Progression or Regression: Case Study for Commuter Rail in San Francisco Bay Area

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Commuter rail, once a transit option in many cities, is currently experiencing a resurgence in popularity in this country. A case in point is the Bay Area Rapid Transit District's (BART's) plan to return commuter rail to the East Bay Area. BART is now considering a plan that will return commuter rail to the Bay Area in the form of a 322-km (200-mi) regional commuter rail system in the East Bay Area. This system would use existing rail infrastructure and provide service to five counties. BART developed this program as a near-term and cost-effective transportation solution for relieving highway congestion and maximizing limited financial resources for new rail extensions in the Bay Area. The BART Commuter Rail Program could begin service within 2 years after funding sources have been secured. Short-term implementation is possible because the existing infrastructure and facilities can support service today. The BART Commuter Rail Program would be coordinated with existing regional transit services and provide an integrated and coordinated regional transportation system. Compared with other proposed rail transit and highway expansion projects in the region, the BART Commuter Rail Program is a cost-effective and efficient use of the region's financial and physical resources. In addition, the expected operating performance of the program is within the industry range of performance levels experienced by new-start commuter rail systems across the nation.

Commuter rail, once a transit option in many cities, is currently experiencing a resurgence in popularity in this country. A case in point is the Bay Area Rapid Transit District's (BART's) plan to return commuter rail to the East Bay Area. Critics consider this plan regressive for a state-of-the-art system such as BART and believe that it may eliminate established and committed local projects. This paper will examine how commuter rail, in the San Francisco Bay Area, is determined to be a progressive and cost-effective solution within a context of dwindling resources and urban decentralization.

Since 1992, BART has evaluated the opportunity of implementing a 322-km (200-mi) regional commuter rail system in the East Bay. The system would use existing rail infrastructure and provide service in the counties of Solano, Contra Costa, Alameda, San Joaquin, and Santa Clara, as shown in Figure 1. BART developed this program as a near-term, cost-effective transportation solution to increasing highway congestion and limited financial opportunities for rail extensions in the Bay Area.

Background

BART currently operates a 114-km (71-mi) rapid transit system in three counties (Alameda, Contra Costa, and San Francisco). In 1991 BART embarked on a $2.5 billion rail extension for its Phase I program, which includes the addition of 60 km (36 mi) of new rail and 11 new stations, as shown in Figure 1. The Phase I extensions are expected to be complete and in revenue service by 1996, serving over 100,000 daily riders (*1*). Whereas the new extensions are expected to address significant

