

Planning for Express Buses in Congested Corridors: The Contra Costa Express Bus Study

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Abstract: The Contra Costa Transportation Authority, through its Bus Transit Coordinating Committee and their consultant team, studied express bus service expansion across this suburban California county of 948,000 persons. Building upon existing express bus routes and freeway HOV lanes, this paper describes how the study's resulting enhanced express bus plan was developed.

The study included research that demonstrated local instances where express routes that used HOV lanes on congested freeways had high ridership and productivity. In contrast, express bus routes that operated in congested freeway traffic performed at low productivity levels.

Based upon study findings, the operators and consultant team developed and refined an express bus plan that concentrates on four corridors within Contra Costa County. The plan contains several all-day and commute period freeway routes, and arterial rapid bus corridors to be phased in over time. These are complemented by new capital investments such as park-and-ride lots, HOV lane direct access ramps, arterial roadway signal priority systems, and new buses. The plan includes projected capital investment and operating strategy costs and subsidy scenarios, and identified possible funding sources. The study team and operators' staff also concluded that express bus expansion is hampered by institutional issues.

Introduction

Contra Costa County, a suburban county in the San Francisco Bay Area, contains approximately 948,000 people in the 2000 Census. The population concentrations are in a variety of communities, most with a high level of population growth in the past few decades. The county topography has resulted in the development of four general population basins and several smaller valleys, separated by hills and mountains.

Much of the Contra Costa development patterns has been the focused on highly successful Bay Area Rapid Transit (BART) rail corridors, that provide frequent and high-speed connections to Oakland, San Francisco and other parts of the Bay Area. To serve the local population basins and connect with the BART regional rail system, several local bus transit operations began to evolve across the county.

As employment and population settlement patterns evolved along other non-BART corridors and in lower density environments, the commuters in much of the county have been unable to use transit to travel to and from other parts of the county in a high-speed and frequent manner. Many of these trips can require two or three transit transfer in order to complete trips within the County.

The Contra Costa Express Bus Study centered around the development of an integrated express bus service concept plan, encouraging both capital and operating strategies that would

make such a service successful. The study was developed as a participatory process among the consultant team and staff members from each of the participating transit operators serving as the Bus Transit Coordinating Committee.

The successful acceptance of the study and its plan relied on the identification of four major ideas. First, the express bus concept and its benefits were defined and explained. Next, the study involved participatory development of a conceptual plan for integrated, enhanced express bus service in Contra Costa County. Once the plan was developed, likely benefits and costs and benefits were estimated, so that plan could be further enhanced. The study concluded with participants discussing the institutional constraints that hamper efforts to develop a successful express bus system.

Express Bus Concept

Express bus service can take many forms. The committee agreed to define express bus in two primary forms that are complementary to the buses that operate today:

Freeway Express Service. Buses that operate on freeway segments are most effective if they stop no more frequently than every two to five miles for most or all of the length of their route, and have easy access to High Occupancy Vehicle (HOV) lanes wherever possible.

Arterial Rapid Bus. A “rapid bus” design for arterial roadways can effectively serve express bus routes. Services on these facilities are best as “limited stop,” with stops spaced between one-half and two miles. Examples of appropriate design treatments for such operations are:

- Signal prioritization: express buses are given signal pre-emption;
- Queue jump lanes: bus-only right-of-way is granted at congested intersections; and
- Arterial HOV lanes: lanes allowing carpools and buses to bypass slow traffic on local streets.

The participants agreed to envision several different types of transit service concepts that would overlay on each other. These service concepts include:

All-day express service: This regularly scheduled service would operate between 5:30 AM and midnight. Ideally, service would operate every 15 minutes during the peak periods, every 20 minutes during the off-peak, and 60 minutes late evening. These services can have significant savings in travel times if HOV lanes can be used.

Commuter express: This regularly scheduled service would operate between 5:30 to 8:30 AM and again between 4:00 and 7:00 PM. Ideally, service would operate every 15 minutes, although ridership may not always justify this frequency. These services can also have significant savings in travel times if HOV lanes can be used.

All-day parallel arterial “rapid bus” service: This regularly scheduled service would operate between 5:30 AM and midnight. Ideally, this service would also operate every 15

minutes during the peak periods, every 20 minutes off-peak, and 60 minutes late evening. Studies elsewhere suggest that such operations can achieve up to a 25 percent travel time savings over normal arterial bus operations.

