Development of a Rail Transit Plan and Implementation Strategy for Los Angeles County

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In November 1980 the Los Angeles County Transportation Commission (LACTC) sponsored an initiative, locally known as Proposition A, to improve transit services. The initiative called for a half-cent sales tax increase throughout the county. The proceeds from the tax would go toward reducing bus fares, improving local jurisdictions' transit services, and building a countywide rail transit system.

From January 1983 to July 1984 the commission developed a basic plan for a systemwide rail network and began its implementation. The purpose of this paper is to summarize how this was done.

APPROACH

The task was approached in three stages, each one logically evolving into the next. The starting point was the Proposition A ballot map, the "Future Rail Transit Network." In broad strokes, it outlined 13 generalized transportation corridors. The rail lines for two of the corridors were already known. The Metro Rail subway had previously been identified by the Southern California Rapid Transit District (SCRTD) and the Urban Mass Transportation Administration as the appropriate transit mode to improve transportation services in its densely populated corridor.

In addition, LACTC had already studied a light rail line from Long Beach to Los Angeles that would connect with the Metro Rail. LACTC had contemplated building the line whether or not Proposition A was validated.

Because it was realized that rail transit projects could not be built in all 13 corridors within the foreseeable future, the first step was to designate certain high-priority corridors. These corridors warranted rail transit service in the near term. Relevant statistics were derived for the 11 corridors from past studies and future projections. The corridors were then stratified using criteria in the draft regional transportation plan prepared by the Southern California Association of Governments. In April 1983 LACTC adopted six high-priority corridors.

The work in Stage 2 evaluated a number of possible rail routes and modes within the first five high-priority corridors. (The Century Freeway corridor was not evaluated at this point.) This work involved engineering studies, cost estimates, patronage forecasts, land use analyses, and the continued involvement of community officials and representatives. In October 1983 the commission adopted the representative route and mode for four of the corridors; in January 1984 it did the same for the fifth corridor.

By combining the five representative routes and modes with the Wilshire Metro Rail starter line, the Long Beach-Los Angeles light rail line, the El Monte busway, the Harbor busway, and the Century Freeway transitway, an interim system of rail lines and busways was formed. The first step in Stage 3 was to evaluate this system to better understand how it might operate, what design requirements would be needed where rail lines or busways intersect, and how the attractiveness of the system of routes might affect patronage estimates for the individual lines.

The second task in Stage 3 was to evaluate the system implications of either a busway-high occupancy vehicle (HOV) facility or a rail line-HOV facility within the Century Freeway transitway. This question was the only one not answered by the work of Stage 2 because, to evaluate it, the results of Stage 2 were needed.

The third step in Stage 3 was to take the estimated costs of all these rail lines and compare them with LACTC's projected revenue stream for rail capital. LACTC's ability to construct more of the Proposition A rail system depends on this, plus the order in which LACTC may wish to implement the segments of the system.

Thus an evaluation was also made of the cost-effectiveness of each segment. The ability of LACTC to construct more of the Proposition A rail system is directly related to the amount of Proposition A funds programmed for the two top-priority lines, especially the Metro Rail line. That, in turn, may depend on the level of federal funds committed to the Metro Rail, which is not known at this time.

STAGE 1--IDENTIFYING HIGH-PRIORITY RAIL CORRIDORS

The work in Stage 1 progressed as follows: First LACTC staff reviewed previous technical reports to derive future congestion levels, transit patronage, and costs. Demographic and land use information was added. A set of criteria developed by the Southern California Association of Governments (SCAG), the

local metropolitan planning organization, was then used to rate each corridor. The results were discussed with other county transportation agencies and local jurisdictions, and recommendations were made to select the high-priority corridors.

Review of Previous Studies

Instead of starting from scratch and spending a great deal of time and money studying innumerable rail routes, previous technical reports (from 1968 to the present) were used to derive basic information on rail transit alignments within Los Angeles County. The reports varied tremendously in scope, detail, and technical method. The following technical analyses were the most consistent: rail patronage, costs, and corridor congestion (Table 1); other analyses that complement the more technical issues with recent socioeconomic and land use information were added.

For the remaining variables in Table 1--growth centers per route mile, land use distribution, and 1980 transit dependents--there was current information. To develop the ranges given in the table staff calculated the mean and standard deviation of the values for each variable in each of the 13 corridors. Ranges were then determined on the basis of the variation from the mean.