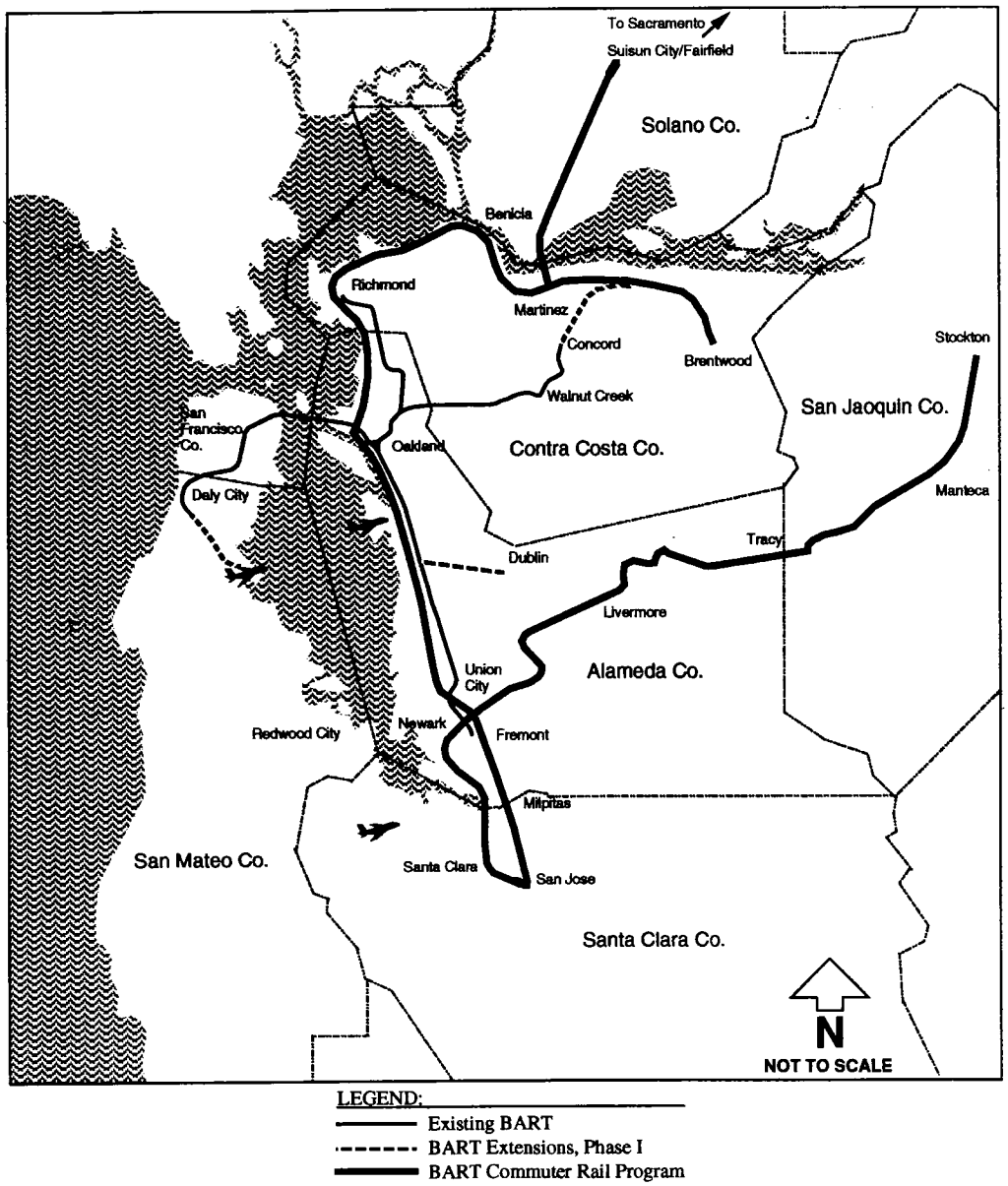


FIGURE 1 BART system and Commuter Rail Program.

travel needs for the region, they cannot meet them all because of rapidly changing travel characteristics and markets.

Several studies that examine other rail opportunities in the Bay Area have been prepared. These studies, which include an intercity rail corridor study (*2*) and commuter rail studies between Solano and Alameda counties (*3*) and between San Joaquin and Santa Clara counties (*4*), determined that there is an immediate need for additional rail service in the region's most heavily traveled corridors. With BART extensions estimated to cost between $48 million and $129 million (1994 dollars) per kilometer ($30 million to $80 million per mile) (*1*) and the estimated time to plan, design, and construct a BART extension ranging from 5 to 10 years, future BART extensions are considered long-term solutions.

In 1992 and 1993, the Union Pacific Railroad (UP) and the Southern Pacific Transportation Company (SP) made separate proposals to provide their rights-of-way, currently used primarily for freight, for commuter service in the East Bay Area. The UP offered its right-of-way between San Joaquin and Alameda/Santa Clara counties, and the SP offered its right-of-way between Solano, Alameda, and Santa Clara counties. In each case the rail company's proposal included the opportunity to lease or purchase existing rail rights-of-way and infra-

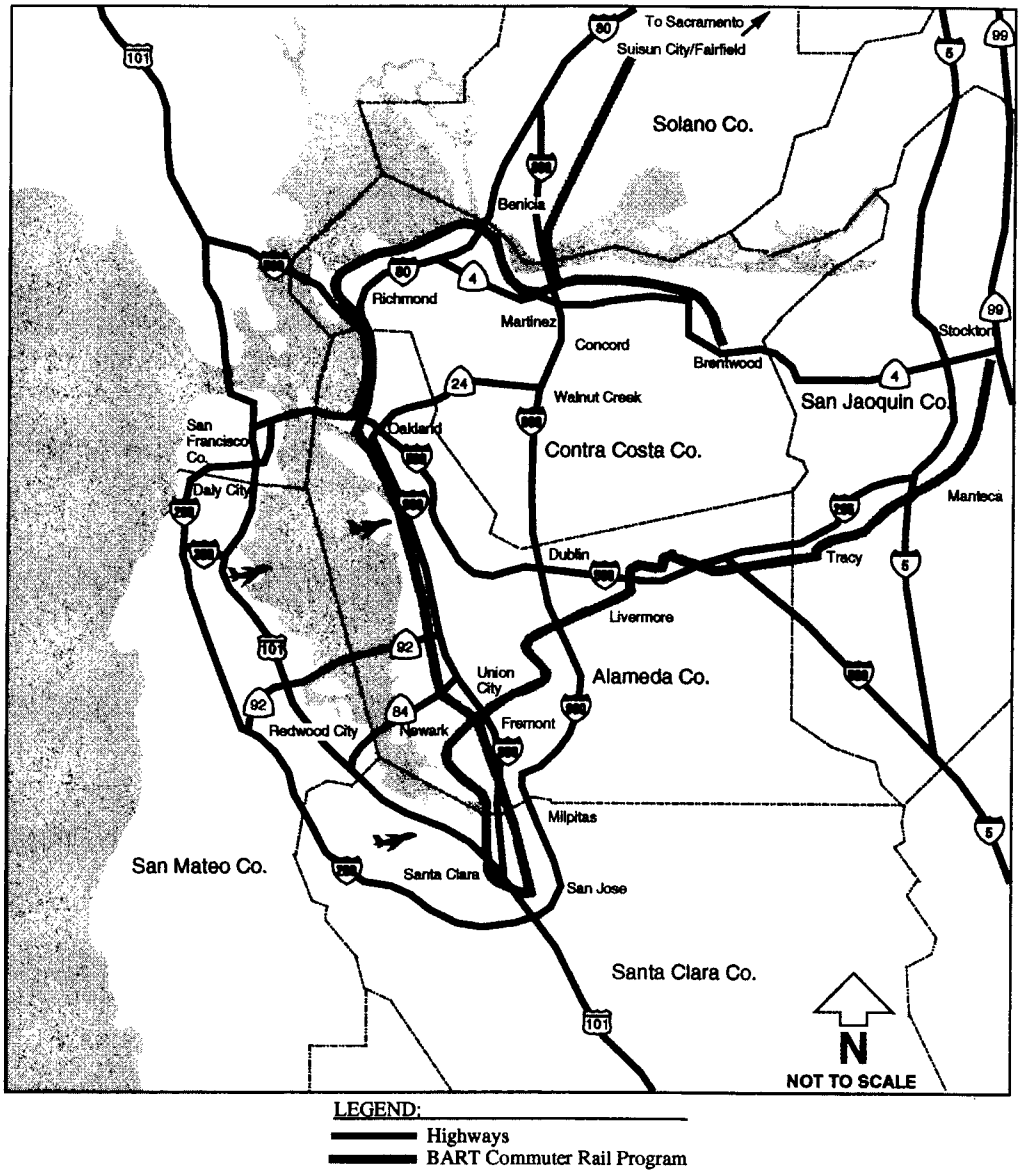


FIGURE 2 Highway corridors.