Subscription bus service: Riders subscribe to this specially designed service, which can operate either on the freeway or as an arterial rapid bus. One trip is provided in each direction at peak commute hours.

A comparison of these service types is presented in Table 1.

Table 1
Transit Service Types

| Type | Hours of Operation | Method of Payment |
|----------------------------|----------------------------|------------------------------------|
| All-day Freeway Express | 5:30 AM to midnight | Pay/pass when boarding |
| Commuter Freeway Express | 5:30 to 8:30 PM; 4 to 7 PM | Pay/pass when boarding |
| All-day Arterial Rapid Bus | 5:30 AM to midnight | Pay/pass when boarding |
| Subscription Bus | 5:30 to 8:30 PM; 4 to 7 PM | Advance purchase subscription pass |

Source: Contra Costa Express Bus Study

The participants agreed to propose express bus services as an enhancement, and to assume that current local bus and shuttle bus services would continue to operate at current levels.

Support Facilities

The participants also focused on strategizing additional capital investments to maximize ridership and the benefits of an integrated express bus system. Suggested investments fall into five categories:

Adequate park-and-ride facilities. Many of the Contra Costa County park-and-ride facilities at BART stations and other locations are approaching or are over capacity today. This is true for most large park-and-ride facilities that have high frequency express bus service. An express bus system based from existing park-and-ride lots will worsen this shortage. Thus, new spaces were recognized as important if this plan is to be implemented.

Direct Access to the HOV (High Occupancy Vehicle) lane system. State and local agencies have funded and installed over 40 miles of HOV lanes in Contra Costa County since 1990. However, many express buses cannot gain from the advantageous travel times on HOV lanes. When buses enter and exit freeways on the right and HOV lanes are on the left, express buses have difficulty using these lanes quickly and safely. Direct Interstate 80 HOV ramps installed at two locations in Contra Costa County -- Richmond Parkway and El Cerrito del Norte BART – and these have resulted in better safety and significant travel time savings to express bus operators. Thus, construction of more HOV access ramps is integral to this plan.

Arterial rapid bus improvements. In order to provide faster travel speeds on important routes off of freeways, communities can design and implement operational improvements on the local arterial roadways where rapid buses operate. These include queue jumps (where

buses are given a special “head start” signal at congested intersections), signal prioritization (where rapid buses are given signal preemption) and pedestrian crossing treatments. A rapid bus corridor is current in the early stages of implementation in along one arterial roadway in Contra Costa County – San Pablo Avenue – and participants see benefits to expanding this concept.

Adequate pedestrian and bicycle connectivity. Express bus stops in this plan must have good and safe pedestrian and bicycle access at both ends of the rider’s trip. Safe and secure bicycle storage, well-lit waiting areas, crosswalks, adequate sidewalks and signage are all important to improving bus stop access, visibility and safety.

Real-time transit information. Recent technology advances in real-time bus arrival information will continue to improve, and riders will likely expect such information in the future. Currently, several Bay Area bus operators are installing global positioning systems on the buses to allow real-time schedule information to be collected. Some are now field-testing real-time arrival information systems. This plan recommends having an integrated, real-time bus arrival system in operation as part of this plan.

Examples of Travel Time and Productivity Benefits

Many transit operators and local jurisdictions have worked across the country to develop systems that reduce passengers’ travel time. Several examples of the usefulness of travel time benefits were found and highlighted within Contra Costa County and across California in order to build a clearer understanding of this.

A significant Contra Costa County example of travel time benefits is the result of using special HOV lanes and ramps on the Interstate 80 corridor in the western portion of the County. The WestCAT Route that uses these ramps, Route JX -- El Cerrito del Norte BART/Hercules Transit Center Express, is able to travel ten miles in only 16 minutes. The result is ridership is recorded at 37 passengers per hour, and bus frequencies are now at 15 minutes. Vallejo Transit routes, which also use this HOV system, have experienced between 19 and 34 passengers per hour.

In comparison, an express bus route in another congested corridor in eastern Contra Costa County has no HOV ramps or lanes for use on the route. This route must use only freeway mixed-flow lanes. This route -- the Tri-Delta Route 300: BART/Hillcrest P&R/Oakley/Brentwood Express -- takes 34 minutes to travel ten miles and its productivity is less than five passengers per hour.