For example, SCAG had done a projected volume-capacity analysis for the year 2000 within corridors similar to the Proposition A corridors. Where one of the rail transit routes in a corridor (whatever its validity as long as it had been previously studied) crossed a screenline, the projected volume-to-capacity (V/C) ratio would be noted. The average future V/C ratio was calculated and these were arranged. The top four corridors were noted.

Criteria for the Selection of Corridors

Definitions of the three system criteria used to select high-priority corridors follow. These criteria were taken from the draft document of SCAG's Regional Transportation Plan. Included, as appropriate, is an indication of how they are measured.

1. Support development of centers. A basic objective of both the Los Angeles County and the Los Angeles City general plans is the connection of centers of high population or employment by transit lines. The criteria used is the number of centers a rail line would traverse in a given corridor on a per mile basis. The Los Angeles County and the Los Angeles City general plans were used to determine the number of centers in each corridor. These plans defined centers as a high concentration of employment, residential, recreational, and service facilities within a confined geographic area.

2. Relieve capacity deficiencies. This is perhaps the most important priority of SCAG's Regional Transportation Plan. The SCAG 1982 Regional Line Haul Study year 2000 highway volume-to-capacity ratios were used to indicate those corridors likely to have the most traffic congestion. The higher the V/C ratio the more needed is a transportation improvement.

3. Promote balanced subregions. Promoting balanced subregions means encouraging travel within a subregion instead of travel between subregions, which reflects long commuter trips as opposed to downtown-oriented commuter trips. Selected land uses and transit dependency were used as a reflection of this criterion.

The land use distribution score indicated in Table 1 was based on architectural traffic engineers' land use automobile trip generation factors adjusted for transit mode. Land use distribution for each corridor was derived from the Los Angeles County Assessor's parcel computer files.

The higher the density of mixed residential and commercial uses in a corridor, the greater the amount of potential intrasubregion travel. Staff also used the number of transit-dependent riders, assuming that a corridor that has more transit-dependent riders would probably have more intracorridor travel.

The data in Table 1 indicate which corridors scored the highest in each of the criteria. From this table (supplemented by reviews by other Los Angeles County transportation agencies and local jurisdictions) the commission adopted the following high-priority corridors (in addition to the Metro Rail and Long Beach-Los Angeles corridor):

- Pasadena,
- San Fernando Valley (east to west),
- Santa Ana,
- West Los Angeles (east to west),
- West Los Angeles (north to south), and
- Century.

STAGE 2--IDENTIFYING "REPRESENTATIVE" ROUTES WITHIN THE HIGH-PRIORITY CORRIDORS

The first step in Stage 2 was to derive possible rail alignments that might serve the rail transit

TABLE 1 Results of Technical Analysis

Corridor	Congestion (200 V/C ratio)	Cost per Mile Capacity (millions of 1982 dollars)		Patronage (daily boardings in year 2000)	Growth Centers per Route-Mile	Land Use Distribution Score	1980 Transit Dependents (percentage of population)	Percentage of Line Existing Facilities
		High	Low					
Century	1.5-1.8[a]	16-35	<15	61,000-100,000	<.25	<30	>3.00	100
El Monte	1.0-1.2	16-35	<15	61,000-100,000	.25-.50	30-50	<1.75	100
Exposition	1.2-1.5		<15	<30,000	>.50[a]	30-50	>3.00	100
Glendale	1.0-1.2	36-60	16-35	<30,000	<.25	>50[a]	>3.00	50-99
Harbor	1.0-1.2	36-60	16-35	61,000-100,000	.25-.50	30-50	>3.00	100
Pasadena	1.0-1.2	16-35	<15	61,000-100,000	.25-.50	>50[a]	1.75-3.00	100
Route 2	1.0-1.2		16-35	<30,000	>50[a]	>50[a]	1.75-3.00	50-99
San Fernando (E/W)	1.0-1.2	36-60	<15	31,000-60,000	.25-.50	<30	1.75-3.00	100
San Fernando (N/S)	1.2-1.5	36-60		31,000-60,000	<.25	<30	<1.75	50-99
Santa Ana	>1.8[a]	36-60	16-35	61,000-100,000	<.25	<30	<1.75	50-99
South Bay/Harbor/Long Beach	1.2-1.5	36-60		<30,000	.25-.50	30-50	<1.75	50-99
West Los Angeles (N/S)	1.5-1.8[a]	36-60	16-35	<30,000	>.50[a]	>50[a]	1.75-3.00	<50
Wilshire West	1.5-1.8[a]	>60		>100,000	>.50[a]	>50[a]	>3.00	<50