structure (rail, signals, dispatching) for potential commuter services. The envisioned commuter service along these corridors would replace historical travel routes and could take advantage (for a fee) of existing stations, layover, maintenance, and other facilities. The recently announced proposed merger of the UP and SP offers potential benefits to commuter rail service in the region. If the merger is approved, the Bay Area and surrounding region will be served by only two Class 1 railroads, the newly combined Burlington Northern-Santa Fe and UP-SP. The potential benefits to commuter rail service could include efficient management of freight movements on shared rights-of-way, consolidation of and access to infrastructure capacity, and the opportunity to purchase excess rail rights-of-way at competitive prices.

Travel Need

The Bay Area's travel markets are increasingly defined by new residential construction in areas farther from the urban core and the development of dispersed suburban employment centers. Urban decentralization has a dramatic effect on the East Bay. New travel markets between Solano, Contra Costa, San Joaquin, and Alameda counties have been created, while demand in the traditional travel markets serving San Francisco and the Peninsula has declined. As a result, more residents are traveling from communities farther from the urban core than ever before, and the highway corridors that connect these areas, as shown in Figure 2, are becoming increasingly congested.

TABLE 1 Increase in Daily Work Trips, 1987 to 2010 (*5*)

Travel Corridor	Primary Highway	Number	Percent
Solano - Contra Costa	I-80	15,000	55%
Contra Costa - Alameda	I-80	23,000	18%
San Joaquin - Alameda	I-580	38,100	140%
San Joaquin - Santa Clara	I-580/880	10,000	92%

The population in Solano and Contra Costa counties is expected to increase by more than 200,000 each (a 60 percent and a 36 percent increase, respectively) between 1990 and 2010, and by 380,000 (a 75 percent increase) in San Joaquin (*5*). The average population growth during this period for the entire Bay Area is projected to be about 24 percent (*5*). As a result of these high levels of growth in outlying areas, it is estimated that between 1987 and 2010 the number of daily work trips along the proposed rail corridors will increase by 18 to 140 percent, as indicated in Table 1 (*5*). The increase in population results in existing and future congestion on the region's major travel corridors. As indicated in Table 2, traffic volumes at key screenlines along these travel corridors will increase by 16 to 57 percent and result in severe congestion (Level of Service F) by 2010 (*6,7*).

There are relatively few programmed improvements capable of bringing short-term relief (within 5 years) to existing and projected congestion along the I–80, I–880, and I–580 corridors (which parallel the SP and UP rights-of-way) (*3*). The BART extensions currently under construction will not be able to address the travel needs of these corridors, and planned extensions would be implemented too far in the future to gain any short-term mitigation. However, a commuter rail alternative in these corridors would provide near-term additional passenger capacity and a viable alternative to driving on congested freeways.

Funding and Institutional Issues

In the Bay Area, there is consensus on the need to relieve traffic congestion, but there is disagreement on what that relief should be. The disagreement stems more from a financial concern than a technical one. The current funding picture for the region is equivalent to a zero-sum game: $1 spent on a new project means $1 less for projects already programmed. Therefore, agencies and jurisdictions typically are not willing to give up their projects' funding for a new regional initiative.

Rail alternatives historically are capital intensive and require long-term implementation. However, the commuter rail system being considered in the Bay Area would use existing infrastructure along established travel routes. This would significantly reduce the need for extensive planning and environmental clearances, right-

TABLE 2 Highway Traffic Volumes, 1995 and Projected for 2010 (*6,7*)

Travel Corridor & Screenline	Year 1995	Year 2010[1]	% Increase
North Bay - I-80 Westbound AM Peak			
Emeryville/Oakland	9,000	12,000	33.3%
Richmond	5,900	8,500	44.1%
Carquinez Bridge	5,400	7,400	37.0%
Fairfield	7,100	10,700	50.7%
Altamont Pass - Daily			
I-580 @ Pleasanton	157,000	182,000	15.9%
I-580 @ Livermore	140,000	168,300	20.2%
I-580 @ Altamont Pass	103,000	161,400	56.7%
I-205 @ Tracy	65,000	100,600	54.8%

1. These screenlines are projected to be operating at severe congestion (Level of Service F) in the year 2010.

of-way purchases, and major capital investments. A number of local, state, and federal financing opportunities have been reviewed to fund a proposed commuter rail program. In addition to pursuing the inclusion of the program in the Regional Transportation Plan, new sources of financing and strategies to deploy existing funds are being evaluated and identified. For instance, ways to link the BART Commuter Rail Program with other regional and local projects are being investigated to leverage funding opportunities and maximize the benefit from both projects.

Currently, there are more than 25 transit agencies in the Bay Area (including BART) providing transit services. The Metropolitan Transportation Commission (MTC), the region's metropolitan planning organization, is the Bay Area's transportation planning and funding clearinghouse. One of MTC's charges is to ensure coordinated and efficient provision of transportation services for the Bay Area. MTC has participated in discussions with BART and other agencies to consider commuter rail as an opportunity to consolidate and integrate transit services in the Bay Area with a single operator, fare structure and transfers, and schedules.