A successful example of an arterial rapid bus system is found in the City of Los Angeles, where two corridors have been redesigned to serve as arterial rapid transit corridors. In these corridors – Wilshire Boulevard/Whittier Boulevard and Ventura Boulevard – travel time saving of 25 percent on each major segment have been achieved. This benefit has remarkable implications for the users of the transit system. Just as significant as travel time gains, average ridership in each corridor has increased about 27 percent.

Cost-recovery ratios of most express bus systems are much higher than the local buses that must travel slowly on neighborhood streets. From the operator’s standpoint, these travel time advantages have a double benefit. Not only does the faster system gain riders, but also the hourly labor costs are much lower when the route takes less time to operate. Research within California identified several successful express bus routes with high cost recovery. These are shown in Table 2.

Table 2
Representative Performance Statistics of Selected Express Buses

| Operator/Route | Passengers Per Hour | Farebox Recovery |
|-----------------------|----------------------------|-------------------------|
| Vallejo Transit 80 | 25.9 | 85% |
| Vallejo Transit 85 | 19.2 | 48% |
| Vallejo Transit 90 | 34.7 | 56% |
| Orange County TA 205 | 29.3 | 22% |
| Los Angeles MTA 720 | 55.5 | 66% |
| Los Angeles MTA 750 | 40.3 | 48% |

Source: Annual statistics, various operators, 2001

The participants also noted that express bus systems improve employment opportunities for persons in low income, no-auto ownership neighborhoods. As people identify better jobs that are available in other areas, transit travel time becomes a primary determinant for the viability of working elsewhere.

The Contra Costa Express Bus Plan Development

The intent for developing this vision was to demonstrate how transit connectivity in Contra Costa County can be greatly improved through an expanded express bus system. The fastest growing trip patterns are associated with suburban-to-suburban commutes that are not easily served by a drive-to-BART trip. Several commutes around Contra Costa are time consuming and not easy to make today; they would be substantially improved if this plan were implemented.

This vision was developed in an iterative process. The consultant team prepared background information on commuter travel patterns using model data made available from the Contra Costa Transportation Authority, and the participants agreed to focus the plan in four general corridors – Interstate 80, Interstate 680, East-to-Central and Far East.

Next, the participants attended an all-day workshop to design initial route concepts under the assumption that all local operators had been merged into one agency. The consultant team took proposed route concepts from two participants “teams” that were formed, and proposed the initial route structure. This structure was subsequently revised twice once ridership, operating cost, capital cost and institutional issues were presented.

The express bus plan was finalized in a three-phased vision.

1. The first phase was the new routes recently funded through a special funding program (“Call for Projects for Express Buses”) sponsored by the California Governor’s Office and

implemented by the Bay Area Metropolitan Planning Organization – the Metropolitan Transportation Commission. Inspired by the express bus concepts, local operators submitted applications to acquire buses to operate in congested corridors. Successful transit operators were notified during the course of the study, and about half of the entire region's share were routes that would begin and/or end in Contra Costa County.

2. As these services improve, a second level of services – the Basic Scenario – was be introduced. New all-day limited-stop express services that would service Contra Costa markets were identified as early-start efforts. These new services, which would be an enhancement beyond the MTC-funded program, were assumed to be in place by 2007.
3. The Enhanced Scenario was the final phase, where a large system of express buses would operate across the county by 2020. To improve mobility for those who travel on the increasingly congested freeway corridors, a number of new and enhanced services are envisioned.

The Enhanced Scenario included considerable expansion of support facilities and bus fleets. Specific expansion requirements are summarized here by category.

Buses. Generally, the new services would initially be enhanced with the new buses from the MTC Express Bus program. In addition to these, another 131 new buses for the corridor would be needed to complete the enhanced scenario.

Park-and-Ride Spaces. Park-and-ride spaces are vitally important to the success of express buses in suburban areas. They need to be large enough to enable frequent buses, and thus high ridership. In order to facilitate rider use, 3,000 new park-and-ride spaces are recommended for distribution across Contra Costa County.

