Pre-Feasibility Study of an Integrated Mass Transit System to Reduce Commuter Congestion and Air Pollution in San José, Costa Rica

Prepared for:
Compañia Nacional de Fuerza y Luz
San José, Costa Rica

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U.S. TRADE AND DEVELOPMENT AGENCY
Washington, D.C.

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13. ABSTRACT (Maximum 200 words)
This study, conducted by ICF Kaiser, was funded by the U.S. Trade and Development Agency. The objectives of the report are the following: 1) develop a plan for an integrated transit system for San Jose; 2) examine various transport technology options; 3) maintain the goal of deploying as much electric technology as possible over time; and 4) provide a set of transit and technology options to the client so he can make informed decisions on which technologies to use in the short and long terms. Volume 1, which contains the main report, is divided into the following sections: Acknowledgements; Executive Summary; I) Background of and Introduction to the Study; II) General Concept of an Integrated Transit Solution; III) Ridership Demand Analysis and Forecast; IV) Environmental Feasibility Analysis; V) Economic Analysis of Transit Options; VI) Investor, Operator, and Supplier Survey Results; VII) Legal Issues; VIII) Seminar/Workshop Results and Recommendations; IX) Revised Costs for Busway, ETB, and LRT Projects; X) Concession Approach; XI) Recommendations and Next Steps. The appendices are contained in Volume 2.

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Executive Summary

Introduction, Background, and Approach

This study was co-funded by the U.S. Trade and Development Agency (TDA), part of the U.S. State Department, which serves as an export promotion facility for the U.S. Government. ICF Kaiser International, Inc. (ICF Kaiser) contributed equal amounts to the performance of the study. The sole interest in this project by the U.S. Government is to develop it to the point at which there is an opportunity for U.S. companies to participate in some way in the project, through either the provision of equipment and supplies or additional consulting assignments. There has been no agreement by the Costa Rican client to purchase any U.S. products or services beyond this immediate consulting assignment.

The study was developed during the summer of 1996 jointly by ICF Kaiser and by a special task force in San José, consisting mainly of representatives from Compañia Nacional de Fuerza y Luz (CNFL), to study the potential for the introduction of various forms of electric transport into San José.

The objectives of this study are to:

- develop a plan for an integrated transit system for San José
- examine various transport technology options
- maintain the goal of deploying as much electric technology as possible over time
- provide a set of transit and technology options to the client so he can make informed decisions on which technologies to use in the short and long terms

With nearly 60 percent of the nation's population concentrated in the San José valley, which covers only 4 percent of the country's area, with about 1.2 million passenger trips each day, with over 70 percent of the daily commuters dedicated to the use of existing bus services, and with the current radial system of inbound and outbound corridors generating dense focal points of congestion, there is a serious need for the development of an integrated transit plan that simultaneously recognizes the following interests and constraints:

- shorter commuting times
- cleaner air
- cost effective transport
- use of existing infrastructure, if possible
- lack of government subsidies

This is a challenge in any city and especially in San José where there is a great concern for the quality of the environment.

To meet this challenge, ICF Kaiser established five general principals on which the overall transit system design is based. In particular, these principals include the effective use of the INCOFER right-of-way (ROW) as an available corridor that can provide a high capacity route to both the Atlantic Station and the Pacific Station, while retaining the ROW for all possible technologies including electric trolley buses and electric light rail systems (LRT).

The five principals of an integrated transit system for San José are:

- High capacity transit in the railway ROW
- Suburb-to-suburb connections (*diametrales, intersectorales*)
- Downtown San José / suburban areas major bus lines with potential for electric trolley bus service
- Feeder bus services outside the downtown area
- Circulators/shuttles in the downtown area

The ICF Kaiser team discussed these components with representatives of CNFL, INCOFER, MOPT, INVU, Municipality fo San José, and representatives of the bus operation over a 3-day period (12-14 March, 1997) and arrived at an agreed definition of the system.

Also taken into consideration was the fact, based on survey data, that many of San José's commuters do not need to go into the heart of the downtown area.

Origin/Destination	Percent of bus riders going to/from San José
San Pedro	36%
Paso Ancho	44%
Tibas	41%
Desamparados	36%
Pavas	36%

Additionally, on the *diametral* corridor, such as San Pedro - Pavas, the vast majority of the passengers transit the entire East-West length (57%), with less than 20% of the passengers exiting at San José.

While the client for this study was the Unidad de Transporte Electrico, set up within CNFL for the purpose of studying the feasibility of introducing electric transportation options into the general picture of commuter transit in San Jose, the ICF Kaiser study team and the Costa Rican team jointly decided, following discussions with The World Bank, to include other non-electric technologies in the evaluation.

The technologies evaluated in the study were:

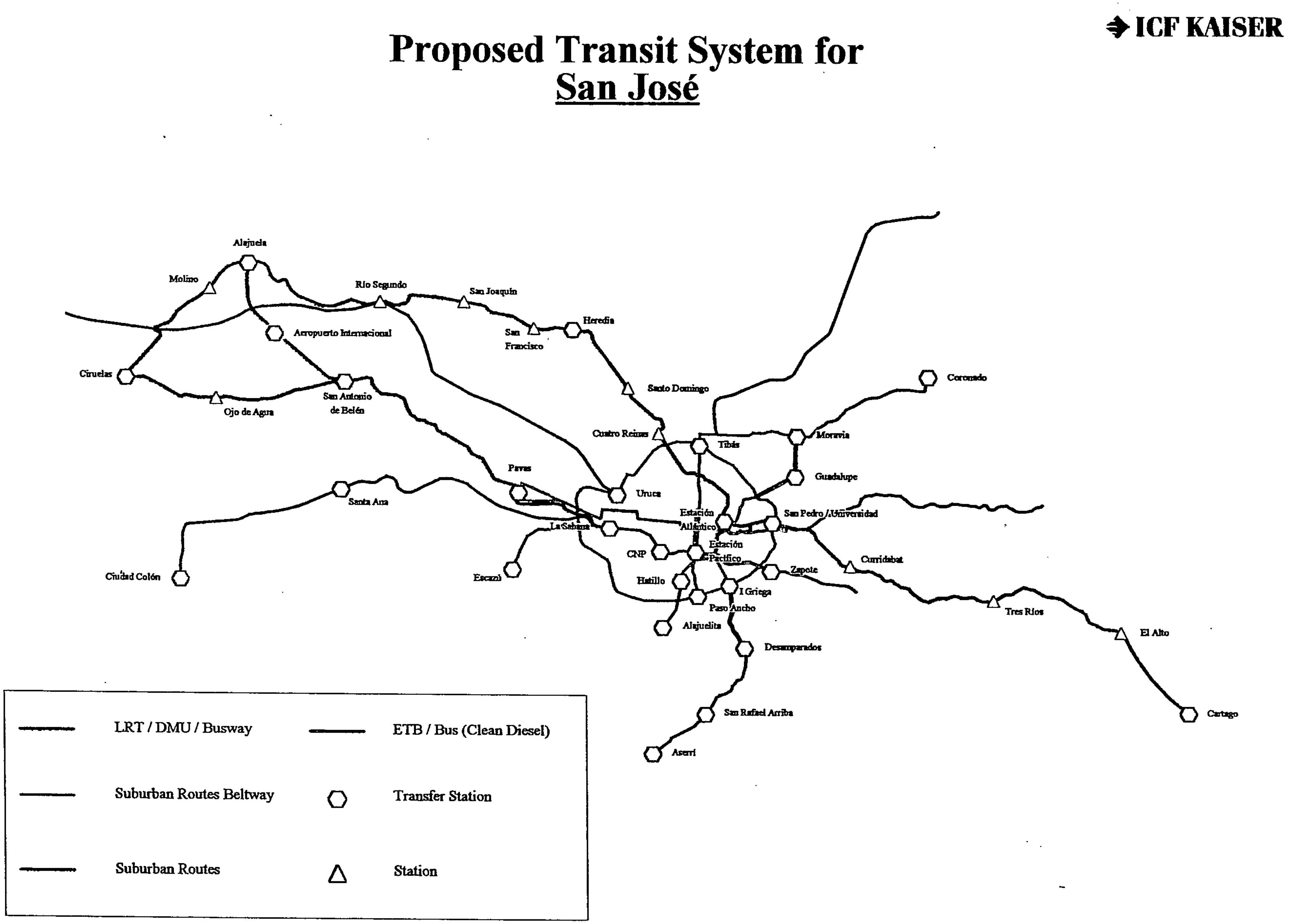
- Electric light rail train (or tram), (LRT)
- Diesel Multiple Units, which require tracks but are individually powered (DMU)
- Busway for clean diesel buses (exclusively)
- Electric Trolley Buses (ETB)

Not all technologies apply to all the routes of the proposed integrated transit system. The following table shows the particular technologies that were evaluated in each of the routes.

		Technology/Approach		
Component	**LRT/TRAM**	**DMU**	**Busway**	**ETB**
•Heredia to San Pedro	X	X	X	X
•Alajuela to San Pedro	X	X	X	X
•Alajuela to Cartago	X	X	X	X
•San Antonio de Belen to Pacific Station	X	X		
•Pavas to Pacific Station	X	X		
•Ciruelas to Pacific Station	X	X		
•Alajuela to Pacific Station *(via Ciruelas)*	X	X		
•Alajuela to Pacific Station *(via San Antonio de Belen)*	X	X		
•Atlantic Station to Pacific Station - *Single Track*	X	X		
•Atlantic Station to Pacific Station - *Double Track*	X	X		
•Pavas - San Pedro *(diametral)*	X		X	X

The map on the next page shows the individual corridors which make up the "backbone" of the system. The railway ROW between Alajuela and Cartago was evaluated in terms of four potential technologies, as indicated in the legend, across three segments, as indicated in the table above. The line between Alajuela and Pacific Station that passes through San Antonio de Belen would include an underground station stop at the International Airport. The alternative route from Alajuela to the Pacific Station through Ciruelas would likely involve the transfer of the Pacific Station freight operations to a new facility in Ciruelas, thereby leaving the Pacific Station available purely for passenger traffic.

Proposed Transit System for San José



The proposed system is designed to:

- reduce the number of buses entering the downtown metropolitan area
- provide suburb-to-suburb connections that will not require a trip to the city center
- improve the capacity of particular routes and shorten transit times
- provide downtown maneuverability through (electric/low emission) shuttle buses
- preserve the flexibility to use various technologies including electric powered vehicles and systems

The concept of using electric shuttles or circulators in the downtown metropolitan area has been under discussion and review for some time. The first battery powered electric bus, from Advanced Vehicle Systems of Chattanooga, Tennessee, was delivered to San José on 1 May, 1997. Such circulators would serve only the downtown area. In some U.S. cities such services are provided free of charge, but these are heavily subsidized by the city government. In San José, downtown shuttle fares will have to be set so that operators of such services can make a profit and have an incentive to hold down their costs.

A two-day seminar/workshop co-sponsored by ICF Kaiser and CNFL, was held on 16-17 April, 1997, at the Hotel Bougainvillea in Santo Domingo de Heredia. Each of the following groups were represented:

- Municipality of San José (city government)
- the Costa Rican Government
- INCOFER, the railway company
- CNFL, the national power distribution company
- MOPT, the Ministry of Transport and Public Works
- Camara de Transportistas and Camara Nacional de Transportistas, , the principal association of private bus operators
- INVU, Instituto Nacional de Vivienda Urbanismo

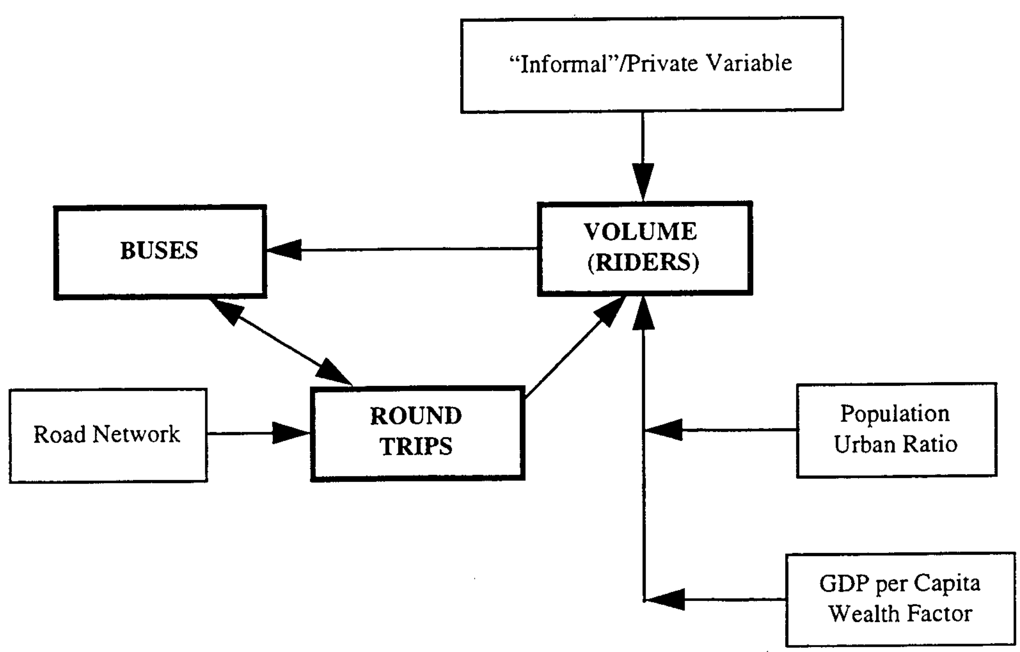
Over 40 individuals attended.

It is important to note that the group ranked 6 criteria in terms of the importance for the development of an integrated mass transit system in San José. These criteria, and their ranks, as shown below, clearly indicate that the *cost* of the system is the most important aspect of any proposed technology, followed secondly by *the impact on the environment.*

Criterion	Average Rank	Final Rank
Economics (cost)	32.5	1
Environmental Impact	16.2	2
Legal Considerations	15.2	3
Rider Appeal	13.8	4
Feasibility of Early Implementation	11.2	5
Reduction in Oil Imports	11	6

The Costa Rican Government has made it clear that it will not subsidize any new transit system. Therefore, the capital and operating costs of any proposed transit system must be reflected in the ultimate fares charged to passengers. ICF Kaiser calculated the break-even fares that would have to be charged in order for the bus operator to cover his annualized capital costs and ongoing operating costs. Based on the above inputs from the workshop participants, such economic considerations that affect the passenger fare are twice as important as the environmental impact.

ICF Kaiser developed a sophisticated ridership demand model for San Jose using historical bus ridership data by corridor provided by MOPT. The model showed that bus operators respond to growing demand by adding more buses to the network in order to maintain service; however, the larger number of buses creates more congestion and, as a result, the number of passengers per bus decreases and it become more and more difficult to maintain the number of round trips per bus. The structure of the model is shown in the following diagram.

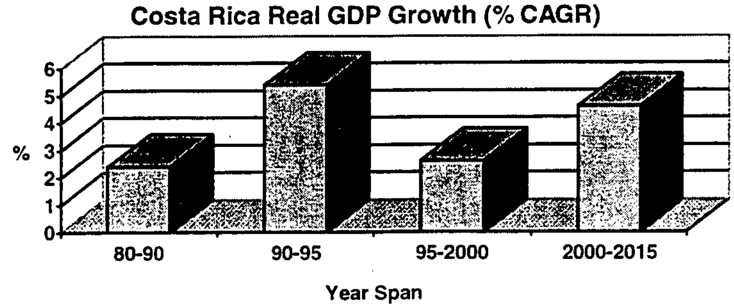


This modeling approach was used to forecast bus ridership in the key 14 routes under study. The forecasts were developed through the year 2015. In short, the model shows that ridership can be expected to grow at more than 4 percent per year on average across all routes, with some routes growing at only 3 percent per year and others at 4.8 percent. The differences in expected growth stem from variations in income levels and population growth rates along each route.

The macroeconomic outlook for Costa Rica was taken from the WEFA Group, a respected U.S. forecasting firm that has developed a forecasting model for Costa Rica linked to other country models throughout the world. The WEFA forecast for Costa Rica through 2015 calls for real GDP to grow more slowly over the 1995-2000 period than in the first five years of this decade. This slower growth is already evident in the recent economic data (1995, 1996).

Real GDP Growth (Compound Average Annual)			
Year			
80-90	90-95	95-2000	2000-2015
2.4	5.4	2.6	4.6

Costa Rica Real GDP Growth (% CAGR)



This macroeconomic outlook served as the driver of the demand projections using the ICF Kaiser model. This model is being delivered to the Costa Rica team for use in the future.

Study Results

A survey was carried out of U.S. based equipment suppliers and transportation service operators using a common questionnaire. Their responses concerning the idea of investing in a transportation project in Costa Rica are summarized in the following two tables. The first highlights areas of concern.

Risk Assessment

Area	*Level of Concern: 1=Low, 5=High* Average score
Government subsidy policy is not clear	4.25
Not clear who's in charge in the CR govt	3.75
Don't understand the legal issues	3.50
Currency Risk	3.25
Fear of next Govt changing the rules	3.25
Project not yet well-defined	3.25
Political shake-up's	3.00
Government expropriation	2.75
Inflexible labor laws	2.00
OTHER:	
Includes - project control, material specs logistics, labor force, return on investment	

The second table shows suggested areas of action.

Ranking of Suggested Actions

Suggestion	Level of Interest: 1=low, 5=high *Average Score*
The Govt must provide a clear long-term transport plan for SJ and indicate its willingness to carry it out	4.50
Get The World Bank involved in order to cover some of the country (sovereign), political, and currency risks	4.25
Results of solid analysis of the local market must be provided in the RFB	4.25
CR Govt would set up an autonomous agency to deal with SJ transport development, making the contracting simpler and transparent	3.25
Operating concessions for a Light Rail Transit system would be granted for only 10 years but would be renewable based on performance	3.00
Have a U.S. Project Manager with experience in urban transit projects of this type	2.75

From these responses, it is clear that the Costa Rican Government must have a long-term transit plan in place and express its commitment to carrying it out. This study provides a solid framework for such a plan.

Additionally, further analysis of the potential market demand for commuter transport services should be undertaken, according to potential investors. This study, again, provides a new approach to the demand modeling and forecasting.