BART, a multicounty and multimodal transit operator (BART operates express bus and rapid rail transit service), is well positioned to manage the planning and operation of a commuter rail operation. However, current statutory restrictions prohibit BART from operating any service outside of its three-county district (Santa Clara, Solano, and San Joaquin counties are outside of the BART district). The formation of a joint powers agency or legislative reform is necessary to enable BART to manage, administer, and operate commuter rail service outside of its district.

BART Commuter Rail Program

In response to the initial studies and issues described, BART prepared a commuter rail program (*8*). The pro-

gram consolidates the rail alternatives described in the previous studies into a comprehensive regional rail system consisting of 322 km (200 mi) of commuter rail on existing rail lines in five counties, as shown in Figure 1. This section summarizes the BART Commuter Rail Program and the preliminary operating plan.

Program Description

BART developed the regional commuter rail program as an essential component of an integrated regional public transportation network. To ensure successful implementation, BART also developed service standards and refined patronage estimates for the proposed program.

Service Standards

Service standards were developed to define the commuter rail program and specify systemwide equipment and facilities requirements (*8*). The standards established the program's basic infrastructure commitment and a methodology for implementation. They were developed to ensure rapid start-up of service with minimal capital investment. The five major service standard concepts are summarized in this section.

Service Concept It was determined that the service will be operational within 2 years after receiving funding. The service will offer weekday morning and evening peak-hour line-haul service that closely integrates BART and other regional transit services. Initially, the service will not include off-peak or weekend service. However, it is anticipated that alternative rail and bus services that operate in the corridors during off-peak and weekend periods will be marketed to passengers and, wherever possible, integrated into the schedule and fare information. Wherever feasible, stations will be provided with park-and-ride and kiss-and-ride facilities and will be served by local bus systems. Maximum performance, reliability, and equipment availability goals will be established to ensure high-quality service. Commuter service travel times will be competitive with the automobile, with an on-time arrival target similar to BART's (95 percent of trains arrive within 5 min of scheduled times).

Infrastructure Rights-of-way and grade crossings will be protected and controlled in accordance with existing legislation and each railroad's existing standards. Station platforms will be constructed to handle five-car trains and positioned to allow future expansion. Stations will not be staffed and will include only basic passenger amenities (i.e., shelters, lighting, seats, and fare collection equipment). Additional station amenities may be provided by local jurisdictions. Sufficient parking will be provided to meet the expected demand.

Fare Collection A simple, single fare instrument that is compatible with BART and other transit systems will be used to integrate and coordinate transfers. Fares will be based on a zone and proof-of-purchase system. Discounts will be offered for multiride fares, people with disabilities, and seniors.

Rolling Stock The commuter rail rolling stock will be leased or purchased and will meet all Federal Railroad Administration requirements. The rolling stock will be state-of-the-art equipment and will be capable of providing push-pull operation. Diesel-electric locomotives are expected to be capable of pulling at least five passenger cars at the maximum allowable speeds. High-capacity (bilevel) passenger coach and push-pull cab cars will be used.

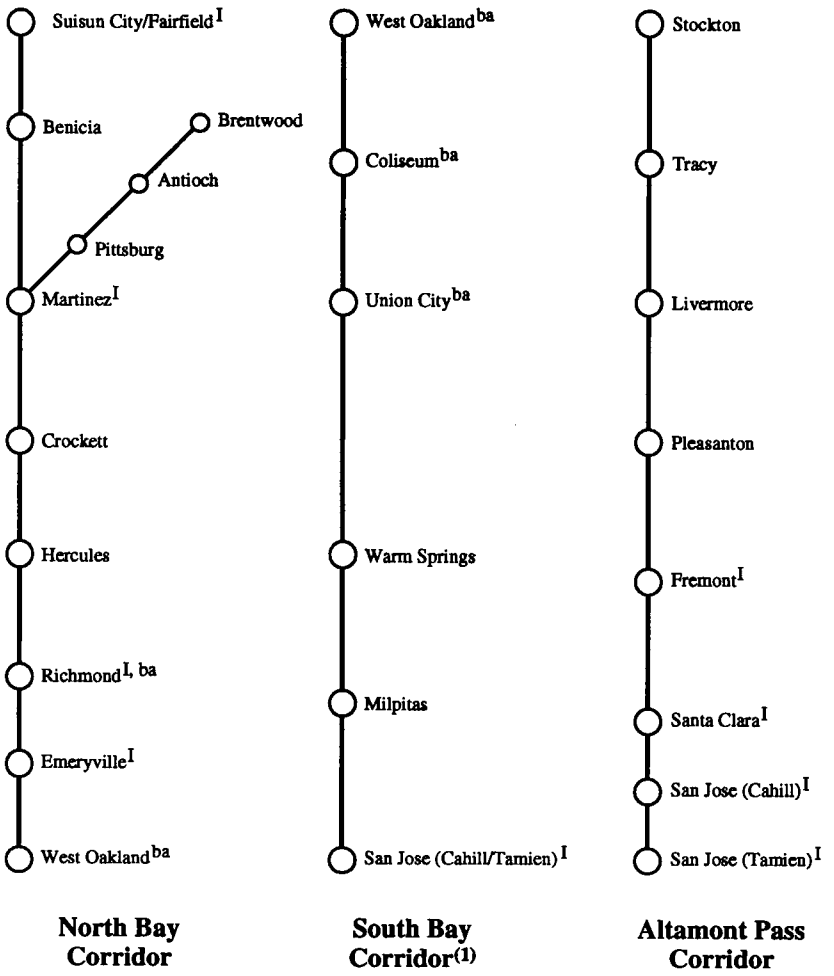
Accessibility All elements of the program (facilities and rolling stock) will meet current Americans with Disabilities Act requirements.