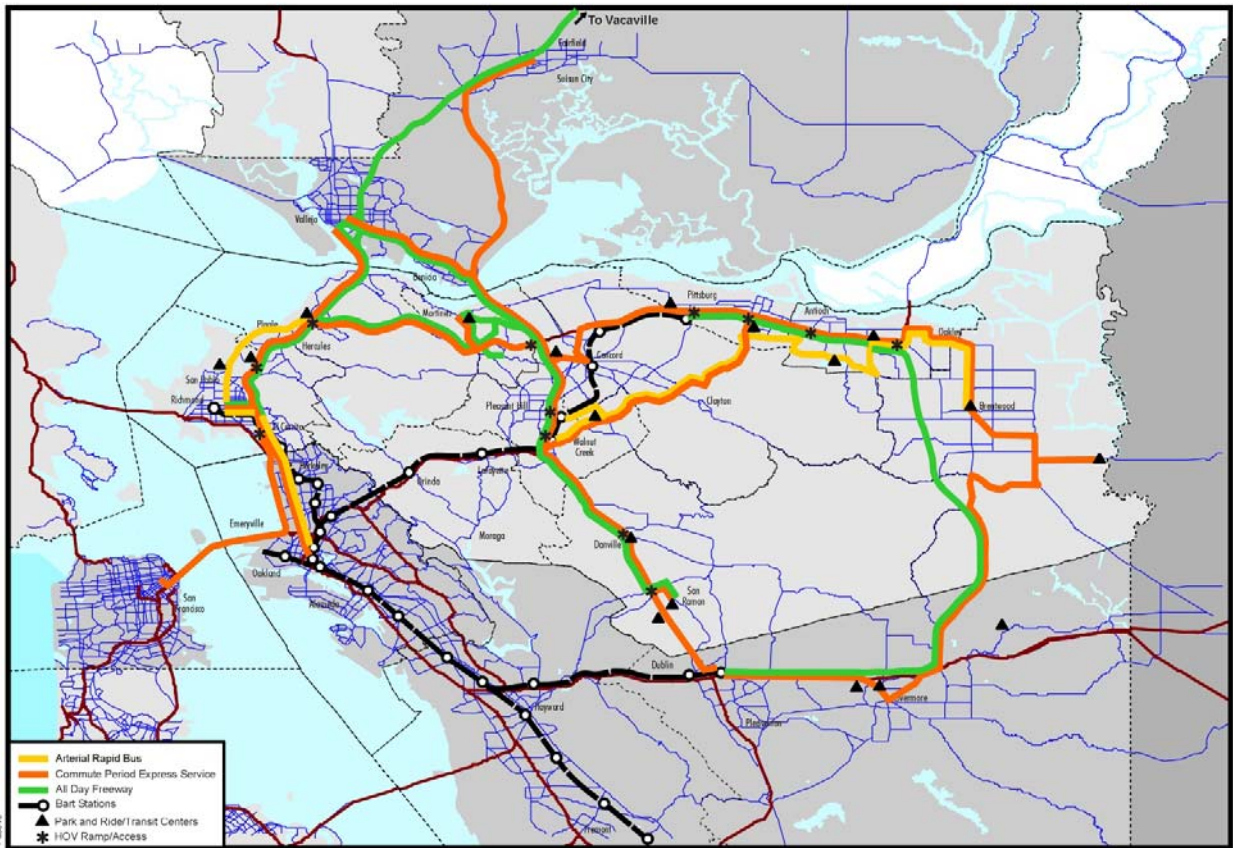
Expressway HOV Access Improvements. Access to and from HOV lanes is critical if buses are to be on time and reliable. HOV access is envisioned as either mid-freeway loading areas (away from traffic flow) or by HOV exit/entrance ramps. These improvements would be provided at about 20 locations across the county.

Arterial Rapid Bus Corridor Improvements. These corridors would be developed as four arterial rapid bus corridors or segments placed along key activity areas in the County.

Bus Stop Amenities. Careful bus stop design is needed at each major boarding and alighting point, including park-and-ride lots, BART stations, transit centers and major trip destinations. In addition, a special bus stop identity is envisioned to promote the services would be provided at these points.

A map showing the enhanced bus conceptual routes, the general locations of important HOV or freeway access points, arterial rapid bus corridors, and major park-and-ride locations is shown as Figure 1.