[a]Top-rated corridors.

needs of each high-priority corridor. These were selected using past studies and consultation with representatives of both local jurisdictions and transportation-oriented community groups. Any reasonable rail alignment suggested was included and became a candidate for detailed study. When these candidate routes had been agreed on, staff drove along each route and appraised it for engineering feasibility and rough cost-effectiveness. The intent of this step was to eliminate (from further, more detailed, and costly study) those candidate rail routes that were agreed to be in some way infeasible. Six routes of the 26 candidates were dropped at this point. The alternative rail routes that remained were then studied in some detail.

Engineering and Costs

Estimates were made of the civil construction that would be necessary to build each alternative. Included were any necessary street improvements, grade separations, and major railroad or highway relocations. On the basis of this engineering work, cost estimates were prepared for each route. Another phase of the work involved the estimate of future patronage for each route. A final effort involved assessing the land use along each alternative route for the dual purpose of determining its ability to attract a range of trip types and its possible community impacts.

Ridership Estimation

The purpose of the patronage modeling effort was to give LACTC staff an estimate of the potential ridership demand each rail alternative would have, assuming the alternatives would be operating in the year 2000. To build the transportation system, SCAG constructed a "baseline" highway and transit network to which each alternative was added. The baseline rail network consisted of the Metro Rail, the Long Beach-Los Angeles light rail line, and the Century Freeway transitway that was coded for bus or rail vehicles.

This procedure estimated the year 2000 ridership for all alternatives. The model necessarily emphasizes work trips because much more is known about travel patterns for these trips than about those for shopping or recreational trips. Daily ridership was obtained by factoring work trip volumes by an overall average factor that is known. In some cases this procedure may overestimate or underestimate expected trips. In any case, the procedure was identical for all alternatives.

Land Use Assessment

This work focused on generalized land use impacts and development potentials of route alternatives in each corridor. Specific impacts were not evaluated because the precise alignments of the alternative routes were not known. Maps were prepared that illustrated the 10 uses along each route. The city and county then estimated the percentage of residential, industrial, and commercial uses that the route passed through.

Community Involvement

The LACTC community involvement program for the Rail Transit Implementation Strategy used a hierarchy of organizations to represent different levels of community interests for different phases of the strategy. In Stage 1, determining high-priority corridors, LACTC worked with regional-level community groups, agencies, and politicians to discuss the countywide development of the rail system. In Stage 2 groups that had interest in the general location of the rail line within a corridor were identified and asked to help select a representative route within the corridors. These local jurisdictions, chambers of commerce, political representatives, and other community groups approved the "representative" routes chosen in the Stage 2 process.

Selection of Representative Routes

Table 2 gives a summary of the cost-effectiveness, land use, and community support of the alternative

TABLE 2 Summary Comparison of Alternative Routes

Corridor and Route	Cost-Effectiveness[a]	Land Use Support[b]	Community Support[c]
San Fernando Valley (E/W)			
A1. Burbank Branch (HRT)	654,000	Fair	High
A2. Ventura Freeway (HRT)	502,000	Fair	Low
A3. Burbank Branch (LRT)	1,282,000	Fair	High
A4. Southern Pacific Main Line (LRT)	1,149,000	Poor	Low
West Los Angeles (E/W)			
B1. Wilshire Extension (HRT)	311,000	Very good	Very high
B2. Wilshire/Santa Monica (HRT)	240,000	Good	Medium
B3. Route 2 (LRT)	451,000	Fair	Medium
B4. Exposition (LRT)	581,000	Fair	Low
West Los Angeles (N/S)/South Bay			
C1. South Bay Trolley (LRT)	685,000	Good	Medium
C2. Marina/Atchison, Topeka, and Santa Fe Railroad (LRT)	586,000	Very good	Very high
C3. Marina/Imperial (LRT)	305,000	Fair	Low
C4. I-405/Sepulveda (HRT)	193,000	Fair	Low
Santa Ana			
D1. East Los Angeles/Atchison, Topeka, and Santa Fe Railroad (HRT)	324,000	Good	Medium
D2. Santa Ana Freeway (HRT)	481,000	Fair	Medium
D3. Yorba Linda (LRT)	377,000	Fair	Low
D4. Fairestone/Union Pacific Railroad (LRT)	425,000	Good	Medium
D5. Firestone (LRT)	348,000	Good	Low
E1. El Monte/Route 7 (LRT)	800,000	Fair	Medium
E2. Lincoln Heights/Route 7 (LRT)	513,000	Good	High