Corridor Descriptions

Three corridors have been studied independently for possible commuter rail service, including the North Bay, South Bay, and Altamont Pass corridors, as shown in Figure 3 (*8*). BART conducted a complete reconnaissance survey of the existing lines to determine the condition of the facilities and found they were all capable of accommodating commuter operations consistent with the service standards described earlier. Each of the corridors is described briefly in this section.

North Bay Corridor This corridor generally parallels I-80, serving the emerging residential communities in Solano County and the traditional employment centers in Oakland and San Francisco. It is 76 km (47 mi) long and would provide service between Solano County and West Oakland (with a direct connection to BART for transfers to San Francisco and other points in the East Bay) on the SP Sacramento Line. Branch service could also be provided on a 43-km (27-mi) corridor between Martinez and Brentwood on the SP Mococo Line in Contra Costa County. There are four existing intercity rail stations in this corridor that could be used by a commuter service: Suisun City/Fairfield, Martinez, Emeryville, and Richmond (also a BART station).

South Bay Corridor This corridor would serve residents in Alameda County traveling to the emerging employment centers in Santa Clara County and the Silicon



(1) Assumes either SP or UP alignment. Additional station sites (between Milpitas and San Jose) may be selected depending upon preferred alignment.

I Existing cross-platform transfer to Intercity Services.

ba Existing cross-platform transfer to BART.

FIGURE 3 Commuter rail corridors.

Valley. Service in this 68-km (42-mi) corridor, which generally parallels I–880, would be provided between West Oakland and San Jose on either exclusive SP or UP rights-of-way or a combination of the two. The selection of the preferred right-of-way will be determined on the basis of local preferences and future funding and implementation conditions. There are two existing stations in this corridor located in San Jose: the Cahill joint Amtrak/Caltrain station in downtown San Jose (used by several intercity rail services and the Caltrain Peninsula Commute service) and the Tamien station (which serves Caltrain and the Santa Clara Transportation Authority light rail transit).

Altamont Pass Corridor This corridor would serve residents in the emerging residential communities in East Alameda and San Joaquin counties and the employment centers in East Alameda and Santa Clara counties. It generally parallels the I–580 and I–880 corridors with service provided on the UP and SP rights-of-way. Four stations currently provide intercity rail service, including Stockton, Fremont, Santa Clara, and San Jose (Cahill).

Patronage Estimates

The service plan also evaluated and refined initial patronage estimates for each of the corridors and prepared a systemwide estimate along all three corridors (*8*). Patronage estimates for 2000 were developed on the basis of a regional planning model and travel data, and the program is expected to serve about 3.73 million passengers annually, as indicated in Table 3.

TABLE 3 BART Commuter Rail Patronage Estimates: Total Daily and Annual Trips in 2000 (*8*)

Corridor	Daily	Annual
North Bay	6,400	1,600,000
South Bay	5,520	1,380,000
Altamont Pass	3,000	750,000
Total	14,920	3,730,000

Preliminary Operating Plan

A preliminary operating plan was prepared on the basis of the service standards, physical infrastructure conditions, and travel demand data of the three potential commuter rail corridors (*8*). The preliminary operating plan is summarized in Table 4. The basic premise of this plan is to maximize the operating potential of this service while ensuring a rapid start-up and minimal capital investment.

Economies of Scale

It was determined that significant economies of scale could be gained by implementing the entire system at once rather than phasing in one corridor at a time. The preliminary operating plan qualitatively identified economies of scale to be achieved through consolidation of maintenance functions, rolling stock requirements, crew and staffing needs, and maximizing integration of fares and service schedules.

Service Plan

An effort was made to find a cost-effective balance between passenger requirements and optimal equipment and crew utilization among the three corridors. On the basis of preliminary discussions with the UP and SP, it was determined that an operations window for the commuter service could be established to minimize conflicts between freight and passenger movements.

In all cases, the resulting optimum service plan was based on patronage estimates and existing infrastructure conditions. The service plan assumed 22 stations within the entire rail network (7 exist). Service schedule scenarios were tested using a rail operations simulation program, which estimated run times on the basis of required track speeds, other rail operations (freight and passenger services), scheduled station stops and dwell times, and crew changes and train turn times.

A fundamental operating strategy assumed that schedules would accommodate business travelers and provide reasonable arrival and departure times in San Francisco, Oakland, and San Jose. The schedules also assumed sufficient time for transfers to connecting bus/rail services. As indicated in Table 4, the optimum service schedules included up to six peak-direction trips (a.m. and p.m.) in the North Bay and South Bay, and two peak-direction trips (a.m. and p.m.) in the Altamont Pass Corridor. The initial service plan does not include off-peak service. After the successful initiation of the service, additional midday, evening, and weekend off-peak service will be considered and added to the schedule and incorporated into the operating plan.

Competitive Travel Times

Estimated travel times of automobile and commuter rail service for origin and destination pairs for 2000 were compared (*9*). As indicated in Table 5, it is estimated that the commuter service would provide travel time savings of up to 24 percent compared with the automobile.