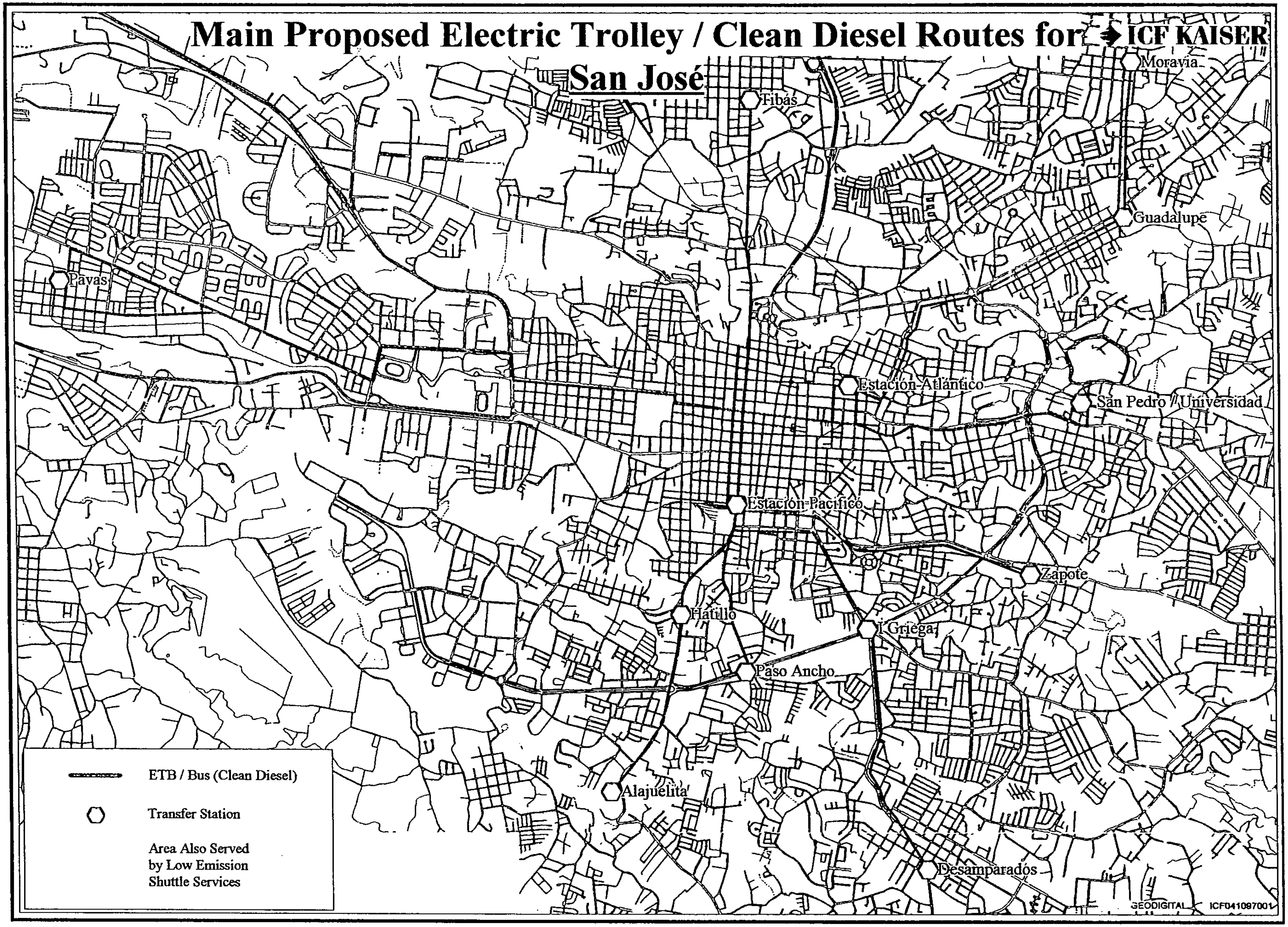
Due to the density of economic activity in the greater San Jose metropolitan area, the current mass transport system must be improved using the most feasible scheme in terms of cost, ease of implementation, and environmental improvement. Therefore, the following stages, based on the use of clean diesel buses, will help in the partial improvement of air quality.

Diametrales and Intersectoriales

As stated earlier, the proposed transit plan incorporates the concepts of *diametrales* and *intersectoriales*. These parts of the system should be implemented first, in these stages:

- Establish the corridor(s)
- Use the current buses (for now)
- Develop a program of fleet modernization
  - clean diesel technology
  - electric trolley buses
  - others (e.g. battery-powered)
- Demarcation of bus lanes
- Demarcation of bus station stops
- Development of information systems for traffic monitoring, etc.

The downtown San Jose routes that are potential for either ETB or clean diesel buses are shown in the attached map.


Main Proposed Electric Trolley / Clean Diesel Routes for
San José
ICF KAISER
Moravia
Tibás
Guadalupe
Pavas
Estación Atlántico
San Pedro / Universidad
Estación Pacífico
Zapote
Hatillo
I Griega
Paso Ancho
Alajuelita
Desamparados
ETB / Bus (Clean Diesel)
Transfer Station
Area Also Served
by Low Emission
Shuttle Services
GEODIGITAL
ICF041097001

INCOFER Right-of-Way

The next full-system development phases should focus on the INCOFER right-of-way (ROW), expanding its capacity and making it available for faster commuter transit into and out of San Jose.

Due to lack of urban space, congestion, pollution, the low level of infrastructure investment, and the high acceptance of the public to mass transit (75%), the development of bus lanes, whether on the ROW or on existing streets, should be encouraged.

The ROW is an important part of the greater metropolitan transit system and should be activated using an approach that is economically achievable in the short term. The details of this approach are outlined in Chapters VIII and IX, and the conceptual design of the busway for the first segment is provided in Appendix VIII.

The development of the ROW as a busway should be undertaken in the following stages:

- Implement busways by stages:
  - Heredia - San Pedro and/or Pavas - Pacific Station
  - Alajuela - Heredia (linking with above segment)
  - San Pedro - Cartago (extending Alajuela - San Pedro segment)
  - Alajuela - Pacific Station (two alternative routes suggested)
- Improve technology to electric trolley buses (ETBs) and light rail trains(LRTs) for the future

This approach, as discussed later in this report, preserves the ROW because it will retain the existing tracks, and it permits the near-term use of the ROW for commuters, initially using the existing buses but switching to cleaner technologies over time.

Cost of Technologies

A consistent approach to the estimation of costs was taken across all technologies and segments in order to assist in selecting an appropriate technology for both short-term and longer-term development phases.

Capital Costs

The capital costs involved in each of the technologies include physical projects such as the designing and constructing of a busway, the track materials required to revitalize the INCOFER ROW and to install an LRT, signaling systems, and various vehicle types such as clean diesel buses, LRT cars, or ETBs.

Methodology

For each of the 34 combinations of technologies and segments (routes), capital costs were developed using typical prices in the U.S. Since some capital cost items will, in fact, be lower in Costa Rica due to their higher labor content for installation and/or construction, ICF Kaiser adjusted such items by multiplying their U.S.-based values by 60%, which is a factor determined to reflect both lower labor rates and productivity in Costa Rica. It is the *adjusted* capital costs, therefore, that represent a better estimate of the costs in Costa Rica.

As an example of this adjustment, the capital costs associated with the development of an LRT from Heredia to San Pedro include the purchase of new track and also the rehabilitation of 4 existing bridges. The track costs are not adjusted since the majority of the cost is the purchase of the track outside of Costa Rica. However, the rehabilitation of the 4 bridges involves the potential use of a great deal of local labor; therefore, the estimated cost of this work, $500,000, was reduced to $300,000.

For each of the technology-segment combinations, the total capital costs were increased by 20 percent to reflect the expected cost of final design work, construction management, etc., for each project. Such a percentage is typical in U.S. work.

Similarly, a 25 percent contingency was applied to the total cost, including the design and construction management costs. This may appear high, but, at this early stage of the project formulation, when only 20% of the project has been designed (this was completed by ICF Kaiser for the busway option, Heredia-San Pedro), it is reasonable to make a 25 percent contingency assumption. This contingency assumption would be lowered later as further design work is completed and official bids on capital items are received. Also, for the purpose of this study, which was to provide a basis on which the Costa Rican team could begin to make informed, rationale comparative decisions between technologies and segments, it was principally important to use a consistent contingency factor throughout the analysis.

As part of the capital costs estimation, the expected life span of each item was included, and adjustments were therefore made to capture the fact that track will last 30 years while a new bus will last 12 years. In each of the capital cost sheets, the expected lifetimes of each item and the resulting adjusted cost are shown clearly. The adjustment for life span was made with the U.S. Federal Transit Agency (FTA) formula using a discount factor of 15 percent. In the case of the bridge rehabilitation, the Costa Rican cost of $300,000 resulted in an annualized capital cost of $76,150 given that the bridges are assumed to last 30 years.

Operating & Maintenance Costs

Operating and maintenance (O&M) costs include such items as fuel, maintenance of vehicles and related infrastructure, labor, overhead and administrative expenses, etc. These costs are typically a function of the rate at which a the transit system is operated and the technology employed.

Methodology

Using the assumed headways, vehicle sizes, numbers of round-trips, etc., ICF Kaiser calculated an O&M cost using factors supplied by the U.S. FTA. The O&M cost is basically a function of the technology and the number of kilometers of use per year. The following table shows the assumed O&M cost per vehicle-kilometer for each of the technologies studied.

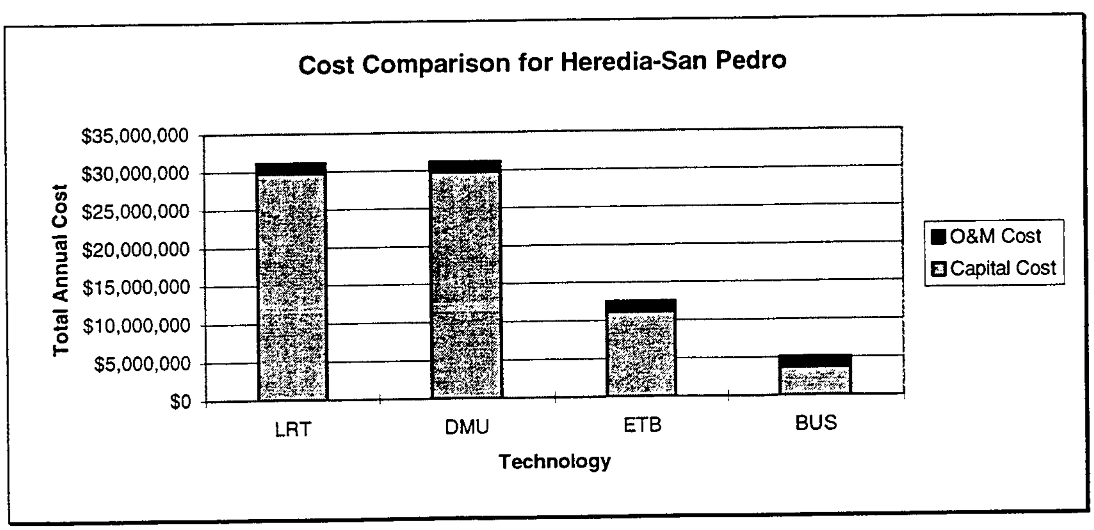
Technology	O&M Cost per Vehicle-Kilometer
LRT	US$2.41
DMU	US$2.21
ETB	US$2.29
BUS	US$1.23

For each segment (route) analyzed in the study, the expected annual vehicle-kilometers were multiplied by the above factor. It is clear that the O&M costs associated with operating buses are considerably lower than those for rail-based electric and diesel technologies (LRT and DMU) and for road-based electric trolley buses (ETBs).

Cost Comparisons

Total, annualized capital and O&M costs vary considerably across the four technologies studied. Additionally, the ICF Kaiser team assumed that, for each segment, the technology is financed completely through debt (i.e. no equity investment) and that there is no government subsidy. The team assumed that all of the initial investment was obtained at 10 percent interest rate through a loan with a maturity in 15 years. Therefore, annual costs include both the capital and O&M costs, as well as the interest payments on the debt. Also, all capital costs include a fee for design, project management, etc. (about 20% of direct capital costs) and a contingency of 25%, as mentioned above.

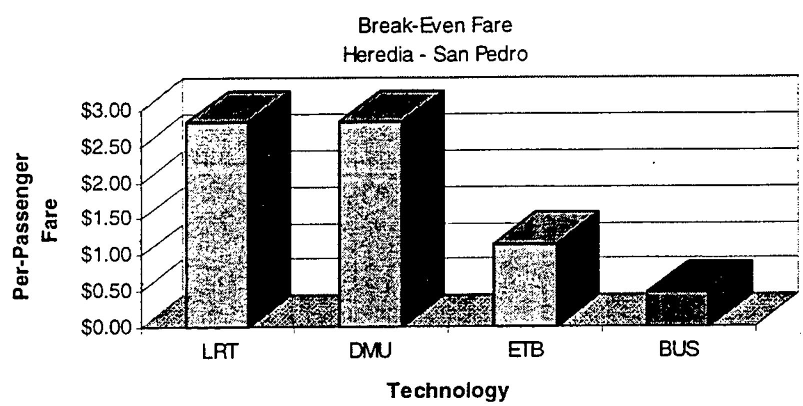
To show this variation across technologies, the chart below shows the individual capital (including interest) and O&M costs for each technology along the segment from Heredia to San Pedro.



It is clear that LRT and DMU costs are quite costly even though, in the case of the LRT, the track materials were assumed to be used, perhaps purchased from a U.S. railroad that is changing or upgrading its track. Along this particular INCOFER right-of-way, the ETB costs are those for the capital, O&M and interest costs assuming the construction of a 2-lane paved surface, on which the ETBs can operate. However, this cost is over double that of bus technology since the ETBs themselves tend to be expensive items, typically built to order. (Note: currently, lead times for delivery of ETBs is about three years.)

The ridership demand on each segment was calculated through the modeling exercise described earlier. Therefore, as an example, in the Heredia-San Pedro segment, each of the above four technologies results in a different fare requirement for the 11 kilometers between the two end points. Under the assumption that each rider travels the entire, the break-even fares required to cover all costs, including the financing costs, are in the same proportion as in the above chart. These break-even fares were calculated using a model developed by ICF Kaiser and delivered to the Costa Rica team.

For the Heredia - San Pedro line, the break-even fare is $2.82 (or almost 650 colones at 230 colones per dollar) for LRT service. Similarly, the total cost of each technology was calculated on each segment and the break-even fare was then determined. The break-even fare for each technology on the Heredia-San Pedro segment is shown in the chart below.



At 230 colones per dollar, the break-even fares for the four technologies on this line very considerably as shown in this table.

Technology	Break-Even Fare	
	U.S. Dollars	Colones
LRT	$2.82	650
DMU	$2.83	650
ETB	$0.77	178
BUS	$.47	107

The capital and O&M costs for LRT and DMU on all of the lines considered are considerably higher than the costs for bus options, and also for ETBs, although the ETB option would involve higher costs in the beginning due to the catenary installation costs and other required infrastructure developments. The above fares for the bus are completely in line with current fares, making the bus option the best one from an economic standpoint.

Conclusions - Cost Comparisons

It is clear from the cost analysis that the electric options are the most expensive in general, in terms of capital cost. Also, O&M costs per kilometer are higher for electric options than for buses, for example. The finance costs associated with each technology are also higher for the ETBs, DMUs, and LRTs because of their higher capital costs.

Based on these costs, it is reasonable from an economic viewpoint to consider transit options that

- are cost-effective in the short term
- help to improve San Jose air quality
- assist in reducing congestion in the downtown area and on access routes
- preserve the option to implement the cleanest technologies in the longer term.

Given that buses are clearly the cheapest option, but also more polluting than electric solutions, it is recommended that the Costa Rica team consider those options that start with a busway concept, transitioning to electric technologies such as ETBs or even LRTs in the longer term, or even battery powered buses, in the slightly longer term. Such an approach will help to relieve the congestion in San Jose soon and, at the same time, preserve the possibility of switching to cleaner transport modes when the fundamental economics of those modes becomes more favorable to Costa Rica.

Other Economic Costs and Benefits

The implementation of any major transportation infrastructure project generally will stimulate secondary and tertiary economic effects along the corridor. In particular, whether an improved rail service or a busway is considered for the INCOFER ROW (e.g. on the Heredia - San Pedro segment, as a starting project), other service businesses are very likely to develop along the route and at stations and transfer points. Typical among the services that are created are:

- Food and drink services
- Newspaper and magazine sales locations
- Snacks and quick foods
- Clothes cleaning services
- Gift shops (flowers, etc.)
- Bank offices, or Automated Teller Machines
- Parking facilities and related services (e.g. car washing, repair)

Such new businesses also create space for new advertising and generate revenue, assuming this is permitted by law.

The electric options, such as the LRT and ETB, will generate a string of positive economic effects that go beyond the above, more localized, economic developments. Since Costa Rica is rich in hydro-electric power, any reduction in the use of diesel buses will help to reduce Costa Rica's cost of imported oil. This cost was $235 million in 1996, a substantial amount for the country. Reducing this cost will help to reduce the federal deficit, which, in turn will assist in the flight against inflation. Lower inflation, in turn, will help to increase real personal/household incomes, leading to greater levels of household consumption. The precise multipliers along each link in this chain are not well defined and depend on many factors, many of which are unique to Costa Rica; however, the linkage has been shown to be a real one, with significant economic benefits stemming from the reduction in oil costs.

In this regard, reducing Costa Rica's dependence on foreign oil has the effect of reducing the country's risk to supply fluctuations. This effect, too, is difficult to quantify but should be considered as a positive effect of moving to electric transport options that rely on more reliable, domestically produced energy.

Pro's and Con's of Each Technology

Summarizing the above analysis, the following is a condensed list of the pro's and con's of each of the technologies reviewed in this study. Some of the aspects of this comparison are based on the economic costs outlined above, as well as legal and political realities facing Costa Rica at the time of the study.

Light Rail Train (LRT)	
Pro's	**Con's**
Very clean environmentally	The most expensive option generally
Large passenger capacity per car	Restricted to rail operations
Would rely on domestically produced energy	High maintenance costs
Many manufacturers: cars and parts	Requires track upgrade (INCOFER)
	Technology level could require local training or import of maintenance workers

Light Rail Train (LRT)	
Pro's	**Con's**
Very clean environmentally	The most expensive option generally
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Would rely on domestically produced energy	High maintenance costs
Many manufacturers: cars and parts	Requires track upgrade (INCOFER)
	Technology level could require local training or import of maintenance workers

Diesel Multiple Units (DMU)	
Pro's	**Con's**
Individually powered	High cost, comparable to LRT
Train marshaling is easier, more flexible	Requires diesel fuel, not reducing Costa Rica's oil imports
	Noisier than electric (LRT)
	Requires track upgrade (INCOFER)
	Restricted to rail operations
	Limited manufacturers: cars and parts
	Technology is being developed

Electric Trolley Buses (ETB)	
Pro's	**Con's**
Individually powered	High cost
Would rely on domestically produced energy	Limited number of manufacturers
	Higher maintenance costs compared to bus
Very effective in high-pollution areas	Current order lead time is 3 years
	Being phased out of most major cities that have improved their air quality in other ways
	Restricted movement side to side
	Potential power cut-off at cross-over's
	Capacity lower than rail

Based on the above analyses, the ICF Kaiser team recommends starting with a project along the INCOFER ROW, from Heredia to San Pedro, in which a paved (concrete), 1-lane busway is built on each side of the track, with cross-over's at stations, and with bus terminals at the end points of the line. This concept has the following advantages:

- it does not disturb the rail right-of way
- it can be implemented quickly
- the technology required for the paving is not expensive
- the number of buses needed to serve the estimated demand is not large
- a paved busway can be used by clean diesel buses, but conversion to electric vehicles can be made in the future
- use of rail technology is still possible
- the costs of the capital development and the operations can be covered by a fare that is within reach of current passengers using existing bus routes.