[a]Based on 1983 annualized costs not including vehicle or yard costs that may be shared between two lines. The figure indicates the number of annual riders attracted by each $1 million in capital investment.

[b]Based on route's ability to support or foster development of centers.

[c]Based on discussions with officials of corridor cities and others in the working groups involved in the study as interpreted by commission staff.

routes within each high-priority corridor. On the basis of the results shown in this table and in collaboration with the community groups working with LACTC, LACTC selected the following candidates as "representative" routes in the high-priority corridors. Modes were light rail transit (LRT) or heavy rail transit (HRT).

Corridor	Recommended Route and Mode
San Fernando Valley (east to west)	A3 Burbank Branch (LRT)
West Los Angeles (east to west)	B1 Wilshire Extension (HRT)
West Los Angeles (north-south) to South Bay	C2 Marina/ATSF (LRT)
Santa Ana	D2 Santa Ana Freeway (HRT)
Pasadena	E2 Lincoln Heights/Rte 7 (LRT)

Figure 1 shows the overall network formed by combining these high-priority lines.

STAGE 3A--SYSTEMWIDE OPERATION OF THE INTERIM SYSTEM

A systemwide operating plan was developed for the full interim rail system including a Century Freeway rail line and a connection to an Orange County light rail line. The approach taken was to assume a certain preliminary operating plan, to estimate line patronage levels on the basis of this plan, and then to modify the plan on the basis of the initial patronage results. A final operating plan was then assumed and the ridership estimates recalculated. Table 3 gives a summary of the findings on headways, train size, and fleet size by routings.

The operations analysis also provided guidance on how intersecting rail lines should be treated to allow convenient transferring and easy maintenance. It pointed out where demand, due to greater accessibility, begins to exceed the initial concept for the line.

When such a case occurred, additional costs were added to the estimate for that route. This information is used in the financial model first. As each line advances to preliminary engineering much more work will be done to determine and cost out grade separations. In no case was a light rail line clearly infeasible because of higher demand loads than were initially projected.

STAGE 3B--CENTURY FREEWAY TRANSITWAY

The Century Freeway crosses west-to-east through the Los Angeles Basin from just south of the Los Angeles

FIGURE 1 Network of high-priority lines.

TABLE 3 Conceptual Operating Plan Summary for Full Interim Rail Transit System[a]

Routing	Peak-Hour Headways (min)	Train Length	Peak Fleet (with 16% spares)
Metro Rail			
North Hollywood-Norwalk	3.5	6	195
Santa Monica-Norwalk	3.5	3	143
Total Metro Rail fleet			338
Light rail			
Long Beach-Los Angeles			
Long Beach-Route 7/Colo. Blvd.	9	3	55
Compton-Route 7/Colo. Blvd.	9	2	28
Compton-Pasadena	9	3	45
Subtotal			128
Century, Norwalk-Torrance	6	3	38
Coast, Marina-Palos Verdes	8	1	11
San Fernando Valley, Chatsworth-North Hollywood	3.5	3	63
Total light rail fleet			240

[a]Based on probable maximum ridership.

International Airport to the San Gabriel Freeway in Norwalk. It has been a contested project since its inception. To help move the project forward, the presiding court issued a consent decree in September 1981 that included certain design features. Chief among these was the requirement to incorporate a transitway within the median of the freeway. The transitway was to be constructed as a bus-HOV facility, designed for convertibility to light rail, or, if funds were committed for the extra cost, the transitway could be constructed initially as light rail. The method LACTC staff used to determine whether a rail line or a bus facility should operate in the transitway when the freeway opens is described in this section.