Rolling Stock Requirements

Rolling stock requirements were based on the service standards and preliminary service schedules described earlier (*8*). The basic train set includes a locomotive, three bilevel passenger coaches, and a bilevel cab control car, for a total capacity of 580 passengers per train. The total rolling stock requirement is 15 locomotives, 46 coaches, and 16 cab cars. These estimates include a 15 percent spare requirement for locomotives and a 20 percent spare requirement for coach and cab cars, consistent with industry standards (*8*). On the basis of an industry survey, it was determined that these rolling stock requirements could be met within a 2-year time frame through either a lease or a purchase option (*8*).

Capital and Operating Costs

The estimates of capital and operating costs for the commuter rail service were based on the assumptions that equipment would be used on multiple corridors, joint maintenance and layover facilities would be shared, and labor costs could be reduced through these and other staff and crew efficiencies (*8*).

Capital Costs Capital costs for infrastructure are based on an inventory of the corridors and estimates for the improvement of tracks and signals, layover and maintenance facilities, and stations. Estimates for rolling stock and right-of-way access fees were based on an industry survey and discussions with the railroads. Station costs were based on the assumption that existing facilities would be used or that minimal stations would be constructed, as described earlier. It was also assumed that the commuter rail program would use existing maintenance facilities or would share the Amtrak, Cal-

TABLE 4 Preliminary Operating Plan (Peak-Period Service Only) (*8*)

	AM Peak Period		PM Peak Period	
Service Corridor	Trains	Headway (minutes)	Trains	Headway (minutes)
North Bay				
Suisun/Fairfield to West Oakland	3	30 - 60		
Brentwood to West Oakland	3	30		
W. Oakland to Suisun/Fairfield			3	40 - 60
W. Oakland to Brentwood			3	40 - 45
South Bay				
W. Oakland -Union City - San Jose	1		2	55
Union City to San Jose	3	20 - 25		
San Jose -Union City -W. Oakland	2	30	1	
San Jose to Union City			3	30
Altamont Pass				
Stockton to San Jose	2	60		
San Jose to Stockton			2	40

TABLE 5 Comparative Travel Times and Speeds, 2000 (*9*)

	Automobile			Rail			
Selected Pairs	Miles	Time (min.)	Speed (mph)	Miles	Time (min.)	Speed (mph)	Travel Time Savings (%)
Fairfield-W. Oakland	44.8	92	29.2	49.0	75	39.2	18
Pittsburg-W. Oakland	31.8	79	24.2	41.5	61	40.8	23
Martinez-W. Oakland	23.8	57	25.1	28.0	47	35.7	18
Warm Spring-W. Oakland	32.9	58	34.0	36.9	47	47.4	19
San Jose-W. Oakland	43.4	77	33.8	50.9	71	43.2	8
Fairfield-San Francisco	50.6	111	27.4	54.9	90	36.6	19
Pittsburg-San Francisco	38.9	100	23.3	47.4	76	37.4	24
Martinez-San Francisco	30.8	78	23.7	33.9	62	32.8	21
Livermore-San Jose	42.6	84	30.4	42.0	71	35.4	15

trans, and Peninsula Commute Service Pullman maintenance facility to be located in San Jose. Maintenance facility costs are based on a prorated share of use. The capital costs presented in this paper assumed purchase of rolling stock. The initial capital costs for the program are estimated to be about $340 million (1994 dollars) total or $1.06 million per kilometer. They are summarized in Table 6.

Operating Costs Annual operating and maintenance costs for the commuter service include crew, fuel, facility and equipment maintenance, administrative, and associated costs. The costs were based on a survey of similar costs for other new-start and traditional commuter rail systems (*8*). In particular, the experiences of the Peninsula Corridor Caltrain service in the Bay Area and the new Metrolink service in Southern California were used as a baseline reference to approximate local conditions. Total annual operating costs for the system were estimated to be up to $17.2 million (1994 dollars).

Fare Revenue Projections and Net Operating Costs

A distance-based "zone" fare structure was assumed for the commuter rail service (*8*). The fare program was assumed to be integrated with the BART fare system, requiring only a single payment for trips originating on the commuter rail service and transferring to the BART system. Discounts were assumed for multirides, people with disabilities, and seniors. The annual revenue generated from passenger fares is estimated to be about $5.2 million (1994 dollars). Applying these fare-box revenues to operating costs, the net operating cost of the commuter rail service would be $12 million (1994 dollars), resulting in a fare recovery ratio of 30 percent.

Implementation Issues

Once funding is secured, it is expected that the entire system could be operational within 2 years (*8*). This

TABLE 6 Preliminary Capital Costs, BART Commuter Rail Program (*8*)

Cost Item	1994 Dollars (millions)
Track and Signal Modifications	$24.79
Layover facilities	2.12
Station modification/construction	30.74
Maintenance facilities	4.00
Rolling Stock	128.00
Track Access Fees	150.00
Total Capital Costs	$339.75

includes a realistic estimate of the planning and implementation phase of the program. A 2-year start-up was considered realistic because it is estimated that railroad negotiations and infrastructure improvements (track, signals, and facilities) could be completed within the 2 years. In addition, it was determined that the project may qualify for a categorical exemption under the California Environmental Quality Act because it would establish rail service along rail lines already in use. The exemption could significantly expedite the environmental review process. On the basis of discussions with railcar manufacturers, it was determined that a 2-year lead time was required for procurement and delivery of new commuter rail equipment. It was assumed that leased equipment could be used on a temporary basis until the new equipment was delivered if the lead time requirement could not be met.