The ROW is wide enough for the busway. A conceptual (20%) design was provided by ICF Kaiser and is contained in Appendix VIII of the main report.

Concession Approach

It is recommended that Costa Rica undertake a dual concession, consisting of

- a company that will design, build, maintain, and later transfer the busway (DBMT)
- a company, or group of companies, that will operate bus service on the busway

The approach should be a competitive, negotiated concession which is completely transparent, which is open to domestic and international bidders, and which permits Costa Rica to obtain the best inputs from qualified bidders. The process to be following in this concessioning approach is described in greater detail in the final report.

The general idea is to have the users of the busway, that is, the bus service operators, pay a service toll to the DBMT for their use. In order to keep traffic flowing especially during rush hours, the buses could be equipped with a roof-top bar code that would provide information to an overhead reader including the number of the bus, its direction, and time of day. With this information, the DBMT could then invoice the operator for his use of the busway.

In the analysis of this concept, the ICF Kaiser and the Costa Rica teams worked together to find ways to reduce the construction cost of the busway and to determine optimal bus operating conditions that could also help in reducing capital and operating costs for the bus operators. Then, the teams made a series of assumptions about the concession structure and the objectives of the DBMT and the bus operators. These assumptions are:

- The selected DBMT firm finances its capital costs entirely through debt
- The term of the loan is 20%, the interest rate 10%

- The DMBT and the bus operator(s) split the O&M costs of the entire operation: 25% for the DBMT, 75% for the bus operator(s)
- The DBMT seeks 15 percent internal rate of return (when equity is provided and, hence, the debt percentage is lowered, the 15 percent IRR is assumed to apply to the entire project, not just the equity portion)
- The number of buses required on the Heredia - San Pedro line is 23; 70 buses would be required on the Pavas-Pacifico-Atlantico line
- The design for the Heredia - San Pedro line is presented in Appendix VIII
- The bus operator(s) will seek a 15% profit from fares.

When the revised capital costs and the above assumptions were put into a dual-concession model developed by ICF Kaiser for this assignment, the results for the Heredia-San Pedro line were quite favorable, as can be seen in the following screen from the model:

DUAL CONCESSION FEE CALCULATION

Segment: HEREDIA TO SAN PEDRO

Technology: New Busway (Clean Diesel)

Assumptions

IRR:	15%
Operating Cost Split: (DBM/Bus System):	25%
Term:	20 Years
Interest Rate:	10%
Exchange Rate (colones/dollar):	230
Debt/Equity Ratio:	100%

☑ Use PPP

Calculate Now

	DBM Concession	Bus System Concession
Total Capital Cost:	$11,939,400	$7,555,500
Total Adjusted Capital Cost:	**$9,563,400** *	**$7,555,500** *
Operating Cost:	$200,738	$602,214
Annual Payment:	$1,123,313	$887,466
Total Annual Cost:	$1,324,051	$1,489,680
Total Annual Cost + 15%	$1,522,659	$1,713,132

Demand Adjustment: 0%

1997 Total Annual Ridership: 11,014,704

Toll per Passenger: $0.14

Break Even Fee + 15% $0.16

Total Fee: **$0.29**

Total Fee (colones): **¢67.57**

*** Used in Annual Payment calculation.**

Note: Total Fee = Toll per Passenger + Break Even Fee

Each passenger would be charged a fee of US$0.29 (68 colones) for the trip. This is comprised of a US$0.16 fee to cover the operating costs of the bus operator(s), including a 15% profit, and a US$0.14 fee (toll) paid to the DBMT to cover his capital, financial, and operating costs. This fare is even more reasonable than the earlier analysis in view of the lowered capital costs.

Summary

The long-term goal of the improved, integrated transit system for San Jose is to provide clean technologies that will help in improving air quality and that can move people in and out of the city more quickly and more efficiently. The most environmentally clean options are electric.

Based on the economic and demand analysis performed by ICF Kaiser and the Costa Rica team, an overall integrated plan was developed which will accommodate San Jose's growth in the next 10-15 years. As part of this plan, an initial, feasible project is the use of the INCOFER right-of-way as a busway, using a two-way paved surface on each side of the existing rail. This approach does not interfere with the longer-term potential use of the rail, and yet, it provides short-term help in relieving congestion, at least along this initial corridor. Indeed, while clean diesel buses could be mandated for the busway, the option is still open under this approach for other, cleaner technologies such as ETBs or battery-powered buses. A similar busway concept can also be considered along the Pavas - San Pedro right-of-way.

The ICF Kaiser teams encourages a quick and energetic start to the building of the Heredia - San Pedro segment so that the benefits of reduced congestion and improved air quality can be seen and felt in San Jose as soon as possible.

I. Background of and Introduction to the Study

Background

This study was co-funded by the U.S. Trade and Development Agency (TDA), part of the U.S. State Department, which serves as an export promotion facility for the U.S. Government. ICF Kaiser International, Inc. (ICF Kaiser) contributed equal amounts to the performance of the study. The sole interest in this project by the U.S. Government is to develop it to the point at which there is an opportunity for U.S. companies to participate in some way in the project, through either the provision of equipment and supplies or additional consulting assignments. There has been no agreement by the Costa Rican client to purchase any U.S. made products or services beyond this immediate consulting assignment.

The idea behind the study was developed during the summer of 1996 jointly by ICF Kaiser and by a special task force in San José consisting mainly of representatives from Compañia Nacional de Fuerza y Luz (CNFL), to study the potential for the introduction of various forms of electric transport into San José. The task force had been in existence for over one year when ICF Kaiser began discussions in July, 1996.

By applying its transport economists and engineers, ICF Kaiser proposed that a study be undertaken that would examine the overall transit problem in San José and would evaluate and various options to solve the problem, given the costs and environmental impacts of each option. A detailed Terms of Reference was developed by ICF Kaiser, approved by CNFL, and an official request for financial consideration was made by President José Maria Figueres of Costa Rica to the TDA. After a desk study to review the project, changes were made to the scope of work. The formal grant to CNFL was finalized in December, 1996, and the work began immediately.

The World Bank's Transport and Air Quality Management project was started at almost exactly the same date in December, 1996. At a coordination meeting in San José to discuss study topics and roles, and in an interest to maintain close collaboration between the respective efforts of The World Bank and ICF Kaiser, The Bank urged that ICF Kaiser study technologies beyond electric (LTR and electric trolley buses) and specifically clean diesel bus technology. Expanding the technology options amounted to a change in the scope of work at the outset of the study.

Introduction

A solution to the increasing congestion and associated air pollution in San José must be found and implemented soon. Otherwise, the "system will collapse under its own weight" in the words of the Camara Nacional de Transportistas, one principal organization of (private) bus operators in San José.

With nearly 60 percent of the nation's population concentrated in the San José valley which covers only 4 percent of the country's area, with about 1.2 million passenger trips each day, with over 70 percent of the commuters dedicated to the use of existing bus services, and with the current radial system of inbound and outbound corridors generating dense focal points of congestion, there is a serious need for the development of an integrated transit plan that simultaneously recognizes the following constraints and interests:

- shorter commuting times
- cleaner air
- cost effective transport
- use of existing infrastructure if possible
- lack of government subsidies

This is a challenge in any city and especially in San José where there is a great concern for the quality of the environment.

The ICF Kaiser team assembled to carry out this assignment consisted of:

Name	Title	Location
Robert West, Project Manager	Vice President	Boston, MA
Ben Hackett	Sr. Vice President	Fairfax, VA
Steve Wyngarden	Vice President	Fairfax, VA
Ede Ijjasz	Senior Associate	Fairfax, VA
Lorena Solorzano-Vincent	Research Assistant	Fairfax, VA
Carmen Guerrero	Research Assistant	Fairfax, VA
Ronald Rypinski	Transportation Specialist	Phoenix, AZ
David Blond	Vice President	Fairfax, VA
Yvonne Taylor	Project Manager	Fairfax, VA
Deborah Cheng	Associate	Fairfax, VA
Julie Fieber	Senior Associate	San Rafael, CA
John Bergerson	Sr. Vice President	Oakland, CA
Jim Parsons	Sr. Vice President	New York, NY
Darryl Brogan, P.E.	Project Manager	Pittsburgh, PA

The team carried out a variety of steps in the project including:

- Review of previous studies
- Collection of data (MOPT, INCOFER, World Bank)
- Generation of new data (income and population by corridor)
- Estimation of a demand model and forecasts

- Presentation of a conceptual plan for commuter transit in San José
- Specification of system components to be evaluated
- Investor/operator survey (U.S. only)
- Development of economic/cost evaluations and environmental feasibility
- Presentation of a seminar/workshop
- Selection of preferred solution(s)
- Refinement of capital and operating costs
- Recommendations
- Proposed Concession strategy

Structure of the Remaining Report

This report presents the details of the team's analysis and findings. It also presents the conclusions and recommends a dual solution which is actually comprised of a short term start-up of a clean diesel busway on two corridors using a rail-in-road approach so that the longer term option of moving to a light rail electric transit (LRT) solution is preserved. This approach, consisting of a short term, cost-effective and feasible option followed by a longer term, albeit more expensive option, appears to be consistent with the views and opinions of the key decision makers who attended the seminar/workshop, and it is consistent with the current focus of the Costa Rica government to stimulate private sector involvement in transportation throughout the country and, at the same time, to reduce or eliminate the financial pressure on the government to provide subsidies for such projects. Additionally, this solution, phased in over time, provides the opportunity to get started right away with a project that will help to move larger numbers of commuters faster into and out of San José while helping to reduce air pollution in the city.

The rest of this report outlines the overall, integrated transit solution for San José, the economics and environmental feasibility of each technology by route, and the recommended short and long-term phases for implementation. The appendices include details of the study's output including detailed environmental impact evaluations, capital and operating cost estimates, plan and profile design sheets, seminar worksheets, and past studies, legal issues, photographs of the ROW, and field trip notes.

II. General Concept of an Integrated Transit Solution

The objective of the overall, integrated transit system for San José is two-fold:

1) Help to relieve commuter congestion
2) Reduce air pollutants caused by transit vehicles

The system must also be responsive to the socio-economic differences between the regions in the commuting vicinity of San José and to the long-term goals of the Costa Rican Government to reduce the impact of the transit system on the environment.

Additionally, the original focus of the project was to determine the feasible role of electric transport in solving the congestion and air emission problems in San José. Since The World Bank's Transport and Air Quality Management project was beginning at almost the same point in time, it made sense to coordinate the work of ICF Kaiser and Electric Transport Commission with that of The World Bank. In this regard, it was decided, after discussions with both The World Bank team and Electric Transport Commission, to expand the technology coverage of this study to include "clean diesel buses", the concept of a busway, and the feasibility of diesel multiple units (DMUs) along the INCOFER railway right-of-way. The inclusion of these non-electric options included the full economic and environmental evaluations, consistent with the depth of analysis of the other technologies.

Components of the System

To this end, ICF Kaiser established five general principals or goals on which the overall transit system design is based. In particular, these principals include the effective use of the INCOFER right-of-way (ROW) as an available corridor that can provide a high capacity route to both the Atlantic Station and the Pacific Station, while retaining the ROW for all possible technologies including electric trolley buses and electric light rail systems (LRT).

The five principals of an integrated transit system for San José are:

- High capacity transit in the railway ROW
- Suburb-to-suburb connections (diametrales, intersectoriales)
- Major bus lines with potential for electric trolley bus service
- Other feeder bus service
- Circulators/shuttles in the downtown area

The ICF Kaiser team discussed these components with representatives of Electric Transport Commission, INCOFER, MOPT, INVU, Municipality of San José, and representatives of local bus operators over a 3 day period (12-14 March, 1997) and arrived at an agreed definition of the system. Inputs to this discussion included the

MOPT demand diagnostics ("Sistema Integrado de Transporte, September, 1996) covering 14 radial corridors into San José. This study involved the interrogation of bus passengers, who were asked their final point of destination. In general, less than half of the passengers were actually traveling to or from San José. The following table shows representative results from this study.

Origin/Destination	Percent of Bus Riders going to/from San José
San Pedro	36%
Paso Ancho	44%
Tibas	41%
Desamparados	36%
Pavas	36%

The vast majority of the passengers on the line between the University (San Pedro) and Pavas were transiting the entire East-West length (57%), with less than 1/5 of the passengers exiting at San José. Such information was taken into consideration in the development of the particular corridors to be included in the integrated mass transit overview.

Technologies Considered

While the client for this study was the Electric Transport Commission, coordinated by CNFL for the purpose of studying the feasibility of introducing electric transportation options into the general picture of commuter transit in San José, it was decided, following discussions with The World Bank, to include other non-electric technologies in the evaluation.

The technologies evaluated in the study were:

- Light rail train (or tram), electric (LRT)
- Diesel Multiple Units, which require tracks but are individually powered (DMU)
- Busway for clean diesel buses (exclusively)
- Electric Trolley Buses (ETB)

Clearly, not all technologies apply to all the component corridors of the proposed integrated transit system. In particular, the following table shows the particular technologies that were evaluated in each of the corridors.

		Technology/Approach		
Component	**LRT/TRAM**	**DMU**	**Busway**	**ETB**
•Heredia to San Pedro	X	X	X	X
•Alajuela to San Pedro	X	X	X	X
•Alajuela to Cartago	X	X	X	X
•San Antonio de Belen to Pacific Station	X	X		
•Pavas to Pacific Station	X	X		
•Ciruelas to Pacific Station	X	X		
•Alajuela to Pacific Station *(via Ciruelas)*	X	X		
•Alajuela to Pacific Station *(via San Antonio de Belen)*	X	X		
•Atlantic Station to Pacific Station - *Single Track*	X	X		
•Atlantic Station to Pacific Station - *Double Track*	X	X		
•Pavas - San Pedro *(diametral)*	X		X	X

An 'X' indicates that the particular technology was evaluated for the corridor in terms of its capital and operating costs, and the environmental impacts during construction and after completion. The environmental feasibility of each of the 'X' points is described in Chapter IV, and the economic and cost evaluations are presented in Chapter V.

Additionally, there were five shorter routes whose economic and environmental effects were evaluated in terms of their potential for electric trolley bus (ETB) service. These are:

- Tibas to Pacific Station
- Paso Ancho to Pacific Station
- Desamparados to Pacific Station
- Moravia to Atlantic Station
- Alajuelita-Hatillo-Pacific Station

Transfer Stations

Finally, 28 transfer stations were defined for the overall system. These are locations at which passengers would potentially change their mode of transport or which serve as origin or destination points. These are not simply stops on a route. The complete list of transfer stations included in the evaluations, and incorporated into the economic analysis, is shown below.

1. Alajuela
2. Ciruelas
3. San Antonio de Belen
4. Ciudad Colon
5. Santa Ana
6. Pavas
7. Escazu
8. Heredia
9. Sabana
10. Uruca
11. CNP
12. Hatillo
13. Alajuelita
14. Tibas
15. Paso Ancho
16. Pacifico
17. Atlantico
18. Desamparados
19. Y Griega
20. San Rafael Arriba
21. Aserri
22. Zapote
23. San Pedro/Universidad
24. Guadalupe
25. Moravia
26. Coronado
27. Cartago
28. Aeropuerto Internacional

An integrated mass transport plan such as this must provide fare collection systems and other facilities in the transfer facilitates and station stops. Therefore, the system should provide for:

- fare collection before boarding
- low floor and wide door buses to speed access
- ticketing at the bus stations/shelters
- fare setting that incorporate capital costs, operating and maintenance costs, and the cost of a transport authority (See "Organization" below)

Fares should be studied in the next phase of development in order to determine both their optimal level by segment and the feasibility of implementing a more advanced system of cross-segment transfer pricing and revenue-sharing among the bus operators.

Maps of Proposed Integrated System

The map on the next page (MAP II-1) shows the individual corridors which make up the "backbone" of the system. The railway ROW between Alajuela and Cartago is evaluated in terms of four potential technologies, as indicated in the legend, across three segments, as indicated in the table above. The line between Alajuela and Pacific Station that passes through San Antonio de Belen would include an underground station stop at the International Airport. The alternative route from Alajuela to the Pacific Station through Ciruelas would likely involve the transfer of the Pacific Station freight operations to a new facility in Ciruelas, thereby leaving the Pacific Station available purely for passenger traffic and other facilities.

The map was generated using a GIS system with data provided by CNFL. Some 48 diskettes of data were processed and assembled into a complete map. The level of detail is extremely deep, and such items as drainage systems, houses, and electricity wires had to be removed from the underlying database in order to provide only the necessary minimal dataset to show the proposed corridors and technologies.

The proposed integrated transit system can also be considered to include the following components:

- Diametrales and Intersectoriales
- INCOFER right-of-way
- Downtown Electric Shuttles and Pedestrian streets
- Interurban routes and terminals
- Feeder system
- Parking lots and related facilities

The parking lots do not have to be implemented at the start but will become important as the feeder system develops.

The INCOFER right-of-way, which has the potential to provide a high capacity transit corridor for LRT, DMU, ETB, or bus service is shown on Map II-2. The proposed suburban and intersectorial routes are shown on Map II-3; these routes are designed to provide commuter service up to the perimeter of the greater downtown area, as well as connections between suburban areas. The downtown area where potential electric shuttles and/or clean diesel buses would be deployed, is shown in Map II-4 later in this chapter.