Figure 1
Enhanced Scenario Transit Service



Benefits and Costs

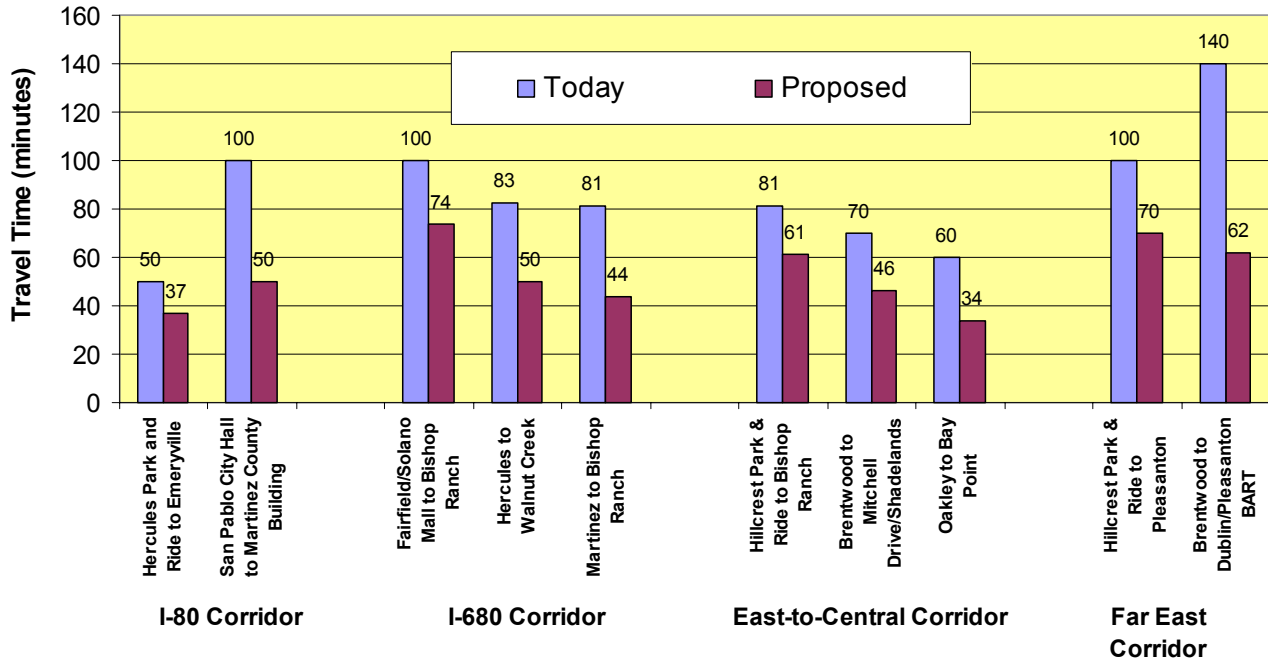
The participants recognized that evaluation of the plan was needed so that the approximate benefit and cost estimates could be better understood. These estimates were also needed in order to begin discussions of whether or not to proceed with arranging for express bus investments and services.

Benefits

One of the greatest advantages of implementing this plan is that it would reduce travel time for people who make suburb-to-suburb commutes in Contra Costa County, reducing travel times by up to 50 percent.

With these improvements, fast, reliable express bus service would significantly improve rider options in the future. In Figure 2, a comparison of projected travel times that would result from implementation of the Enhanced Scenario is compared with travel times on current routes. The benefits are for persons across the county were presented in a single table to highlight the importance of a countywide effort to expand express bus operations.

**Figure 2
Example Transit Commutes**



Based on these travel time savings, more commuters should be attracted to transit. By applying the market shares of current high-speed transit mode shares to the number of commute trips in 2020, a general magnitude of the resulting ridership forecasts can be derived. A spreadsheet was used to roughly calibrate the market share of areas where express buses already operated when compared with year 2000 subarea-to-subarea trip table estimates available from the MTC regional model. Growth in ridership assuming no change in express bus services was developed by applying the year 2000 market shares to 2020 trip tables. Finally, an elasticity formula (derived from regional model mode choice equations) was applied to estimate the benefit of the improved travel times.

The conceptual ridership potential was identified by corridor:

Interstate 80 Corridor. An additional 11,800 riders a day.

Interstate 680 Corridor. An additional 10,700 new riders a day.

East-to-Central Corridor. An additional 7,100 new riders a day.