Service implementation options were developed as an alternative to implementing the entire network immediately. Unforeseen financial, jurisdictional, and institutional issues may make it impossible to implement the entire network in one phase. For instance, funding for the BART Commuter Rail Program has not been identified. However, BART, in coordination with other local and regional agencies and other interested parties, is developing strategies to identify partial and full funding options such as highway mitigation funds, state and federal rail funds, and local sources. Therefore, these service options could allow implementation of a portion of the service while other funding sources for the remainder of the network are identified. The trade-off of implementing the service in phases is immediate start-up of some service versus the benefits of economies of scale of the entire system. A summary of these alternatives is discussed next.

Service Within the BART District

The commuter rail service could initially be provided within the BART District only, including Contra Costa and Alameda counties. This would minimize institutional constraints and maximize immediate service implementation. For instance, service could be provided in the North Bay Corridor between West Oakland and Martinez and Brentwood, in the South Bay Corridor between West Oakland and Fremont, and in the Altamont Corridor between Livermore and Fremont. Service in the South Bay Corridor would parallel and augment existing BART service along the Fremont line with express service (BART serves 10 stations and Commuter Rail would serve 2 stations between Fremont and West Oakland) and provide additional capacity to a rapidly growing travel corridor.

This alternative would prohibit service to other areas where passenger demand is high (i.e., Solano, Santa Clara, and San Joaquin counties). In addition, providing service within the BART District only would limit transit coordination and integration opportunities.

Service Within a Single Corridor

A single corridor (e.g., the North Bay, South Bay, or Altamont Pass) could be identified for near-term implementation. This corridor would be selected on the basis of its operational, economic, and political feasibility to begin service sooner than in other corridors. For instance, as community consensus and support develops within a corridor, funding could be identified to initiate service in that corridor.

This alternative would have to address institutional and jurisdictional constraints that could delay service initiation. Also, the previously identified economies of scale could not be realized with single-corridor service.

Service on Selected Alignments and Segments

Service could be implemented on selected alignments and segments only. For instance, service may initially be implemented in the North Bay between Suisun City/Fairfield and West Oakland, in the South Bay between Union City and San Jose, and in the Altamont Pass between Livermore and San Jose. These alignments and segments could be operated as an initial phase individually or as a system that could be developed into the comprehensive regional system.

As with single-corridor service, this alternative would limit the ability to maximize cost savings through economies of scale. In addition, the service plan would limit opportunities for regional transit integration and coordination.

Comparative Analysis

This section compares the BART Commuter Rail Program with (*a*) rail transit projects in the Bay Area and (*b*) new-start commuter rail systems elsewhere in the United States. The purpose is to test the level of performance and the feasibility of the BART Commuter Rail Program

TABLE 7 Proposed Rail Transit Projects in San Francisco Bay Area

Proposed Rail Transit Project	Implement Schedule	Capital Costs [1994 $]	length [km]	Annual O&M Costs[1994 $]	Annual ridership [Yr 2010]	Capital costs per km [$/km]	O&M Costs per rider [$/trip]
Tasman LRT[1]	5 years	$494.4M	19.3	$20.4M	1.48M	$25.62M	$13.88
BART Warm Springs Extension[2]	5 years	$540.9M	8.7	$11.3M	2.12M	$62.17M	$5.23
BART Commuter Rail-South Bay[3]	2 years	$50.5M	35.4	$2.60M	1.00M	$1.43M	$2.60
BART Commuter Rail[4]	2 years	$339.8M	322.0	$17.2M	3.73M	$1.06M	$4.61

M = million(s); km = kilometer(s); O&M = Operating and maintenance

[1] Locally Preferred Alternative identified in *Tasman Corridor Final Environmental Impact Statement/Final Environmental Impact Report (December 1992)*. All costs were adjusted to 1994 dollars by applying a 3% annual escalation factor.

[2] Alternative 5 (aerial in park design option) identified in *BART Warm Springs Extension Final Environmental Impact Report (November 1991)*. All costs were adjusted to 1994 dollars by applying a 3% annual escalation factor.

[3] Segment of BART Commuter Rail Program-South Bay Corridor (Union City-San Jose) that would serve a similar region as the proposed Tasman LRT and BART Warms Springs Extension projects.

[4] BART, 1994.

against other modes and similar commute rail systems nationally.

Analysis of Proposed Rail Transit Projects

Table 7 provides a comparison of current proposed rail transit projects in the Bay Area. The figures appearing in the table were obtained from published planning and environmental documents (*10,11*). The Tasman LRT (Light Rail Transit) project would provide rail transit service in the north San Jose area, whereas the BART Warm Springs Extension would provide BART (heavy rail) transit service to southwest Alameda County via a southern extension from the existing Fremont BART Station (*10,11*). For purposes of this analysis, these projects are compared with the entire 322-km (200-mi) BART Commuter Rail Program and to a segment of the BART Commuter Rail South Bay Corridor (Union City–San Jose). The segment of commuter rail between Union City and San Jose is 35.4 km and would serve a region and passenger market similar to those of the other proposed projects.

The comparative information for the proposed regional projects includes implementation schedule, capital/construction costs, system track length, annual costs to operate and maintain the service (O&M costs), and annual ridership. All costs were adjusted to 1994 levels by applying an escalation factor of 3 percent per year. As indicated in Table 7, commuter rail (either the 322-km system or the 35.4-km South Bay Corridor segment) could be implemented in less time than the other proposed rail transit projects at about 5 percent of the capital cost per kilometer and about 20 percent of the operating and maintenance cost per rider.