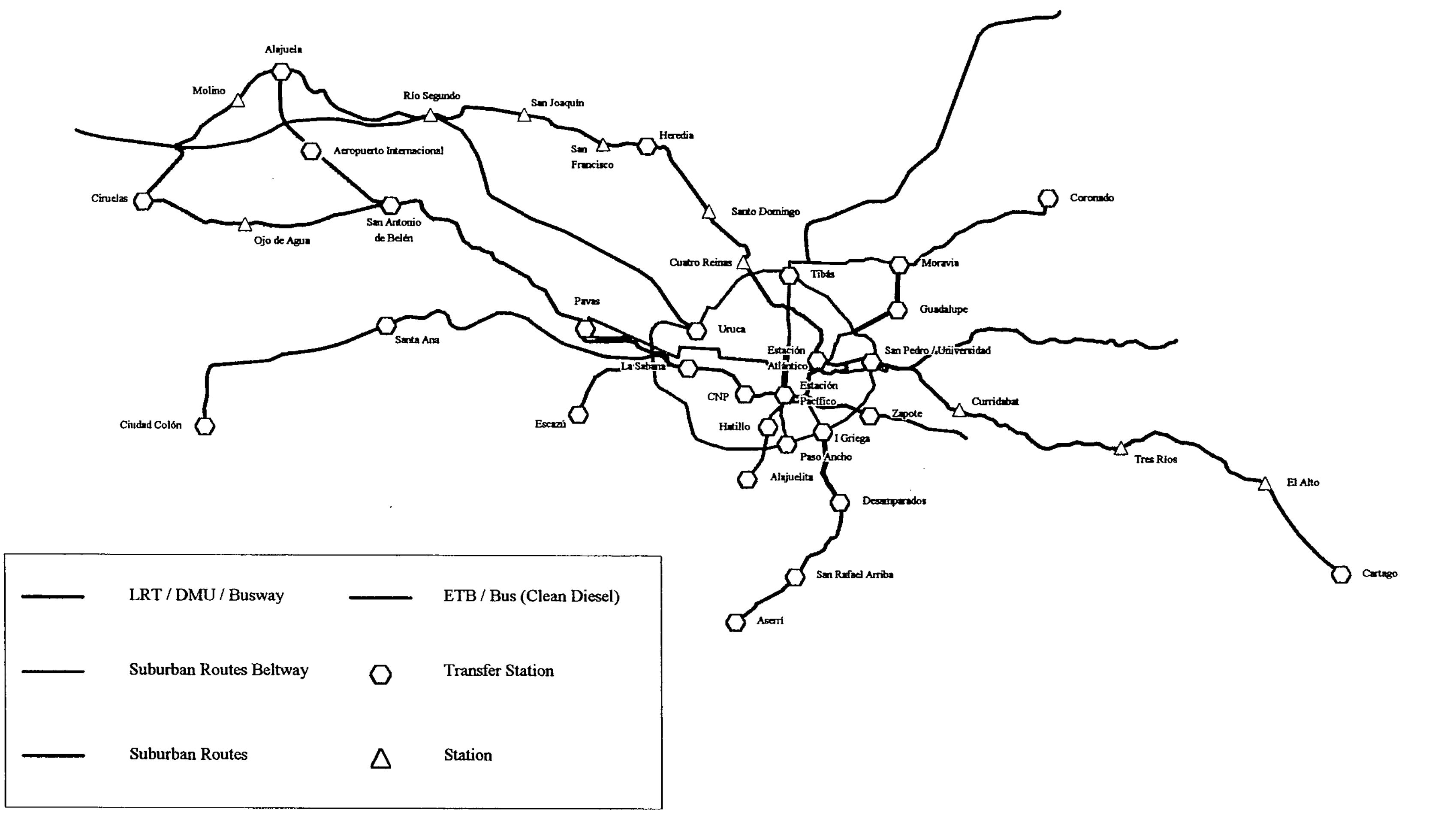
The proposed system is designed to:

- reduce the number of buses entering the downtown metropolitan area
- provide suburb-to-suburb connections that will not require a trip to the city center
- improve the capacity of particular routes and shorten transit times
- provide downtown maneuverability through (electric/low emission) shuttle buses
- preserve the flexibility to use various technologies including electric powered vehicles and systems

The main corridors would be fed by feeder services. Over time, existing bus operators that provide service to and from San José may find it more advantageous to provide feeder service to the main trunks of the overall system, thereby keeping their buses running faster and avoiding the congestion of downtown San José.

Map II-1
Proposed Transit System for
San José

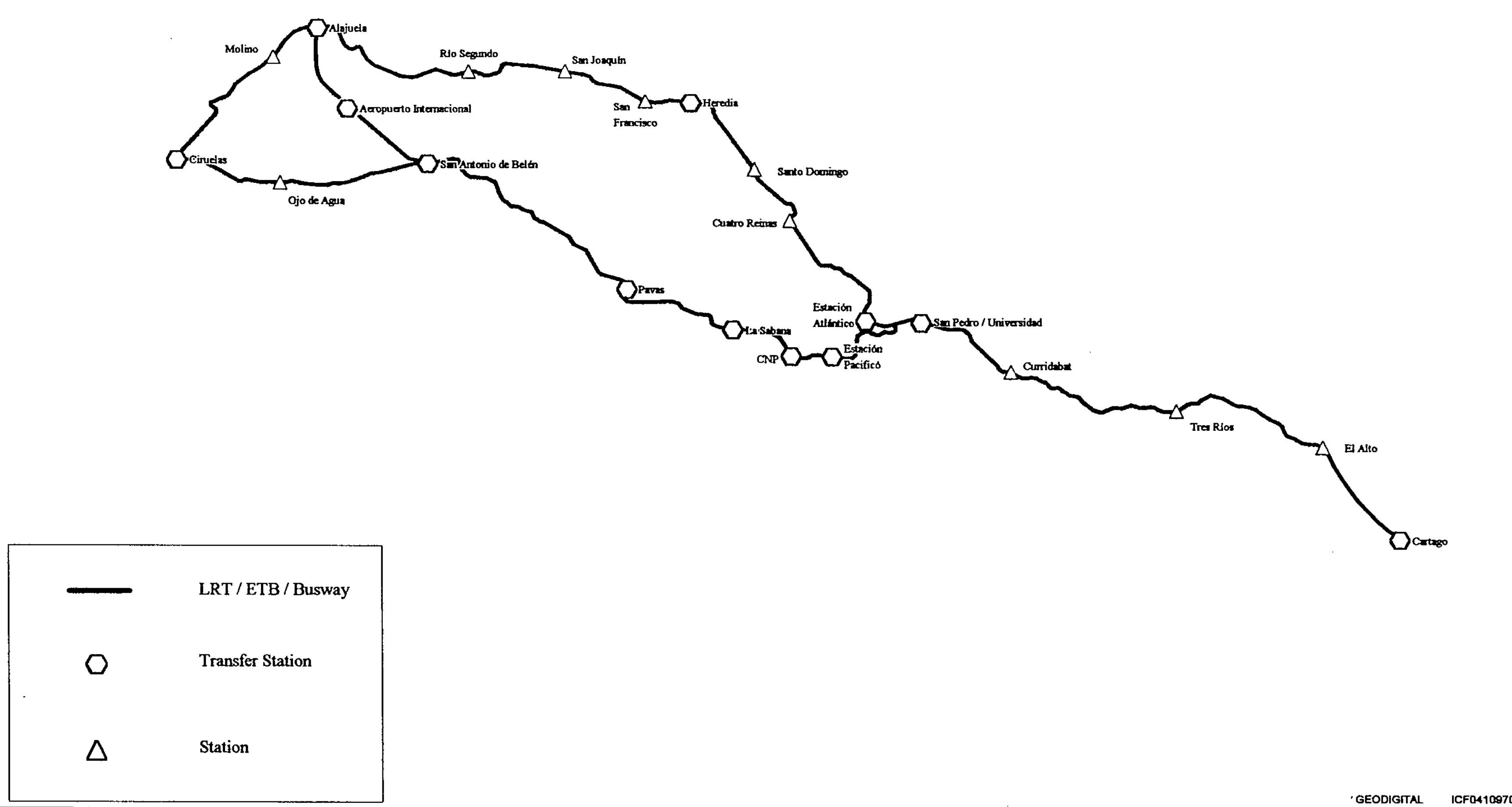
ICF KAISER



GEODIGITAL ICF041097001

Map II-2
Routes on the Right-of-Way for Potential Use of LRT, ETB, or Bus
San José

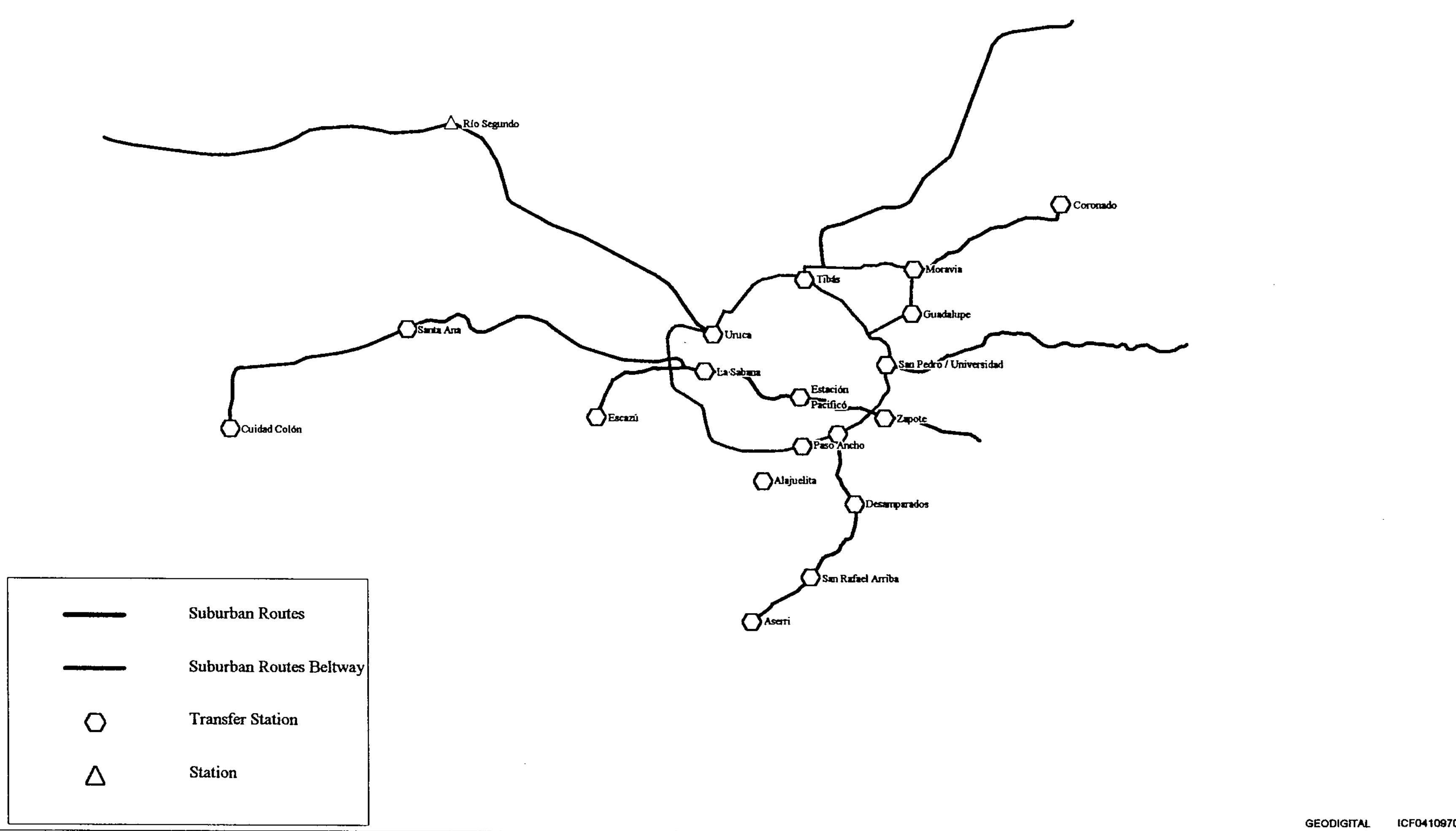
ICF KAISER



GEODIGITAL ICF041097001

Map II-3
Proposed Suburban and Intersectorial Routes for San José

ICF KAISER



GEODIGITAL ICF041097001

The concept of using electric shuttles or circulators in the downtown metropolitan area has been under discussion and review for some time. The first battery powered electric bus, was delivered on 1 May, 1997. Such circulators would serve only the downtown area. In some U.S. cities such services are provided free of charge, but these are heavily subsidized by the city government. In San José, shuttle fares will have to be set so that operators of such services can make a profit and have an incentive to hold down their costs; also, possible transfer pricing agreements with the bus operators serving the major corridors up to the *circunvalación* could be set up.

The proposed integrated system does not conflict with the *diametrales* and *intersectorales* routes defined and proposed, respectively, in the Wesson Study of M.O.P.T. (19961) and the LCR Logistica study ("Evaluación Tecnica Plan de Reordenamiento Vial de San José," 1996). Indeed, the main East-West and the North-South routes were analyzed as part of this study. These cross-city lines are fully consistent with the proposed system. Also, discussions have already advanced between various private bus operators and MOPT authorities concerning their interest in providing a through service in the North-South diametral line (Tibas - Paso Ancho). The use of clean diesel buses on this route, as a requirement for the arrangement, has not been finalized as of this writing.

Implementation Phases

The integrated transit system, as conceived, can and should be implemented in stages. The following stages are considered to be feasible and realistic, to be implemented over a time period that depends on many other factors.

Due to national economic picture and the density of economic activity in the greater San Jose metropolitan area, the current mass transport system must be improved using the most feasible scheme in terms of cost, ease of implementation, and environmental improvement. Therefore, the following stages, based on the use of clean diesel buses, will help in the partial improvement of air quality.

Diametrales and Intersectoriales

As stated earlier, the proposed transit plan incorporates the concepts of *diametrales* and *intersectoriales*. These parts of the system should be implemented first, in these stages:

- Establish the corridor(s)
- Use the current buses (for now)
- Develop a program of fleet modernization
  - clean diesel technology
  - electric trolley buses
  - - others (e.g. battery-powered)

- Demarcation of bus lanes
- Demarcation of bus station stops
- Development of information systems for traffic monitoring, etc.

The downtown San Jose routes that are potential for either ETB or clean diesel buses are shown in Map II-4.

INCOFER Right-of-Way

The next full-system development phases should focus on the INCOFER right-of-way (ROW), expanding its capacity and making it available for faster commuter transit into and out of San Jose. See Map II-2.

Due to lack of urban space, congestion, pollution, the low level of infrastructure investment, and the high acceptance of the public to mass transit (75%), the development of bus lanes, whether on the ROW or on existing streets, should be encouraged.

The ROW is an important part of the greater metropolitan transit system and should be activated using an approach that is economically achievable in the short term. The details of this approach are outlined in Chapters VIII and IX, and the conceptual design of the busway for the first segment is provided in Appendix VIII.

The development of the ROW as a busway should be undertaken in the following stages:

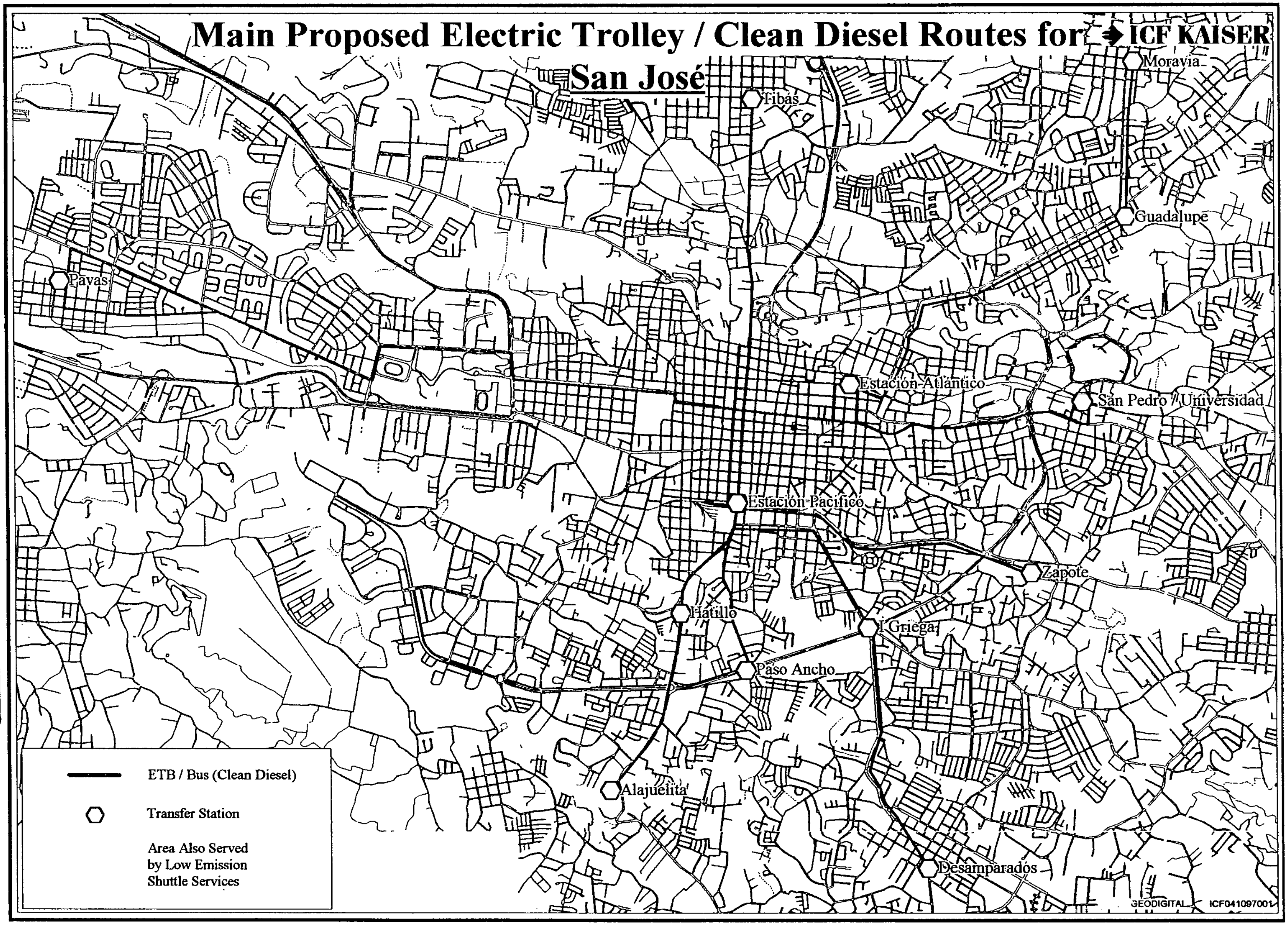
- Implement busways by stages:

  Heredia - San Pedro and/or Pavas - Pacific Station
  Alajuela - Heredia (linking with above segment)
  San Pedro - Cartago (extending Alajuela - San Pedro segment)
  Alajuela - Pacific Station (two alternative routes suggested)

- Improve technology to electric trolley buses (ETBs) and light rail trains(LRTs) for the future

This approach, as discussed later in this report, preserves the ROW because it will retain the existing tracks, and it permits the near-term use of the ROW for commuters, initially using the existing buses be later moving to cleaner technologies.