The first step in the analysis was to develop an agreed-on operating plan specifically for the Century-Harbor busway subsystem. Patronage projections were then calculated. These projections were next translated to vehicle requirements and a total operating cost calculation was derived from required vehicle-miles of operation. This was done for both alternatives.

Meanwhile required design elements were developed for both the busway-HOV and the light rail alternatives. These served as the basis for calculating the capital costs for each alternative. The cost of later converting a busway-HOV facility to light rail was also estimated and the specific construction impacts were described.

The results of the evaluation were as follows: (a) the difference in patronage estimates between the bus and the rail alternatives were not significant when compared to the accuracy of the patronage forecasting process itself; (b) the total net cost increment to initially build rail on the Century transitway is $133 million; and (c) the light rail alternative, compared to the busway, may save up to $9 million a year in operating costs.

These findings were reviewed with LACTC staff members, regional agencies, and local affected jurisdictions. Twenty-two cities officially requested that the light rail line be built initially; no city opposed or favored the busway. On June 13, 1984, the commission committed the funds necessary to build the Century light rail line. It also authorized environmental clearance of its extension into the major aerospace employment center of Los Angeles.

Although construction does not start on this line until 1990, the freeway itself is in final design and early construction. LACTC has therefore started preliminary engineering of the 16-mi light rail line so that the California Department of Transportation (Caltrans) can incorporate the needs of the light rail line (mainly conduits) in its ongoing work. It should be emphasized that a busway convertible to rail is only really convertible if it is designed first as a rail project and only then as a busway.

STAGE 3A--FINANCIAL EVALUATION OF LIGHT RAIL LINES

Cost-Effectiveness and Financial Evaluation

There were a number of criteria that could be used to determine in what order the light rail lines should be built. Three of them were "least cost," "most passengers," or "greatest cost-effectiveness." The last one was chosen for presentation. Cost-effectiveness indicates how many annual passengers would be attracted systemwide by a certain level of capital investment. The level of capital investment is defined as the annualized cost of facilities, vehicles, and land. The annualized cost was calculated using a 7 percent discount rate, a 30-year lifetime for equipment, a 50-year lifetime for facilities, and no salvage value for equipment or facilities.

At the time this paper was written, the cost-effectiveness analysis had not been completed. However, for purpose of illustration, the way the analysis was to be carried out will be described. To derive cost-effectiveness, each line segment was to be added to a base transit system (composed of the Metro Rail starter line, the Long Beach-Los Angeles line, and the El Monte busway) and the increase in systemwide patronage and annualized cost determined. The most cost-effective segment was then to be added to the base system and all other projects added in turn as before. This procedure was to be repeated until all segments were ranked.

For the financial analysis each line was broken into segments that could be implemented incrementally. Separate cost-effectiveness indices were calculated for each of these line segments. To do this each line segment was added to the base transit system (the Metro Rail, Long Beach, and Century rail lines) and the increase in systemwide patronage determined. The most cost-effective segment was then added to the base system and all other project cost-effectiveness indices recalculated. The procedure is repeated until all segments are ranked.

This established a technically derived priority ranking but not a construction schedule. That depends on whatever financial policies may be selected.

The principal ones are (a) the extent to which the commission uses local funds to pay for the Metro Rail program, (b) the coverage ratio to be used for bonding, and (c) the speed with which the system is built. The financial model evaluates the implications of varying these and other policies for the commission's ability to construct the system faster. Any number of scenarios have been formulated and analyzed. Thus far no firm decisions have been made primarily because of continued uncertainty about the Metro Rail project. However, these finds have been made:

1. The commission can build up to 100 mi of light rail and rapid transit lines by the year 2000. Forty miles are now committed by 1992; added to Metro Rail's starter line, that would be 58 mi.
2. It is best for the overall program if progress is made continually and not in a burst of extensive construction. Debt servicing of the intense construction will constrain further building.
3. It is better to build the high-cost sections as soon as possible (the LRT downtown tunnel in particular) to lessen the effects of escalation. However, such sections should be constructed incrementally.
4. Because of their cost, extensions of the Metro Rail starter line will require additional federal and state funds, which cannot realistically be expected to be committed before the Metro Rail is well into construction. Incremental extension of Metro Rail both to the east and to the west will be pursued as fast as federal funding permits.