Far East Corridor. An additional 1,700 riders a day. (Because these would be longer distance trips, fares would likely be higher for these riders, creating a better farebox return that could help support these routes.)

Operating Costs

This plan estimated low and high costs for both operating and capital expenditures. For operating costs, the low and high costs are derived from cost estimates of platform hours multiplied by the hourly rates. High costs are based on the most expensive operator's average hourly costs, and low costs are based on the median average operating cost for the transit agencies participating in the study.

Congested peak period travel times were utilized to begin developing operating costs. Assumptions for dwell time per stop and recovery time for each end of the trip were added to the bus travel times. Different assumptions were utilized for stops with HOV ramps and those stops not utilizing HOV ramps.

Two farebox recovery assumptions of 35 percent and 50 percent were utilized to illustrate the range of operating subsidy requirements.

As shown in Table 3, the full operating subsidy required over the phased-in Enhanced Scenario would require mobilizing between \$100 and \$160 million. This eighteen-year subsidy would represent the magnitude of the subsidy needed. Although future fare box recovery and operating costs are difficult to determine, some new revenue stream would clearly need to be implemented.

Potential sources of revenues to meet the operating subsidy requirements would include:

- Local Transportation Fund (dedicated transit operating subsidy in California)
- State Transit Assistance (dedicated transit subsidy in California)
- New regional funding programs
- Measure C Reauthorization revenues (local sales tax)
- Other sources

Contra Costa County operators have been able to establish excellent funding partnerships with major employment sites for special services. A convenient and attractive express bus network may be able to attract some additional private sector funding.

Capital Costs

Generalized capital cost estimates, described in ranges, were developed for the Enhanced Scenario. These costs were developed by applying unit costs developed from currently funded projects in Contra Costa County, as described in the *Contra Costa Countywide Plan*.

**Table 3 –
Cumulative Operating Cost and Subsidy Requirements**

| | Operating Costs | | Fare Revenues | | | | Operating Subsidy Required | |
|-----------------------------|-----------------|----------------|----------------------|---------------|----------------------|----------------|----------------------------|----------------|
| | Low | High | 35% Farebox Recovery | | 50% Farebox Recovery | | Low | High |
| | | | Low Costs | High Costs | Low Costs | High Costs | | |
| Basic Scenario | Five-Year | | | | | | Five-Year | |
| Interstate 80 Corridor | \$ 2,645,370 | \$ 3,248,700 | \$ 925,880 | \$ 1,137,045 | \$ 1,322,685 | \$ 1,624,350 | \$ 1,322,685 | \$ 2,111,655 |
| I-680 Corridor | \$ 2,645,370 | \$ 3,483,555 | \$ 925,880 | \$ 1,219,244 | \$ 1,322,685 | \$ 1,741,778 | \$ 1,322,685 | \$ 2,264,311 |
| State Route 4 East Corridor | \$ 3,401,190 | \$ 4,176,900 | \$ 1,190,417 | \$ 1,461,915 | \$ 1,700,595 | \$ 2,088,450 | \$ 1,700,595 | \$ 2,714,985 |
| Far East Corridor | \$ 560,000 | \$ 560,000 | \$ 196,000 | \$ 196,000 | \$ 280,000 | \$ 280,000 | \$ 280,000 | \$ 364,000 |
| Total | \$ 9,251,930 | \$ 11,469,155 | \$ 3,238,176 | \$ 4,014,204 | \$ 4,625,965 | \$ 5,734,578 | \$ 4,625,965 | \$ 7,454,951 |
| Enhanced Scenario | Eighteen-Year | | | | | | Eighteen-Year | |
| Interstate 80 Corridor | \$ 62,398,755 | \$ 76,630,050 | \$ 21,839,564 | \$ 26,820,518 | \$ 31,199,378 | \$ 38,315,025 | \$ 31,199,378 | \$ 49,809,533 |
| I-680 Corridor | \$ 43,296,495 | \$ 53,171,134 | \$ 15,153,773 | \$ 18,609,897 | \$ 21,648,247 | \$ 26,585,567 | \$ 21,648,247 | \$ 34,561,237 |
| State Route 4 East Corridor | \$ 61,765,937 | \$ 75,852,906 | \$ 21,618,078 | \$ 26,548,517 | \$ 30,882,969 | \$ 37,926,453 | \$ 30,882,969 | \$ 49,304,389 |
| Far East Corridor | \$ 30,369,107 | \$ 41,255,409 | \$ 10,629,188 | \$ 14,439,393 | \$ 15,184,554 | \$ 20,627,704 | \$ 15,184,554 | \$ 26,816,016 |
| Total | \$ 197,830,294 | \$ 246,909,498 | \$ 69,240,603 | \$ 86,418,324 | \$ 98,915,147 | \$ 123,454,749 | \$ 98,915,147 | \$ 160,491,174 |