MAP II-4



Main Proposed Electric Trolley / Clean Diesel Routes for San José
ICF KAISER
Moravia
Tibás
Guadalupe
Pavas
Estación Atlántico
San Pedro / Universidad
Estación Pacífico
Zapote
Hatillo
I Griega
Paso Ancho
Alajuelita
Desamparados
ETB / Bus (Clean Diesel)
Transfer Station
Area Also Served by Low Emission Shuttle Services
GEODIGITAL
ICF041097001

Organization

It will be important, especially in the concession process, to establish an organization charged with certain responsibilities related to public transit to which the private transportation provider can turn for

- contracting
- conflict resolution
- negotiating terms and conditions
- resolution of public safety issues

among other items. The private sector will want to deal directly with a single entity, if possible, or at least *through* a single entity with authority and responsibility for reaching decisions affecting the viability of the concession; such an institution would serve this purpose.

Dealing with the numerous entities that could have a hand in the concessioning process (See Chapter VII) could be difficult, costly, and cumbersome to an investor/operator. Therefore, a single organization with the responsibility for at least the above functions would be attractive to the investor/operator community.

The proposed organizational unit, or transport authority, should have the following roles:

- Strengthen MOPT's Public Transport Department
- Review current bus concession system, which is based on 7-year periods, most of which expire in 2000/1
- Review the current legal system and adopt it for a new transit system
- Coordinate bus fare policies with ARESEP
- Coordinate planning activities at inter-institutional level

Such an authority would facilitate the implementation of the proposed transit system and making the concessioning process clearer to potential bidders.

In order to implement the proposed transit system, there will have to be a re-organization of the existing bus operators. Based on preliminary discussions with the operators, we are convinced that these changes will be welcome, although any changes to organizational structures are often difficult since there are always winners and losers. In this case, the number of separate bus operating entities (over 60 currently) which operate at few as one bus and as many as a hundred, is too large for any one of them to achieve great economies of scale. Therefore, a restructuring of the bus operations, in line with the overall transit plan proposed in this study, should take place and should include:

- Regrouping the bus operators
- Introducing ideas of new enterprises
- Use of commercial advertisements at the bus stations/stops to help cover operating and maintenance costs
- Designing of corridor and feeder operations

WORLD BANK PROJECT COMPONENTS

There is a clear linkage between the proposed, integrated mass transport system in this study and the World Bank project components, from the Bank's Transport and Air Quality Management project:

- signaling systems
- radial street system improvement (maintenance and repair)
- air quality management
- bus fleet renovation
- vehicle (car and bus) monitoring
- new technologies for buses

among other aspects.

III - Ridership Demand Analysis and Forecast

Demand for commuter service in San José

Demand for public transport in San José has grown substantially over the last ten years. It is generally accepted that approximately 1.2 - 1.3 million passenger trips are made each day in and out of the city. About 70 percent of these trips involve the use of buses, reaching 77 percent in the peak rush hours. The use of public transport in San José is, therefore, very high as a share of total transport. Data for 1996 indicate that several individual corridors have more than 120,000 bus passengers per day.

As mentioned in Chapter I, the Greater Metropolitan Area of San José represents only 4 percent of the country's area but contains nearly 60 percent of its population and generates three-quarters of the country's economic output. As in any high density metropolitan area, this concentration of activity requires viable, flexible passenger transit systems that help to facilitate the current output levels and that, at the same time, provide the necessary infrastructure that can sustain future economic growth, especially in the face of increased population growth in the San José area.

In general, this concentration presents an opportunity for potential concessionaires.

Approach to Modeling

Modeling and forecasting the demand for transit service, especially with limited data, is difficult. At the same time, having a reasonable approach to the modeling is critical to developing forecasts that can be justified. Indeed, in most transit projects that undergo a pre-feasibility analysis, demand is often over-stated (and costs are often under-stated). With this in mind, the ICF Kaiser team developed a creative and rational approach to demand estimation in the face of limited data.

In developing a transit model for the San José area, we have attempted to capture the dynamics of the market for bus transportation along major corridors within the city and the surrounding region. Projected traffic then represents a combination of factors that should influence traffic growth over the next several years including:

- the rate of population growth within major corridors
- the rate of economic growth within Costa Rica
- the relative wealth of different corridors within San José, and
- the ratio of buses to automobiles within Costa Rica.

The forecast is driven by the economic outlook for Costa Rica generated by WEFA Group, a highly respected economic forecasting company in the U.S., plus population projections for small zones in and around the greater metropolitan area generated by LCR Logistica, S.A., a local San José consulting firm.

The Data

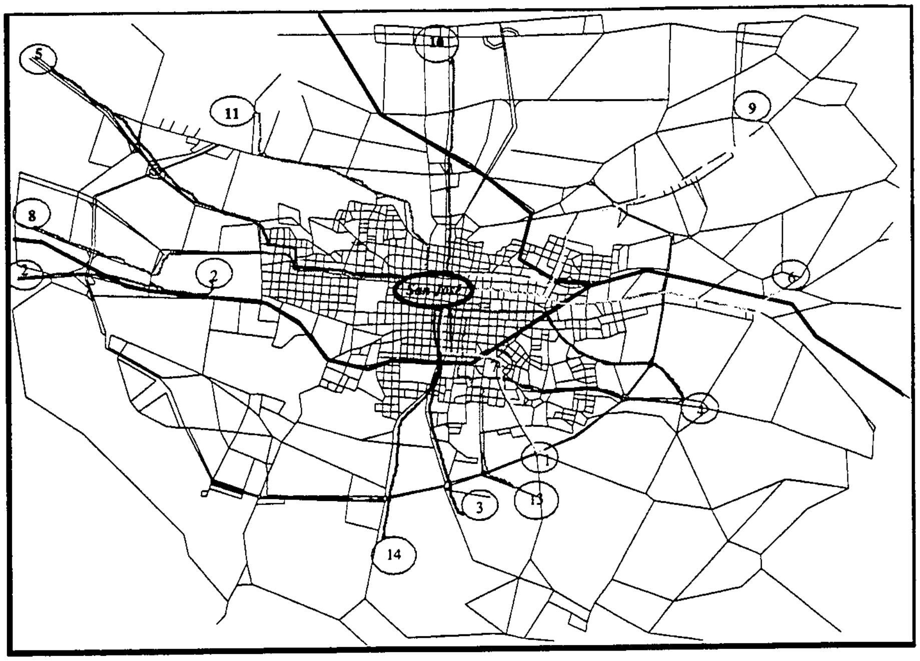
Data on monthly transit volumes for each of the corridors (14 corridors) was obtained from MOPT for three years (1994, 1995, and 1996) showing:

- Volume of monthly traffic by corridor
- Number of buses used, and
- Number of round trips per month.

These data were originally provided by individual route and were collapsed into 14 major corridors to match the MOPT data collected in September, 1996, covering bus ridership in the morning 6-11 AM period. Also, these data ... The 14 corridors are:

Corridor #	San José to/from:
1	Desamparados
2	Sabana-Escazu
3	Paso Ancho
4	Zapote
5	Alajuela
6	San Pedro
7	Plaza G. Viquez-Zapote
8	Pavas
9	Guadalupe
10	Tibas
11	La Uruca
12	Santa Ana
13	Alajuelita
14	San Sebastian

These corridors are shown in the following map.



The model was constructed using the corridor data. Later, the data were transformed to match the particular transit system components/routes evaluated by the ICF Kaiser team and described in Chapter II.

The approach taken to the segment (corridor) analysis was based on a more detailed analysis of population and population trends within corridors. While some segments corresponded directly to existing corridors, others reflected new routes. The following rules were used to assess segments:

- When the segment and the corridor corresponded, the corridor projections were used directly.

- When more than one corridor was combined in a segment, the resulting segment was additive.

- When a segment reflected less than the full corridor, the proportion of the population in the smaller segment was compared to the population in the full corridor. It was assumed that ridership is proportional to corridor population.

- When a new route was considered the average ridership per person was used in conjunction with detailed population estimates along these new routes. For example, for the proposed diametral route (Pavas-San Pedro), the Pavas corridor (Corridor 8) was used as the model for this calculation.

Using these rules, we were able to divide total ridership into 14 segments. The ridership demand on these segments should not be added together because, for some proximate segments, the potential demand consists of riders who may select *either* segment. Therefore, adding such segments together would result in an over-statement of the potential demand.

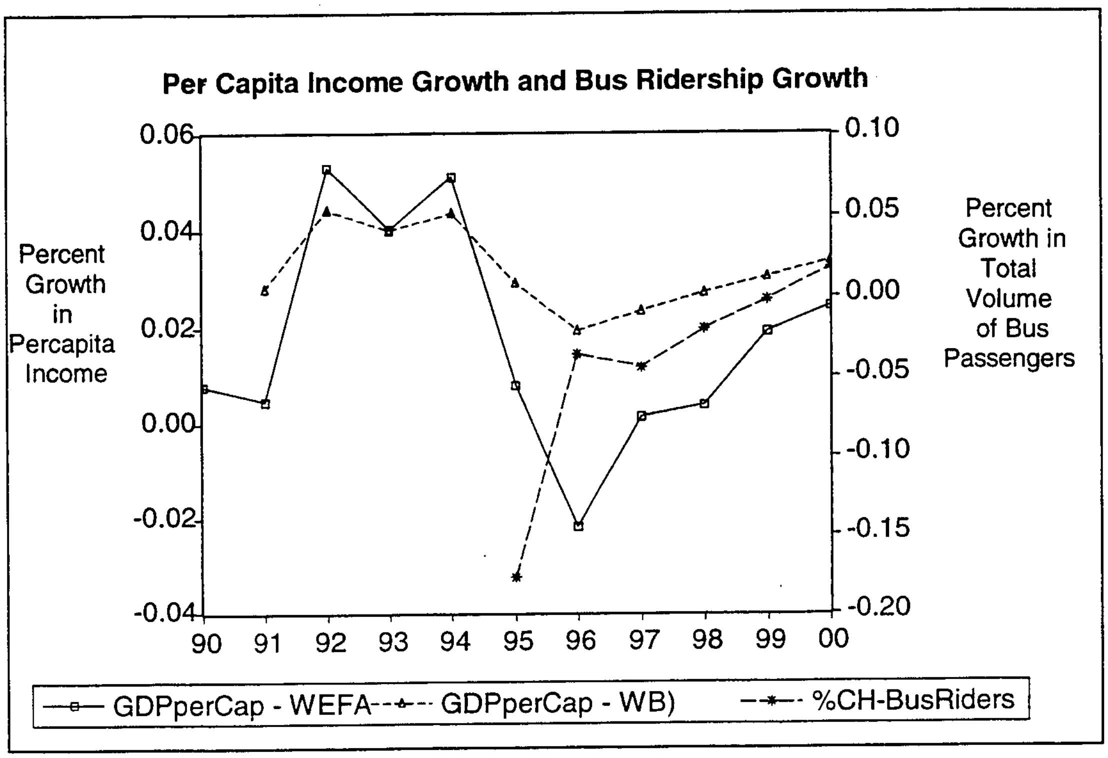
Segment Analysis

Segment	Assumptions
Heredia-San Pedro	Proportion of population along corridor 5
Alajuela to San Pedro	Corridor 5
Alajuela to Cartago	Corridor 4+Corridor 5+Corridor 6 + Corridor 7
San Antonio to Pacific Station	Corridor 8 + Estimated ridership San Antonio to Pavas
Pavas to Pacific Station	Corridor 8
Ciruelas to Pacific Station	Ridership San Antonio to Pacific Station + Ridership Ciruelas to San Antonio
Alajuela to Pacific Station (via Ciruelas)	Ridership Ciruelas to Pacific Station + Ridership Alejuela to Ciruelas
Alajuela to Pacific Station (via San Antonio)	Ridership Alejuela to Pacific Station without Ciruelas traffic
Atlantic Station to Pacific Station	Population share of Corridor 3+10+14 ridership
Tibas to Pacific Station	Corridor 10
Paso Ancho to Pacific Station	Corridor 3
Desamparados to Pacific Station	Corridor 1
Moravia to Atlantic Station	Corridor 9
Alajuelita-Hatillo-Pacific Station	Corridor 13
Pavas to San Pedro (diametral)	Moravia to Atlantic Station + Pavas to Pacific Station

Analysis of Data on Ridership, Buses, and Round trips

In the 3 years of route and corridor data provided by MOPT, the 1994 estimates for traffic volume in some corridors appeared significantly greater than those for 1995 and 1996. Given the limits on available data and the inability to separate what was accurate from what was less accurate, the model was estimated using all data collected. While the 17% decline in 1995 total bus ridership reported in the data may be questioned, there was a simultaneous slowdown in the rate of Costa Rican real economic growth (of GDP) which may help to explain the decline; while real output was growing at a rate in excess of 7% for a number of years, in 1995 the rate of real growth fell to just under 3% and the rate of growth in per capita income declined from over 5% to just above 0% growth. Therefore, it was assumed that the reduced ridership growth in 1995/1994 is real and caused partly by the growth recession in Costa Rica over this time period. Additionally, beginning in 1995, there was a significant increase in non-licensed taxi and bus service on most of these routes. These "pirate" operations siphoned off ridership from the licensed bus operators, and this factor has been incorporated into the model structure as well.

Chart III-1:
Comparison of Historical and Forecast Real Growth in Per Capita Income (WEFA Group versus The World Bank) and Reported Growth in Traffic Volume on Buses in the San José Metropolitan Area



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ICF Kaiser examined two sources of historical and forecast per capita income growth for Costa Rica: WEFA Group, a private economic forecasting company in the U.S., and The World Bank. The growth rates of the two are shown in the above chart. The economic forecasts used in our bus ridership demand model are the latest WEFA projections.

Additional data on registrations of automobiles and other vehicles for personal use in Costa Rica was available for a long time series and reflects the changing mix of vehicles between cars and buses. Car registrations in Costa Rica have grown at around 10 percent per year for the last 35 years. We utilize these data within the bus ridership model to reflect the increasing substitution of automobiles for buses.

Aside from data on vehicles and traffic by corridor, we have also developed estimates of population by corridor using data collected in San José by L.C.R. Logistica, S.A., author of "Evaluación Técnica Plan de Reordenamien to Vial de San José" from September, 1996. These data reflect the size of the regions included in each corridor and also the rate of population growth by corridor. Historical and projected population growth rates for each corridor are shown in the table below.

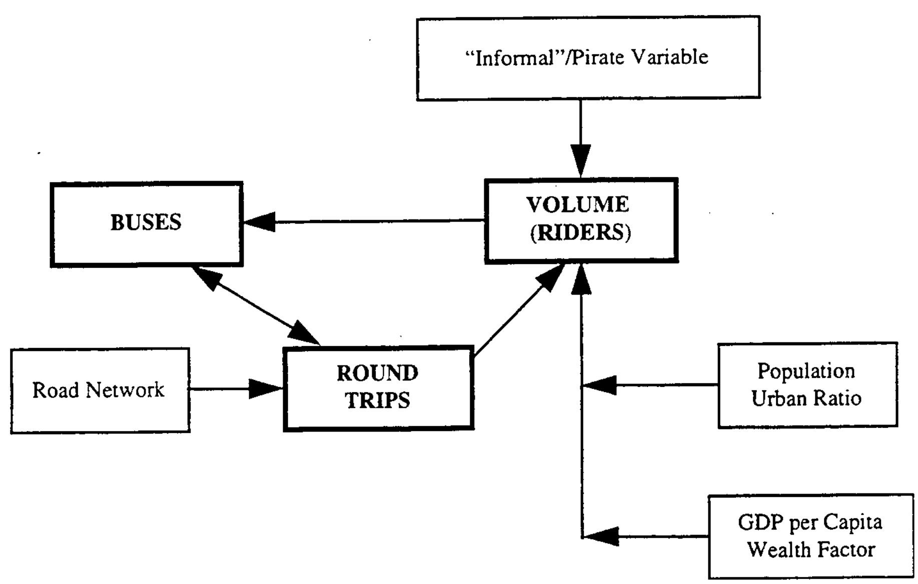
Table III-1
Projected Population Growth Rates (%) by Major Transportation Corridors

	Corridor												
Year	1	2	3	4	5	6	7	8	9	10	11	13	14
1995	2.2	1.4	0.1	2.3	0.1	2.6	0.1	0.0	1.9	2.3	0.1	0.5	0.6
1996	2.2	1.4	0.1	2.3	0.1	2.6	0.1	0.0	2.0	2.3	0.0	0.5	0.6
1997	2.2	1.4	0.1	2.3	0.1	2.6	0.1	0.0	2.0	2.3	0.1	0.5	0.6
1998	2.3	1.4	0.0	2.3	0.0	2.6	0.0	0.0	2.0	2.3	0.1	0.5	0.4
1999	2.3	1.4	0.0	2.3	0.0	2.6	0.0	0.0	2.0	2.3	0.0	0.5	0.4
2000	2.3	1.4	0.0	2.3	0.0	2.7	0.0	0.0	2.0	2.3	0.1	0.5	0.4

The Ridership Model

Constructing models of traffic growth with limited amounts of available data (three years) requires a different type of econometric structure. To insure that there are sufficient degrees of freedom in the model, the data set was pooled. Thus, rather than a single, time series, model for each corridor (which would have been impossible since only 3 years of data were available), the relationships calculated using a cross-sectional approach reflect the jointly-determined influences of income, population size, and other factors affecting the volume of traffic growth.

A pooled cross-corridor time-series model was developed that jointly estimates coefficients based on the three years of data for the 14 corridors in the sample, i.e. a total observation set of 42 (rather than only 3 if a time series model were estimated). The following chart shows the structure of the model and indicates that the three key independent variables, the volume of riders, the number of buses, and the number of round-trips (total) for each corridor, are estimated simultaneously. This aspect of the modeling is extremely important.



The modeling exercise showed that, in short, the bus operators respond to increases in demand by adding more buses. Generally, this results in a decline in the number of passengers per bus and an increase in the number of round trips. However, over time, the number of round trips that are feasible with the existing bus fleet also declines since congestion increases, making it more and more difficult to serve the commuting population with the fleet.

Below is a mathematical description of the demand model's structure.

