight and reporting	\$ 5,280	
Violation enforcement by CHP	\$16,900	
Toll equipment maintenance	\$15,490	
Total	\$66,190	\$70,000