Notes: For the Enhanced Scenario, the cumulative operating subsidy required would be between \$98.9 and \$160.5 million for the eighteen-year period. The low estimate is based on the low operating cost estimate and a 50% farebox recovery assumption. The high estimate is based on the high operating cost estimate and a 35% farebox recovery assumption. All dollar amounts assume no inflation.

Source: Contra Costa Express Bus Study

The capital cost estimates included:

- Purchase of 103 buses at a cost between \$36.7 and \$44.8 million.
- Addition of 3000 park-and-ride spaces in the four corridors could range from \$63 to \$123 million, depending on land acquisition costs and whether surface or garage parking is provided.
- Construction of enhanced bus stop improvements to 16 major bus stops for passenger amenities would cost between \$320,000 to \$480,000.
- Arterial rapid bus corridor improvements such as queue jump lanes and signal prioritization for 49 miles could cost between \$24.5 and \$34.3 million.
- Construction of 20 Bus-only or HOV ramps for a single direction are included at a cost of between \$84 and \$124 million.

The total capital costs over the eighteen-year period were estimated to be between \$218.1 and \$338.3 million dollars as 2001 estimates. It was noted that these costs are highly variable depending on specific project design, resulting in the wide variation in capital cost

Six possible capital cost funding sources were identified:

- Federal Transit Administration programs 5307 (formula) and 5309 (transit capital improvements)
- CMAQ/STP (State/ regional competitive pool program)
- New regional funding programs
- Measure C Reauthorization (local sales tax)
- TDA/STA (dedicated transit subsidy program in California)

Institutional Issues

Local current institutional arrangements in Contra Costa County present several obstacles that were presented that must be addressed before the vision of an express bus system could be achieved. These issues were presented initially by the consultant team, and refined based on feedback from participants. Major obstacles include:

Territorial concerns and perceptions. Under the current institutional arrangements, there is no single agency to consider the needs of the potential express bus rider who is a constituent of the East Bay and not just a constituent of a specific transit district. Therefore, there is no natural advocate for direct services that do not require the rider to transfer among systems.

Leadership void to integrate operations, funding, and capital projects. Under the current institutional arrangements in the Bay Area, the responsibility for planning and funding transit and road projects is segmented, creating a leadership void for an express bus system. Transit operators have either no role or a small role in the planning of street and highway projects. Local cities and the county plan the streets and arterials in Contra Costa County, but do not individually oversee their local transit agency. Caltrans has the responsibility for freeways. The primary goal of road planners has been to move automobiles. Transit usage of the roadway system is, at best, a side consideration.

Funding authority is similarly dispersed. The Contra Costa Transportation Authority (CCTA) primarily funds road projects, which are prescribed under the terms of Measure C. The Metropolitan Transportation Commission (MTC) is the major source of disbursement for transit funds. Therefore, there is no one place where the functions of both planning and funding are integrated for operation of express buses and for the capital infrastructure to support them.

Disparities in size among large and small operators. The disparity in the size of the transit agencies operating in Contra Costa County affects the design of an express bus route system—by whom and how it should be operated. To address this issue, the Boards of Directors will have to weigh the desire for local responsiveness against the advantages to be gained from size.

Funding and cost sharing debates. Understandably, each transit agency must attend to its own funding needs first. This makes it difficult to consider providing services that extend beyond its boundaries, when an agency is unable to meet all the requests for service within its boundaries. Thus, an express bus system that crosses jurisdictional boundaries complicates the funding picture. In order to work out an equitable answer to these questions, the Directors of these multiple agencies must balance the tension between adequate funding for their own agencies and funding for a system that recognizes no boundaries.

The set of actions that came out of this study were focused on creating a working group at the policy level to plan and implement express bus services and associated improvements.

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