Equation 1: $\text{Buses}_{it} = \phi[\textbf{Volume}_{it}, \textbf{Pirate}_t, \textbf{RTrips}_{it}]$,

Equation 2: $\text{Volume Percapita}_{it} = \phi\left[\text{Population}_{it} \times \text{Ratiourban}_t, \text{RTrips}_{it}, \frac{\text{GDP}_t}{N_t} \times \textbf{Wealthfactor}_i, \textbf{Pirate}_t\right]$,

Equation 3: $\text{RTrips}_{it} = \phi[\text{Roadnetwork}, \text{Bus}_{it}]$,

Equation 4: $\text{Volume}_{it} = \text{Volume Percapita}_{it} \times \text{Population}_{it}$.

where **Buses** are the number of buses on each corridor i at time t;
Volume per capita is the bus passenger volume per corridor i divided by the population size of the corridor;
Ratiourban is the ratio of total population for the 14 corridors to the total population for San Jose at time t.
Wealthfactor is the reported average wealth of the corridor i with weights drawn from the consultant created data showing general wealth on a scale of 1 to 5 (1 being low income, 3 medium income, and 5 high income.
Roadnetwork is the number of miles of paved highway in Costa Rica (a constant).
Pirate variable taking on the value of zero in 1994 and 1 thereafter; it measures the impact of non-licensed operators on licensed operator ridership.

A simultaneous model was developed in which there is a linkage between transit ridership, population within each corridor, relative wealth in each corridor, and economic growth in Costa Rica. There is a linkage between the models so that some simultaneous properties are embodied. For example, the number of buses influences the number of round trips, and the number of round trips influences the ridership per unit of population. When the number of buses increases, then the number of passengers per round-trip declines as does the number of round-trips per bus.

The statistical characteristics of the model are shown below.

Endogenous/Exogenous Variables	**Buses**	**Volume/Population**	**Round Trips**
Volume	.47•		
Population*RatioUrban		-1.8526	
GDP/N*Wealthfactor		1.804	
Roundtrips	-.1646	-.033	
Roadnetwork (fixed)			-9.2
Pirate Dummy	.217•	-.17•	
Buses			-.166

• = Statistically significant.

The general fit of each equation is quite good. The F-statistics in the model, which generally measure statistical fit of the collected set of independent variables, are all quite high and the standard errors low.

The signs of the variables suggest certain relationships. In the model, the number of buses will rise as the volume of traffic grows. However, if the number of buses increases and if the rate of increase overshoots the growth in ridership, then the number of round-trips per bus must decline. This market behavior was confirmed by the Costa Rican team and by the participants in the workshop.

Population growth is taken positively in the fourth equation that translates volume per unit of population into total ridership. But population growth also reduces the incremental unit of ridership per unit of population. This may be due to the fact that a fast-growing population is caused by more families, not necessarily more workers or school children who use the bus for transport.

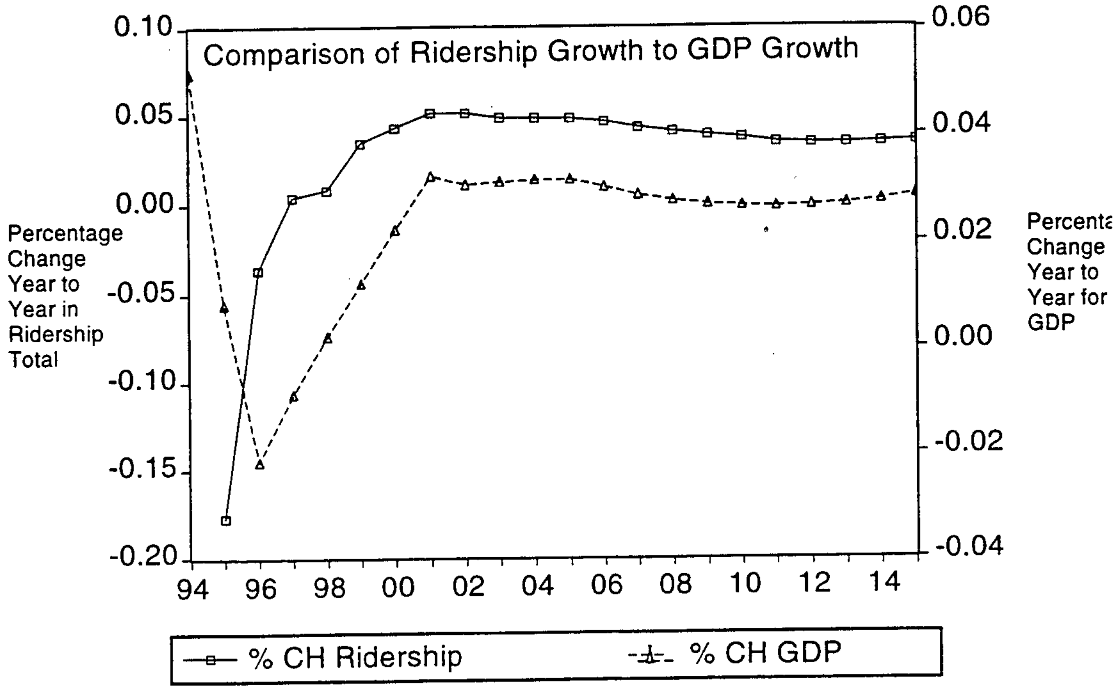
Growth in income stimulates growth in ridership. When the economy is growing faster, there are likely more jobs available which, in turn, generates more riders. We have adjusted income growth for Costa Rica by the relative weight based on the wealth factor. The wealth factor, developed by LCR Logistica, provides a ranking of corridors on a scale from 1 to 5 with the average corridor between 2 and 3. A richer corridor is one with a higher wealth factor. The increase in real income has a more positive impact on richer than poorer corridors. Of course, without any movement in this indicator, the forecast is not dramatically impacted. If, however, we assume a change in this factor over time for some corridors this would have a measurable impact on traffic growth.

The equation representing round-trips has two variables of which one is dynamic. When the number of buses increases, there is a decline in the number of round-trips per month. In short, congestion on the roads along with a slow growth in passengers and an increase in the supply of buses contributes to this decline.

Ridership Projections Using the Model

The model produces useful long-term indicators of potential transit growth within the San José region. As the table below indicates, the overall growth is quite reasonable. Real growth in ridership was negative over the 1994-96 time period mainly due to the slowdown in the economy and the increase in non-licensed ("informal") operators on major routes. The model projects ridership growth of about 2.3% over the 1996-2000 period as the economy recovers. The economic outlook and the continued growth in population produces roughly 5% growth in ridership over the 2000-05 period. However, limits on roads and other factors then contribute to a slower growth in bus ridership for the 2005-10 and 2010-15 time periods.

The maximum growth rate is 5% followed by slower growth thereafter, as shown in the chart below. This corresponds to the recovery in per capita income growth in the Costa Rican economy.



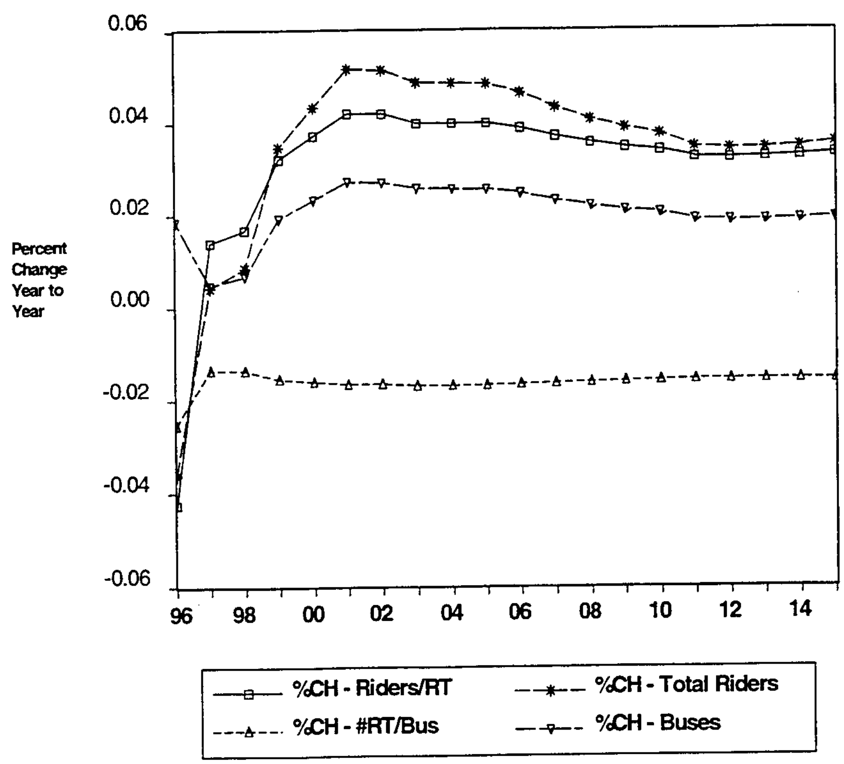
We can see that relatively strong ridership growth is expected and that this will correspond to the growth in income per capita in the economy. The model also projects that there will be a growth in the number of new buses operated. This is based on past patterns of growth and reflects the tendency of bus operators to meet future growth with surplus capacity. As a result of this, the number of round trips per bus will have to decline as the riders per bus remains level at first and then increases. Since the model does not force the number of passengers per bus to be fixed over time, some of this increase in ridership per bus will have to lead to additional buses on the route or to more round trips per bus.

The fastest growing corridors over the 1996-2000 time period are 3, 5, 7, 8, and 11. These all grow by about 3.4% compared to 1.4 to 3% for the other routes. Growth over the 2000 to 2005 period is faster with growth of close to 6% in some years. How realistic is this? We know that the economy will be growing more strongly over this period, and, given the demand for jobs within San José, including the industrial corridor between Alajuela and Cartago, this growth is not out of the question. Even with this faster growth the total ridership in 2005 is only about 17,000 per month higher than the monthly ridership attained in 1994. It is important to note that this forecast is "unconstrained" except for a congestion factor in the form of the number of kilometers of roads in Costa Rica, which is assumed to remain constant.

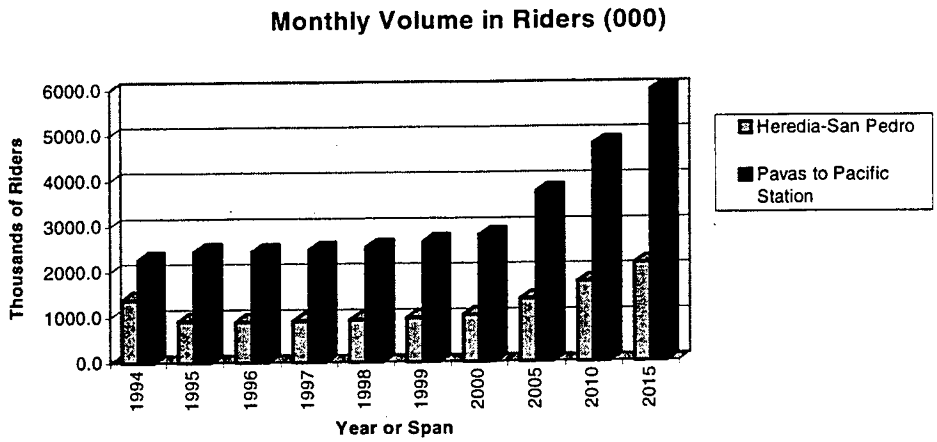
The following chart shows that, in the forecast, the number of round trips per bus is expected to decline even in the face of growth in the number of riders as operators put more and more buses into operation to meet the growing demand. However, the number of passengers per bus does not grow as fast as the number of riders in view of the larger number of buses. While this behavior by the operators was confirmed to be common, it is eventually disastrous since the increased congestion will make it even more difficult than today to keep the buses moving. In this situation, it will become even more difficult for the operators to make money.

The bus operators told the ICF Kaiser team that they can make money when their buses are moving, which is typical outside of San José. Once they enter the downtown area, however, their ability to keep moving, and to make a profit in their operations, is diminished significantly. This congestion effect was taken into consideration in the design of the integrated transit system, Chapter II.

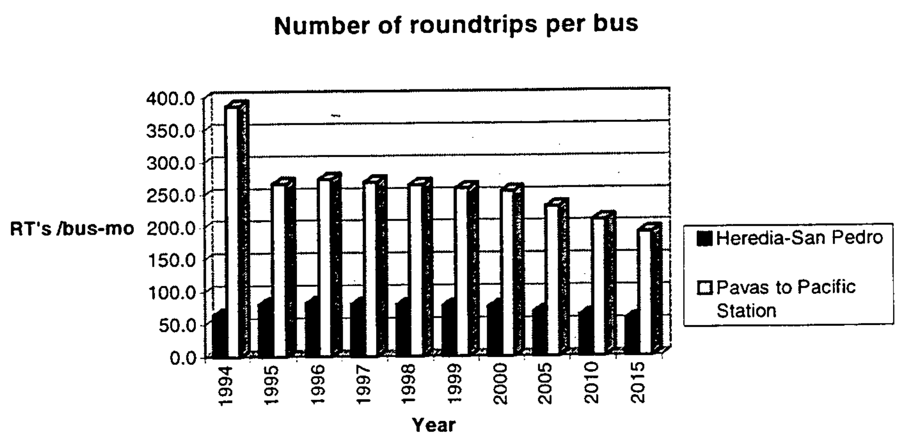
Comparison of Growth in Ridership (Vol) Against Growth in Number of Buses (Bus) Against Growth in Riders per Roundtrip (AVT) Against Growth in Number of Roundtrips per Bus Per Month



Individual corridors show differing growth patterns. In the following chart, two routes are compared. Note that the final three data points represent time spans of five years each. The Pavas - Pacific Station route shows higher demand than the Heredia - San Pedro line, and its growth rate is also slightly higher.



Similarly, the model generates the number of round-trips per bus, and the following chart shows that, in both the Heredia-San Pedro and the Pavas-Pacific Station lines, the required number of round trips per bus is expected to decline. This, of course, assumes that the behavior of the private bus operators is unchanged and that they continue to add buses whenever there is an increase in demand that exceeds the growth in overall population.



The following four pages contain the detailed forecast generated by the model. The tables include the number of bus passengers, the number of buses in operation, the number of riders per bus and the number of round trips per month on each of the 14 corridors in the study.

This model was developed using commerically available software from a company called QMS (California), under the trademark name Eviews under the Windows 95 operating system.

	Monthly Volume in Thousands of Riders											Percent Growth			
	1994	1995	1996	1997	1998	1999	2000	2005	2010	2015	94-96	96 - 2000	2000-05	2005-10	2010-15
Heredia-San Pedro	1387.7	918.8	904.8	917.9	935.7	979.0	1032.9	1380.9	1757.0	2166.3	-19.26%	3.37%	5.98%	4.94%	4.28%
Alajuela to San Pedro	2569.9	1701.5	1675.5	1699.8	1732.8	1813.0	1912.8	2557.2	3253.7	4011.7	-19.26%	3.37%	5.98%	4.94%	4.28%
Alajuela to Cartago	5992.1	4605.7	4610.7	4621.4	4652.7	4801.9	4996.1	6260.8	7554.3	8828.7	-12.28%	2.03%	4.62%	3.83%	3.17%
San Antonio to Pacific Station	2402.9	2601.1	2590.7	2631.0	2682.4	2806.7	2961.3	3970.9	5078.4	6332.1	3.83%	3.40%	6.04%	5.04%	4.51%
Pavas to Pacific Station	2267.2	2454.2	2444.4	2482.4	2530.9	2648.2	2794.1	3746.7	4791.6	5974.5	3.83%	3.40%	6.04%	5.04%	4.51%
Ciruelas to Pacific Station	2687.4	2909.1	2897.5	2942.5	3000.0	3139.0	3312.0	4441.1	5679.7	7081.9	3.83%	3.40%	6.04%	5.04%	4.51%
Alajuela to Pacific Station (via Ciruelas)	3724.3	4031.5	4015.4	4077.8	4157.5	4350.2	4589.8	6154.7	7871.1	9814.3	3.83%	3.40%	6.04%	5.04%	4.51%
Alajuela to Pacific Station (via San Antonio)	3439.8	3723.5	3708.6	3766.3	3839.9	4017.8	4239.2	5684.5	7269.8	9064.5	3.83%	3.40%	6.04%	5.04%	4.51%
Atlantic Station to Pacific Station	480.3	399.5	364.6	366.9	371.2	385.3	403.4	523.5	651.1	784.2	-12.86%	2.56%	5.35%	4.46%	3.79%
Tibas to Pacific Station*	1225.4	1008.0	968.6	964.9	965.1	990.6	1025.4	1265.6	1508.1	1730.9	-11.09%	1.43%	4.30%	3.57%	2.79%
Paso Ancho to Pacific Station*	535.6	481.8	480.6	487.6	497.1	520.1	548.8	736.1	941.4	1166.8	-5.27%	3.37%	6.05%	5.04%	4.39%
Desamparados to Pacific Station	5609.9	3896.6	3927.2	3914.2	3916.3	4021.1	4163.1	5133.2	6106.1	6982.3	-16.33%	1.47%	4.28%	3.53%	2.72%
Moravia to Atlantic Station	4543.6	3713.7	3304.7	3300.9	3309.5	3404.9	3531.8	4395.4	5270.0	6059.7	-14.72%	1.68%	4.47%	3.70%	2.83%
Alajuelita-Hatillo-Pacific Station	1232.4	1445.7	1401.2	1417.8	1440.3	1501.6	1578.6	2085.9	2636.0	3238.9	6.63%	3.03%	5.73%	4.79%	4.21%
Pavas to San Pedro (diametral)	5769.0	4721.7	4273.3	4265.8	4274.6	4395.5	4557.2	5661.0	6778.1	7790.6	-25.81%	3.11%	8.77%	7.26%	5.63%

* diametral Norte/Suv.