Comparing the feasibility and effectiveness of commuter rail with a highway project is more complicated. However, in terms of capital cost, the BART Commuter Rail Program appears to be cost-effective. The range of costs for 1 km of a freeway lane can vary from $1.68 million (based on a recent study prepared by Northern Virginia Transportation Commission) (*12*) to as high as $25.76 million (for a stretch of I–80 between Alameda and Contra Costa counties) (*13*). These costs are significantly greater than the capital costs of $1.06 million per kilometer for the proposed BART Commuter Rail Program.

In terms of performance, commuter rail also compares favorably with highways. The peak-hour capacity of an additional mixed-flow Interstate highway lane is estimated to be about 1,955 persons per hour (1,700 vehicles/peak hour × 1.15 persons/vehicle); that of a high-occupancy vehicle (HOV) lane is about 4,000 persons per hour (1,700 vehicles/peak hour × 2.35 persons/vehicle) (*14*). The operating peak-hour passenger capacity of the BART Commuter Rail Program can be as high as 3,480 persons per hour (6 trains/hour × 4 cars/train × 145 seats/car). Therefore, the peak-hour throughput capacity of the BART Commuter Rail Program is greater than a mixed-flow highway lane and approximates an HOV highway lane at a fraction of the estimated capital cost.

Comparison of Existing New-Start Commuter Rail Systems

Table 8 compares the effectiveness and feasibility of the proposed BART program with existing commuter rail systems that have begun service within the last few years in the United States (telephone interviews with staff at Virginia Railway Express, Tri-Rail, and Metrolink, April 1995). New-start commuter rail systems were selected to avoid any bias or prejudice that would result from using

TABLE 8 Comparison of New-Start Commuter Rail Operating Performance Measures, Fiscal Year 1994

Performance Measures	BART	VRE[1]	Tri-County[2]	Metrolink[3]
Data				
Annual O&M Costs	$17.20M	$11.82M	$20.89M	$42.90M
Annual ridership	3.73M	1.80M	2.91M	4.60M
Annual revenues	$5.16M	$7.49M	$5.18M	$11.00M
Passenger-km	173.39M	92.61M	155.65M	277.42M
Vehicle-km	2.65M	1.55M	3.95M	4.84M
Performance Indicators				
Annual O&M cost/rider	$4.61	$6.57	$7.17	$9.33
Annual subsidy/rider	$3.23	$2.41	$5.39	$6.93
Fare-box ratio	30.0%	63.3%	24.8%	25.6%
O&M cost/vehicle-km	$6.49	$7.63	$5.29	$8.86
O&M cost/passenger-km	$0.10	$0.13	$0.13	$0.15
Passenger-km/vehicle-km	65.43	59.75	39.41	57.32
Revenue/vehicle-km	$1.95	$4.83	$1.31	$2.27

M = million(s); km=kilometer(s); O&M=Operating and maintenance
1. Virginia Railway Express, Virginia; Stafford, Prince William, Fairfax, and Arlington counties.
2. South East Florida; Palm, Dade and Broward counties
3. Southern California; Riverside, Ventura, San Bernardino, Los Angeles and Orange counties

Source: BART, Northern Virginia Transportation Commission (NVTC), Tri-County Commuter Rail Authority, Southern California Regional Rail Authority (SCRRA), 1995.

performance measures of older, established systems that serve mature markets. According to Table 8, the projected performance indicators for the BART Commuter Rail Program are within the range, or better than, the levels experienced by new-start commuter rail systems throughout the nation. For example, the annual operating and maintenance cost per rider for the BART Commuter Rail Program is $4.61, which is considerably less than the other new-start systems, which range between $6.57 and $9.33. However, BART's revenue per vehicle kilometer is $1.95, which is within the range ($1.31 to $4.83) of the other systems.

Conclusion

Some may view the BART Commuter Rail Program as regressive in terms of state-of-the-art transit technology and the elimination of established and committed local projects. However, the analysis summarized in this paper has shown that commuter rail for the Bay Area is a progressive solution that provides a cost-effective and near-term transportation system that will relieve the region's most congested travel corridors and could be compatible with other transportation projects.

An initial evaluation of the BART Commuter Rail Program indicates that commuter rail could begin service within 2 years after funding sources have been secured. Short-term implementation is possible because the infrastructure and facilities can support service today. With a relatively small capital investment (compared with new highway and rail projects), the Bay Area could profit from a safe, reliable, and efficient regional commuter rail service. The BART Commuter Rail Program would be coordinated with existing regional transit services and would provide an integrated regional transportation system.

Compared with other proposed rail transit and highway expansion projects in the region, the BART Commuter Rail Program is a financially feasible and effective transportation option that can provide additional travel capacity in the near term. The expected operating performance of the BART regional commuter rail service is within the industry range of performance levels experienced by new-start commuter rail systems across the nation.

Funding for the BART Commuter Rail Program has not been identified. However, BART, in coordination with other local, regional, and state agencies and other interested parties, is developing strategies to identify

funding options. The options include highway construction mitigation funds, state and federal rail funds, and local sources. BART is confident that the funding and institutional challenges facing commuter rail can be overcome by building consensus and an understanding of the benefits of commuter rail compared with the true costs of other projects, and that commuter rail will be a reality in the near term.

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