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Number of Buses in Operation, by Segment											Compound Average Growth				
	1994	1995	1996	1997	1998	1999	2000	2005	2010	2015	94-96	96 - 2000	2000-05	2005-10	2010-15
Heredia-San Pedro	95.0	134.5	124.2	125.4	126.8	130.0	133.7	155.6	176.9	198.1	14.32%	1.86%	3.08%	2.60%	2.29%
Alajuela to San Pedro	176.0	249.0	230.0	232.2	234.9	240.7	247.6	288.2	327.6	366.8	14.32%	1.86%	3.08%	2.60%	2.29%
Alajuela to Cartago	353.0	454.0	442.0	444.3	447.4	456.0	466.7	530.7	592.0	649.9	11.90%	1.37%	2.60%	2.21%	1.88%
San Antonio to Pacific Station	73.1	128.2	127.2	128.5	129.9	133.1	136.9	159.7	182.0	204.9	31.88%	1.86%	3.13%	2.64%	2.40%
Pavas to Pacific Station	69.0	121.0	120.0	121.2	122.6	125.6	129.2	150.7	171.7	193.3	31.88%	1.86%	3.13%	2.64%	2.40%
Ciruelas to Pacific Station	81.8	143.4	142.2	143.7	145.3	148.9	153.1	178.6	203.5	229.1	31.88%	1.86%	3.13%	2.64%	2.40%
Alajuela to Pacific Station (via Ciruelas)	113.3	198.8	197.1	199.1	201.4	206.3	212.2	247.6	282.1	317.5	31.88%	1.86%	3.13%	2.64%	2.40%
Alajuela to Pacific Station (via San Antonio)	104.7	183.6	182.1	183.9	186.0	190.6	196.0	228.6	260.5	293.3	31.88%	1.86%	3.13%	2.64%	2.40%
Atlantic Station to Pacific Station	19.3	20.6	21.5	21.6	21.8	22.2	22.8	26.2	29.4	32.5	5.48%	1.48%	2.77%	2.37%	2.04%
Tibas to Pacific Station	50.0	50.0	54.0	54.0	54.2	55.0	56.1	62.8	69.2	74.8	3.92%	0.96%	2.28%	1.96%	1.57%
Paso Ancho to Pacific Station	20.0	18.0	17.0	17.2	17.4	17.8	18.3	21.3	24.3	27.3	-7.80%	1.86%	3.08%	2.67%	2.36%
Desamparados to Pacific Station	256.0	241.0	252.0	252.2	252.9	256.8	261.7	293.1	322.6	348.3	-0.78%	0.95%	2.29%	1.94%	1.54%
Moravia to Atlantic Station	216.0	236.0	234.0	234.5	235.3	239.2	244.0	274.4	303.2	328.3	4.08%	1.05%	2.38%	2.02%	1.60%
Alajuelita-Hatillo-Pacific Station	54.0	73.0	95.0	95.8	96.7	98.9	101.6	117.6	133.3	149.0	32.64%	1.69%	2.97%	2.54%	2.25%
Pavas to San Pedro (diametral)	119.0	171.0	174.0	175.2	176.8	180.6	185.3	213.5	240.9	268.1	20.92%	1.59%	2.87%	2.44%	2.16%

Notes

1. Totals of these columns do not sum to correct fleet totals due to overlapping routes.
2. Buses are assumed to be those in the existing fleet, with 60-75 passengers/bus.
3. If articulated buses are used, with a capacity of 180 passengers/bus, the number of required buses may be reduced by more than half assuming no congestion constraints.
4. By using the ROW on the Heredia-San Pedro segment, 23 articulated buses are assumed to operate with a headway of 2.5 minutes.

	Riders per bus per roundtrip										Percent Growth				
	1994	1995	1996	1997	1998	1999	2000	2005	2010	2015	94-96	96 - 2000	2000-05	2005-10	2010-15
Heredia-San Pedro	122.5	45.0	47.8	48.8	50.0	52.0	54.4	68.9	84.8	102.3	-37.53%	3.29%	4.84%	4.24%	3.82%
Alajuela to San Pedro	122.5	45.0	47.8	48.8	50.0	52.0	54.4	68.9	84.8	102.3	-37.53%	3.29%	4.84%	4.24%	3.82%
Alajuela to Cartago	86.3	64.9	63.9	64.5	65.3	67.0	69.0	81.6	94.7	108.4	-13.92%	1.93%	3.40%	3.02%	2.75%
San Antonio to Pacific Station	90.2	80.9	79.2	81.0	83.0	86.3	90.3	114.6	141.4	171.9	-6.31%	3.34%	4.88%	4.30%	3.99%
Pavas to Pacific Station	85.1	76.3	74.7	76.4	78.3	81.4	85.2	108.1	133.4	162.2	-6.31%	3.34%	4.88%	4.30%	3.99%
Ciruelas to Pacific Station	50.4	45.2	44.3	45.3	46.4	48.2	50.5	64.1	79.1	96.1	-6.31%	3.34%	4.88%	4.30%	3.99%
Alajuela to Pacific Station (via Ciruelas)	44.7	40.1	39.2	40.1	41.1	42.7	44.7	56.8	70.0	85.2	-6.31%	3.34%	4.88%	4.30%	3.99%
Alajuela to Pacific Station (via San Antonio)	34.0	30.5	29.8	30.5	31.3	32.5	34.0	43.2	53.3	64.8	-6.31%	3.34%	4.88%	4.30%	3.99%
Atlantic Station to Pacific Station	84.5	27.7	26.7	27.1	27.6	28.6	29.8	37.0	44.9	53.4	-43.83%	2.78%	4.45%	3.93%	3.52%
Tibas to Pacific Station	100.5	85.5	84.2	85.0	86.1	88.6	91.6	110.7	130.9	151.4	-8.47%	2.13%	3.86%	3.41%	2.95%
Paso Ancho to Pacific Station	84.8	77.6	77.7	79.3	81.3	84.5	88.4	112.3	138.6	167.8	-4.28%	3.28%	4.90%	4.30%	3.90%
Desamparados to Pacific Station	99.8	78.8	73.2	74.0	74.9	77.1	79.7	96.3	113.7	131.3	-14.36%	2.15%	3.86%	3.38%	2.92%
Moravia to Atlantic Station	85.7	86.2	75.4	76.3	77.3	79.7	82.5	100.1	118.9	137.7	-6.20%	2.28%	3.94%	3.50%	2.98%
Alajuelita-Hatillo-Pacific Station	101.3	60.3	59.4	60.6	62.0	64.3	67.1	84.5	103.5	124.7	-23.42%	3.09%	4.72%	4.14%	3.80%
Pavas to San Pedro (diametral)	93.1	85.9	79.8	80.7	81.7	84.2	87.1	105.4	124.9	144.6	-7.33%	2.20%	3.90%	3.46%	2.97%

	Roundtrips per month by Segment										Percent Growth				
	1994	1995	1996	1997	1998	1999	2000	2005	2010	2015	94-96	96 - 2000	2000-05	2005-10	2010-15
Heredia-San Pedro	64.4	82.0	82.4	81.1	79.7	78.2	76.7	69.6	63.3	57.7	13.15%	-1.77%	-1.95%	-1.87%	-1.82%
Alajuela to San Pedro	119.2	151.9	152.6	150.1	147.6	144.9	142.1	128.8	117.2	106.9	13.15%	-1.77%	-1.95%	-1.87%	-1.82%
Alajuela to Cartago	1245.2	1135.3	1117.7	1106.8	1096.7	1084.8	1072.5	1006.9	945.9	891.9	-5.26%	-1.03%	-1.25%	-1.24%	-1.17%
San Antonio to Pacific Station	409.0	281.8	288.8	284.1	279.5	274.3	269.1	243.8	221.7	202.0	-15.97%	-1.75%	-1.96%	-1.88%	-1.85%
Pavas to Pacific Station	385.9	265.9	272.5	268.1	263.7	258.8	253.9	230.0	209.2	190.6	-15.97%	-1.75%	-1.96%	-1.88%	-1.85%
Ciruelas to Pacific Station	457.4	315.2	323.0	317.8	312.6	306.8	301.0	272.6	248.0	225.9	-15.97%	-1.75%	-1.96%	-1.88%	-1.85%
Alajuela to Pacific Station (via Ciruelas)	633.9	436.8	447.6	440.4	433.2	425.1	417.1	377.8	343.7	313.1	-15.97%	-1.75%	-1.96%	-1.88%	-1.85%
Alajuela to Pacific Station (via San Antonio)	585.5	403.4	413.4	406.8	400.1	392.6	385.2	349.0	317.4	289.2	-15.97%	-1.75%	-1.96%	-1.88%	-1.85%
Atlantic Station to Pacific Station	117.7	116.6	113.6	111.8	110.0	108.0	106.0	96.2	87.6	80.0	-1.79%	-1.71%	-1.92%	-1.84%	-1.80%
Tibas to Pacific Station	244.0	235.8	213.1	210.0	206.8	203.3	199.7	182.1	166.6	152.8	-6.55%	-1.61%	-1.83%	-1.76%	-1.71%
Paso Ancho to Pacific Station	316.0	344.8	364.1	358.2	352.3	345.8	339.2	307.2	279.4	254.7	7.34%	-1.76%	-1.96%	-1.88%	-1.83%
Desamparados to Pacific Station	219.5	205.3	212.9	209.8	206.6	203.1	199.5	182.0	166.4	152.7	-1.51%	-1.61%	-1.82%	-1.78%	-1.70%
Moravia to Atlantic Station	245.4	182.5	187.4	184.6	181.8	178.7	175.5	160.0	146.2	134.1	-12.61%	-1.63%	-1.83%	-1.79%	-1.71%
Alajuelita-Hatillo-Pacific Station	225.2	328.2	248.2	244.2	240.3	235.9	231.5	209.9	191.1	174.3	4.98%	-1.73%	-1.94%	-1.86%	-1.82%
Pavas to San Pedro (diametral)	582.3	444.9	454.6	447.6	440.6	432.7	424.8	386.1	352.2	322.1	-19.66%	-3.34%	-3.75%	-3.62%	-3.51%

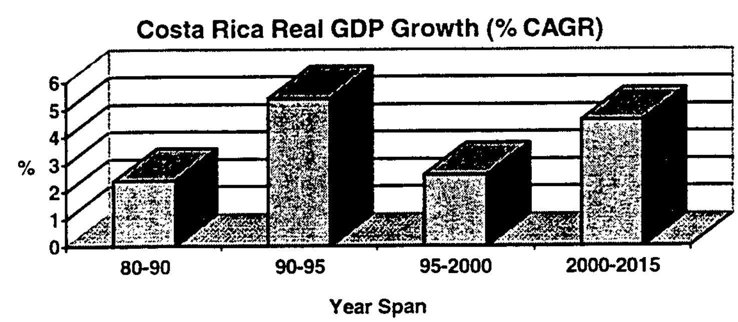
Costa Rica Macroeconomic Outlook

In order to develop an outlook for ridership demand in the San José area that is consistent with expected macroeconomic and income growth, the ICF Kaiser team assembled historical data and forecasts for the economy of Costa Rica. Included in the forecast were key drivers of income and population which were incorporated in the demand model.

Historical data from 1980-1995 was provided by The World Bank. The projections are those of the WEFA Group, a respected U.S.-based economic forecasting firm whose model of Costa Rica is, in turn, tied to other macroeconomic models of Costa Rica's trading partners.

The WEFA forecast through 2015 calls for real GDP to grow more slowly over the 1995-2000 period than in the first five years of this decade. This slower growth is already evident in the recent economic data (1995, 1996).

Real GDP Growth (Compound Average Annual)			
80-90	90-95	95-2000	2000-2015
2.4	5.4	2.6	4.6



Long term models like the WEFA model are structured to achieve equilibrium trend growth rates in the long term. Such built-in structures avoid the likelihood of the model generating "exploding" variables that become inconsistent with the rest of the economic picture. Therefore, the higher growth after the turn of the century can be attributed to the economy's return to the long-term growth trend.

More details concerning the Costa Rican economic outlook are available in the following table.

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The following Chapter IV describes the environmental work that was performed for each of the segments (routes) and technologies, especially in terms of the effects on air quality of each option together with noise and visual effects.

Macro-Economic Profile for Costa Rica
(In Millions of Real 1987 US Dollars, unless otherwise specified)
Source: The WEFA Group, USA

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2005	2010	2015	Compound Average Annual Growth 1990-95	1995-00	2000-15
Gross Domestic Product	5,135	5,250	5,657	6,023	6,480	6,683	6,683	6,836	7,007	7,288	7,616	9,720	12,131	14,991	5.4%	2.6%	4.6%
Percapita GDP (in 1987 US Dollars)	1,692	1,700	1,790	1,863	1,958	1,974	1,931	1,934	1,942	1,979	2,028	2,360	2,706	3,092	3.1%	0.5%	2.9%
Private Consumption Expenditure	3,144	3,114	3,370	3,589	3,855	3,978	3,985	4,080	4,185	4,351	4,545	5,776	7,183	8,844	4.8%	2.7%	4.5%
Investment	1,148	1,001	1,218	1,496	1,645	1,712	1,712	1,764	1,822	1,917	2,030	2,783	3,703	4,857	8.3%	3.5%	6.0%
Exports of Goods	1,432	1,600	1,704	1,931	2,107	2,171	2,148	2,193	2,245	2,346	2,468	3,311	4,355	5,702	8.7%	2.6%	5.7%
Imports of Goods	1,701	1,635	2,086	2,504	2,719	2,801	2,777	2,835	2,903	3,029	3,181	4,222	5,506	7,156	10.5%	2.6%	5.6%
Population (millions)	3.04	3.09	3.16	3.23	3.31	3.39	3.46	3.53	3.61	3.68	3.76	4.12	4.48	4.85	2.2%	2.1%	1.7%
Employment (millions)	1.02	1.05	1.07	1.10	1.12	1.15	1.17	1.20	1.22	1.25	1.28	1.43	1.58	1.73	2.4%	2.2%	2.0%
Nominal Hourly Wages (in US Dollars)	1.09	1.11	1.22	1.36	1.46	1.50	1.49	1.52	1.55	1.61	1.67	2.11	2.63	3.27	6.4%	2.3%	4.6%
Exchange Rate (Colones per USD)	92	122	135	142	157	180	201	227	257	288	314	444	444	444	14.4%	11.8%	2.3%
Gross Production	8,858	8,967	9,923	10,712	11,471	11,858	11,943	12,280	12,647	13,200	13,838	17,942	22,874	29,259	6.0%	3.1%	5.1%
Apparent Consumption	9,965	10,015	11,255	11,885	12,563	12,897	13,090	13,561	14,066	14,797	15,637	21,063	27,538	35,949	5.3%	3.9%	5.7%

IV. Environmental Feasibility Analysis

Introduction

This chapter presents a brief summary of the results of the Environmental Feasibility Analysis (EFA) for the segments and technologies proposed as part of the transit system for San José. The reader is referred to Appendix I for a detailed presentation of the analysis and results. The implementation and operation of an integrated transit system for a city like San José has potentially significant environmental benefits, as well as negative impacts that require mitigation. These environmental effects in an urban setting cover a broad spectrum of issues, including air quality, noise, and induced development, among others.

Air quality is one of the most important environmental aspects of this analysis. The Greater San José Metropolitan Area, comprising the cities of San José, Alajuela, Heredia, Cartago, and intermediate suburbia make up the area of study. This area contains about 56 percent of the country's population, and 75 to 80 percent of all vehicles. Recent air quality data, though fragmentary, indicate that levels of air pollution are high enough to be of concern for public health, especially concentrations of airborne particulates. Air pollution is also considered detrimental to tourism, an important economic activity for the country.

Motor vehicles are considered the main source of pollutant emissions in Costa Rica. Most public transportation in San José is based on buses, which account for approximately 70 percent of the person-trips in the city. Almost all of the buses in San José run on diesel fuel and the bus fleet is quite old, with many of the units in the downtown area being old U.S. school buses using low-grade diesel. This contributes to high particulate levels, especially in the congested downtown area.

The proposed transit system for San José and the related air quality benefits analysis presented in this chapter are related to the Transport and Air Quality Management Project (TAQMP) currently under evaluation by the World Bank. This project is still in a conceptual/development stage and during its work, the ICF Kaiser team maintained close coordination with the World Bank team in charge of the TAQMP. The general objectives of the TAQMP may include, among others, the improvement of air quality in San José by reducing vehicle related particulate pollution, the improvement of the scientific base related to air quality in San José, the implementation of measures to reduce traffic congestion and improve bus performance, and improved road maintenance.

The scope and objectives of an EFA are different from those of an Environmental Impact Analysis (EIA). The main objectives of an EFA include:

- A rapid characterization of environmental conditions in the area of influence of each of the alternatives;
- An environmental comparison of alternatives, including both benefits and potential negative impacts;

- Early determination of environmental impacts that may be so severe as to make a given alternative unfeasible;
- Definition of general mitigation measures to reduce the significance of environmental impacts previously identified; and
- Definition of additional studies recommended for the EIA of the preferred alternative(s) to be prepared in a later phase. It is within the context of the EIA that detailed field-characterization of the affected environment, specific monitoring of key environmental parameters, modeling of potential environmental impacts, and design of specific mitigation measures will be made.

The level of detail of the environmental feasibility analyses is consistent with the scope and detail of other sections of this report (e.g., operations, costs, legal issues). This consistency allows for an integrated comparison of the alternatives.

The following sections present the main results of the EFA for the various categories of impact analysis. The reader is referred to Appendix I for a detailed presentation of the current environmental conditions, the comparison of impacts suggested mitigation measures at a conceptual level, and additional studies recommended to quantify some of the potential environmental benefits and impacts. The following sections analyze air quality benefits, health benefits, traffic interference, utilities interference, visual impacts, noise and vibration, encroachment and induced development, energy requirements and environmental requirements.

Air Quality

The environmental benefits of clean transportation (e.g., an electric system) are expressed in many ways - the quality of life improves from reductions in noxious diesel fumes, urban haze is reduced, overall regional health can improve through reductions in respiratory illnesses, and pollution-caused crop and property damage are reduced. Some research has even indicated a link between the particles released in diesel exhaust, such as is produced by existing transit buses in San José, and some types of cancers. These improvements in the quality of life also translate to economic benefits which, although difficult to calculate due to the uncertainties of valuing some of these intangible elements, contribute to the overall prosperity of a metropolitan area. In this feasibility study, some first steps towards quantifying the relative benefits of different technological approaches to improving the transportation infrastructure were evaluated.

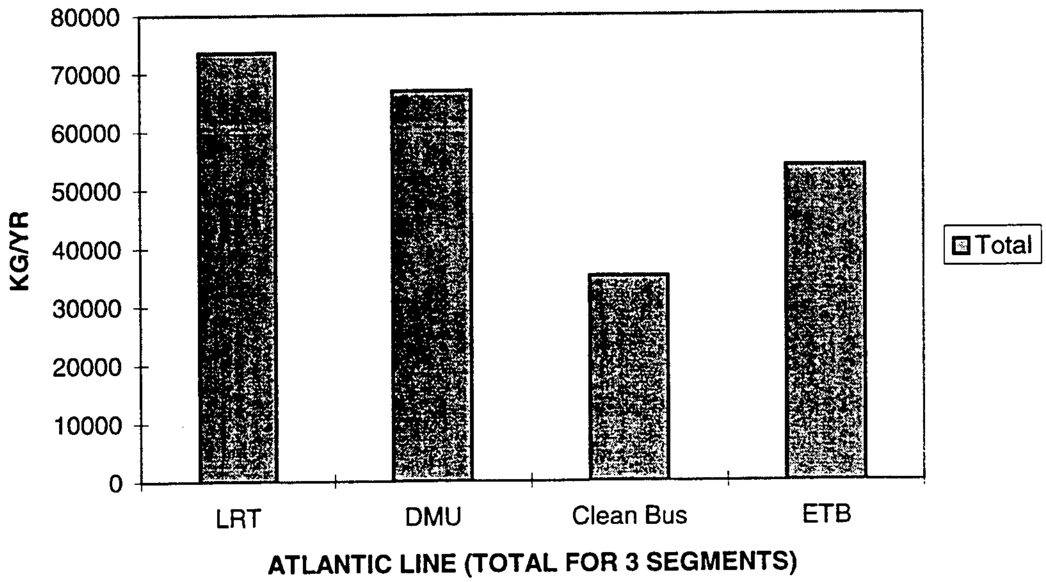
To place these results in context, we also studied the existing ambient pollutant monitoring data that have been collected for the metropolitan area. We compared these data with World Health Organization (WHO), US, and available Costa Rican standards for ambient air quality. With these comparisons, we are able to begin to target specific pollution problems that create the greatest adverse effect for the people of the SJMA. Monitoring data for the SJMA and vicinity show exceedances of Costa Rican guidelines, WHO guidelines, and/or US Ambient Air Quality Standards for CO, lead, TSP, PM_{10}, and SO_2. For example, the Costa Rican standard for particulate matter is an annual geometric mean of 80 $\mu g/m^3$. Measured values at sites in the SJMA in 1996 ranged from 159 to 272 $\mu g/m^3$, exceeding the standard by almost a factor of 3.5. For a detailed presentation of this data, the reader is referred to Appendix I. Available ambient monitoring data are inconclusive for determining whether similar problems exist for ozone and secondary particulate matter. Often, these pollutants are a more significant problem downwind of urban centers due to the time needed for the photochemistry to "cook" the precursor emissions. Motor vehicle emissions are known to be major contributors to concentrations of each of these pollutants. Concentrations of TSP appear to be increasing over time, while there is some evidence that concentrations of lead are decreasing.

The focus of our effort was several regional transportation corridors. Along each corridor, an estimate was made of the existing pollution levels that arise from the metropolitan area's dependence on older technology diesel buses. As a further indicator of transportation-related pollution, simple Gaussian dispersion modeling for generic roadways and intersections was conducted using the model CAL3QHC to estimate the ambient concentrations resulting from transit buses on a per vehicle basis. The modelling results are presented in Appendix I.

The relative benefits of different technological solutions to the problem of transportation-caused pollution were evaluated by estimating how much pollution would be removed from a corridor by switching to a specific technology. In this way, we could decide what technology gave the most environmental benefit, because whichever had the largest emission reduction also would result in the cleanest air in that corridor. An example of the relative benefits of the technologies considered is shown in Figure 4.3-1, which shows the cumulative amount of particulate matter pollution that would be removed from the air by each technology within three segments of the Atlantic Line. The results presented in this figure are representative of the trends shown by the modelling of the various corridors considered. As can be observed in the figure, the greatest benefits accrue from the electrical technologies of LRT. At the left of this figure, one can see that the LRT technology provides the greatest benefit, removing nearly 75,000 kilograms of particles from the air each year. The LRT provides slightly more benefits than the ETB in some corridors, despite being both electric technologies, due to its greater capacity for carrying passengers. The DMU technology reduces particle emissions, though it is diesel-based, because it has greater carrying capacity than existing buses and far better emission control systems. Clean diesel buses provide the least benefit because they only result in emission offsets due to replacement of dirty buses with cleaner buses, unlike LRTs, which remove more transit related emissions. Nonetheless, even clean diesel buses can provide benefits, with the potential to remove over 30,000 kilograms of particles on an annual basis on these particular segments.

Although the results of this feasibility analysis are subject to many caveats, they do demonstrate that significant benefits can be realized from the introduction of cleaner technologies into the SJMA transit system. The reader is referred to Appendix I for a comprehensive presentation of air quality modelling results.

Figure 4-1
Savings Impacts of Technologies on PM



Valuation of Potential Health Benefits Associated with Improvements to Air Quality

In recent years a number of studies have been conducted to evaluate health risks of pollutant emissions in monetary terms, with corresponding benefits of emission reductions. All of these studies use a damage function approach to estimate benefits and/or damages associated with changes in pollutant emissions. A detailed discussion of future studies needed to quantitatively value potential health benefits associated with improvements in air quality in San José is presented in Section 4.2 of Appendix I.

Population exposure assessment requires information about the spatial distribution of pollutant concentrations and the concurrent spatial distribution of individuals. Simple models use residential location as a surrogate for the spatial distribution of populations; more complex models track movements of population subgroups among indoor, outdoor, and in-vehicle locations, as well as among geographic locations. If these exposure estimates are to be combined with a health risk relationship where exposure was estimated from residential location, only residential distributions of populations are required to complete the population exposure assessment.

The exposure-health risk relationships likely to be most important for Costa Rica are:

- Excess mortality and morbidity associated with general particulate matter
- Excess cancer incidence associated with diesel particulate matter

- Excess mortality and morbidity associated with ozone

Prominent examples of studies quantifying the effect of particulate matter on excess mortality are epidemiological in nature. Thus, residential locations may be used to evaluate "exposure" concentrations. The estimates of the percentage increases in mortality per 10 Tg/m^3 daily PM_{10} concentration range from about 0.5% to 1.5%. The WHO estimates a 1% increase in mortality per 10 Tg/m^3 daily PM_{10} concentration. Extrapolation of these studies to Costa Rican conditions may introduce some uncertainty, since factors like smoking prevalence, meteorological conditions, or composition of particulate matter, may be different in Costa Rica.

Some of the PM_{10} morbidity effects for which exposure relationships have been quantified are chronic respiratory disease, respiratory hospital admissions, emergency room visits, asthma attacks, restricted activity days, and acute respiratory symptoms. These studies also rely primarily on measured outdoor concentrations in the vicinity of the subjects residences as estimates of exposure. WHO estimates the following rates of increased morbidity associated with a 10 Tg/m^3 daily PM_{10} concentration increase:

- Hospital admissions: 2%
- Symptoms exacerbation: 5%
- Bronchodilator use: 7%

Excess cancer incidence associated with diesel particulate matter is under investigation by both the California EPA and the US EPA. Evidence is based primarily on animal studies. A carcinogenic unit risk factor is defined as the probability of an individual contracting cancer from continuous exposure for 70 years to an inhalation concentration of 1 Tg/m^3. The assumption underlying US EPA's standard regulatory model of carcinogenic risk at low concentrations is that the risk is linearly proportional to the exposure concentration. Thus, the number of excess cancers in the population is estimated as the product of the unit risk factor, the population at risk, and the average inhalation exposure concentration. In this case exposure should be estimated as the actual exposure concentrations as individuals move among microenvironments and geographic areas. The proposed unit risk factors for diesel particulate matter range from 1.6×10^{-5} to 2.0×10^{-3}.

Some recent epidemiological studies in the US present evidence suggesting a association between ozone exposure and daily death rates (Kinney and Ozkaynak, 1991, 1992), for an annual mean of the daily maximum 1-hour average concentrations in the range of 60 to 80 ppb. The results suggest approximately 1 additional annual death per million population for each 1 ppb increase in the annual mean of the daily maximum 1-hour average concentration. Epidemiological studies relating ozone exposure to morbidity include the risk of respiratory hospital admissions, aggravation of asthma, restricted activity days, and acute respiratory symptom days. Premature aging of the lung due to chronic elevated ozone exposure has also been investigated. In addition, clinical studies have been conducted to estimate the relationship between ozone exposure and acute respiratory symptoms, such as decrements in lung capacity, chest discomfort, and cough. Application of the relationships derived from clinical studies requires estimates of actual exposure concentrations.

Valuing reductions in mortality and morbidity is a difficult and controversial endeavor. In the case of mortality most economists value reductions in the probability of death according to what individuals are willing to pay (WPT) for such reductions, or what they are willing to accept in compensation to forego the reductions. The primary method for estimating WPT utilizes wage premiums associated with different levels of on-the-job risks of fatal accidents. In the case of morbidity, in addition to WTP, a cost-of-illness (COI) approach has also been used, that estimates both out-of-pocket medical and caretaking expenses, as well as the value of lost productivity to value the cost of illness. Because the COI does not include factors of pain and suffering, it is likely to result in lower estimates than WTP.

WPT and COI values are likely to vary from geographically, so that extrapolation from the US to Costa Rica would introduce significant uncertainty into the results. Therefore, an effort should be to identify values estimated specifically for Costa Rica or the Central American area.

Traffic Interference

The construction of any of the four proposed technologies have the potential to interfere with existing traffic and transit system. The potential traffic interference for those segments located in downtown San José are expected to be significant but temporary during the construction phase. The LRT, DMU, and ETB systems are expected to cause higher levels of traffic interference than the Busway system during the construction phase, as their construction activities are more intensive and require temporary lane or street closures. The operation of the new transit system is expected to provide an efficient mass transport system, reduce the number of buses and cars in circulation, and reduce the congestion levels on main streets and avenues, so the operation of the proposed systems with an appropriate signal system and traffic management plan is not expected to cause traffic interference. All potential traffic interference impacts during construction and operation can be mitigated through the development of a comprehensive transportation management plan. Appendix I present the streets and interchanges where a traffic interference during construction may occur.

Utilities Interference

The construction of a transportation infrastructure project like the one proposed for San José in an urban environment has the potential to interfere with existing utilities. Because the proposed technologies would not require large excavation and earth moving activities, potential impacts to underground utility networks are expected to be minimal. However, electric technologies, such as LRT and ETB with the overhead electric catenaries, would interfere with the low overhead cables that cross their routes. These overhead cables are quite common in San José, especially in the downtown area, and transmit electricity, telephone, cable TV, and support traffic lights. The construction of an LRT or ETB system would require the relocation of these overhead cables to an underground network. This process would imply a temporary cut-off of these utilities to specific residences.

The interference with overhead cables would cause a potential temporary and localized impact only for electric technologies (LRT and ETB) and not for the other technologies considered (DMU and Buses). The number of overhead cables that would require relocation is much larger in downtown San José than in other segments of the system. Within the downtown area, the street segments considered and the Atlantic-Pacific Station connectors would have a high potential for interference with the overhead cables. Other rail ROW segments would have a relatively low potential for interference.

The early design and implementation of a relocation plan for overhead cables that cross segments using electric technologies would minimize the temporary and localized impacts and nuisance to residents and business served by the affected cables. A public information and coordination campaign is also recommended. It is also important to coordinate with public utilities with respect to future expansion plans, to accommodate such plans in the design of the transit system.

Visual Impacts

Potential impacts to the visual quality and aesthetic characteristics were evaluated with respect to visual impacts. The visual impacts caused by any of the technological options considered in the rail ROW are not expected to be negative. In the downtown area, no significant visual impacts to monuments, historic buildings, or tourist attractions are expected. Given that the rail ROW is currently in poor condition due to low maintenance, and given that the areas surrounding the historic monuments and tourist attractions are already highly developed and have a commercial character, the new proposed technologies on the rail ROW and the street segments would have little negative visual impact. Overall, renovation or construction of new buildings for transfer stations could have a positive visual impact. Even though few significant visual impacts are expected, sensitive and unobtrusive designs and structures are recommended.

Noise and Vibration

The four technologies proposed for the San José transit system generate different types and intensities of noise. Appendix I presents a review of typical noise level increases for the technologies analyzed in this study. Therefore, each will have a different level of significance in terms of noise impacts to areas with sensitive receptors located near the proposed segments and with current low noise levels. The Busway and the ETB systems are expected to emit lower noise levels during the construction phase than the LRT and DMU systems, as their construction activities differ in intensity. However, the Busway and the DMU systems are expected to emit higher noise levels during the operation phase, as their diesel-powered engines generate higher noise levels than the LRT/DMU electric-powered engines.

Evaluation of the significance of potential noise impacts caused along the various segments would require a detailed monitoring and modeling effort beyond the scope of this EFA. The potential noise impacts for those segments located in downtown San José would probably not be significant, as these areas already experience high levels of noise due to traffic congestion. Depending on the number of vehicle users that move to the new system, there could actually be an improvement in noise levels in the downtown area due to the reduction in traffic congestion. The proposed transit system may, however, cause some noise impacts along areas with sensitive receptors (e.g., hospitals, schools, residences) located close to the proposed segments and in areas with significant increases in noise levels during operation of the proposed transit system.

Several mitigation measures can be applied to noise sensitive areas in order to reduce all potential impacts.

The proposed transit system is not expected to cause vibration levels that could affect existing buildings because these structures have been built to sustain the relatively intense seismic activities in the region. Sensitive receptors located close to segments that currently experience little vibration may experience new levels that could cause nuisance to residents and users of these facilities.

Encroachment and Induced Development

After the closing of operations in the Atlantic Line in 1991 and in the Pacific Line in 1995, there has been a continuous process of encroachment into the rail ROW, from small incidents such as yard fences to sections of residences. A recent inventory by INCOFER in part of the Atlantic Line (Atlantic Station-Alajuela) and the Atlantic-Pacific Station connector indicated a total of 624 cases of encroachment. Many of these are of small nature, but are nevertheless an issue that could have significant impacts to some residents. INCOFER is continuing the inventory, but a more detailed characterization of the nature of the encroachment incidents is required. Although the owners of properties that have encroached into the ROW do not have land titles, an information campaign and public participation program will be required to minimize any conflicts. The construction and operation of any of the technologies along the street segments do not appear to require any relocation at this stage of analysis, as they will use existing transportation corridors. Later phases of design may indicate that some specific residences or infrastructures may need relocation. The large transfer stations would not require any relocation, as existing buildings would be used for this purpose.

See Appendix IV for photographs of the ROW.

The implementation of any of the technological options analyzed for the rail ROW may have an impact on the land use along the corridor but this effect would depend on a variety of other factors and could take a long time. The system along the street segments is not expected to have major impacts as they cross areas that are already heavily urbanized. The transfer stations, with the concentration of a large number of commuters, have the potential to alter the nature of land use around them by motivating the creation of centers of commercial activities. Transfer stations such as San Pedro, Desamparados, Colón, Guadalupe, the Atlantic and Pacific Stations are examples of stations where the commercial activities around them would probably be strengthened. Coordination with existing land use plans and coordination with municipal authorities is recommended to minimize any potential conflicts and to enhance the quality of communities around the transfer stations.

Energy Requirements

The operation of the electric options considered for the proposed transit system (LRT and ETB) will require the supply of electric energy. Appendix I presents an estimate of energy requirements and a comparison with existing capacity. The country of Costa Rica and the area of San José, in particular, currently have levels of energy capacity large enough to cover current demand. Estimates of the annual maximum energy capacity necessary for the operation of the LRT or ETB system are small compared to the existing and projected generating capacity of CNFL, the electric energy distributor company in San José. This implies that no significant energy impacts are expected from these two technologies based on preliminary operations data.

Environmental Requirements

The construction of any of the alternatives considered in this pre-feasibility analysis would require the preparation of a detailed Environmental Impact Assessment. This study would be reviewed by the National Environmental Technical Secretary (SETENA), a recently created government agency. The first step in the EIA process is to fill out a form to determine the requirements for the EIA. The evaluating authority would determine the need to prepare an EIA under the Organic Law for the Environment No. 7554, or if the information provided in the form is sufficient, there would be no need of an EIA. Once the EIA is presented to SETENA, this office has 45 working days to revise the document and comment on it. The project cannot start if the EIA is not approved by SETENA. The EIA document must be published in a public newspaper for public awareness. A period of 45 working days is required to receive public comments.

V. Economic Analysis of Transit Options

In this chapter, the costs of building and operating various technologies on each segment (route) are presented. A consistent approach was taken across all technologies and segments in order to assist in selecting an appropriate technology for both short-term and longer-term development phases.

Capital Costs

The capital costs involved in each of the technologies include physical projects such as the designing and constructing of a busway, the trackage materials required to revitalize the INCOFER ROW and to install an LRT, signaling systems, and various vehicle types such as clean diesel buses, LRT cars, or ETBs.

Methodology

For each of the 34 combinations of technologies and segments (routes), capital costs were developed using typical prices in the U.S. Since some capital cost items will, in fact, be lower in Costa Rica due to their higher labor content for installation and/or construction, ICF Kaiser adjusted such items by multiplying their U.S.-based values by 60%, which is a factor determined to reflect both lower labor rates and productivity in Costa Rica. It is the *adjusted* capital costs, therefore, that have the greatest meaning to the Costa Rica team.

As an example of this adjustment, the capital costs associated with the development of an LRT from Heredia to San Pedro include the purchase of new track and also the rehabilitation of 4 existing bridges. The track costs are not adjust since the majority of the cost is the purchase of the track outside of Costa Rica. However, the rehabilitation of the 4 bridges involves the potential use of a great deal of local labor; therefore, the estimated cost of this work, $500,000, was reduced to $300,000.

For each of the technology-segment combinations, the total capital costs were increased by 20 percent to reflect the expected cost of final design work, construction management, etc., for each project. Such a percentage is typical in U.S. work.

Similarly, a 25 percent contingency was applied to the total cost, including the design and construction management costs. This may appear high, but, at this early stage of the project formulation, when only 20% of the project has been designed (this was completed by ICF Kaiser for the busway option, Heredia-San Pedro), it is reasonable to make a 25 percent contingency assumption. This contingency assumption would be lowered later as further design work is completed and official bids on capital items are received. Also, for the purpose of this study, which was to provide a basis on which the Costa Rican team could begin to make informed, rationale comparative decisions between technologies and segments, it was principally important to use a consistent contingency factor throughout the analysis.

As part of the capital costs estimation, the expected life span of each item was included, and adjustments were therefore made to capture the fact that track will last 30 years while a new bus will last 12 years. In each of the capital cost sheets, the expected lifetimes of each item and the resulting adjusted cost are shown clearly. The adjustment for life span was made with the U.S. Federal Transit Agency (FTA) formula using a discount factor of 15 percent. In the case of the bridge rehabilitation, the Costa Rican cost of $300,000 resulted in an annualized capital cost of $76,150 given that the bridges are assumed to last 30 years.

The full set of capital cost sheets is presented in Appendix V.

Operating & Maintenance Costs

Operating and maintenance (O&M) costs include such items as fuel, maintenance of vehicles and related infrastructure, labor, overhead and administrative expenses, etc. These costs are typically a function of the rate at which a the transit system is operated and the technology employed.

Methodology

Using the assumed headways, vehicle sizes, numbers of round-trips, etc., ICF Kaiser used an O&M cost recommended by the U.S. FTA. The O&M cost is basically a function of the technology and the number of kilometers of use per year. The following table shows the assumed O&M cost per vehicle-kilometer for each of the technologies studied.

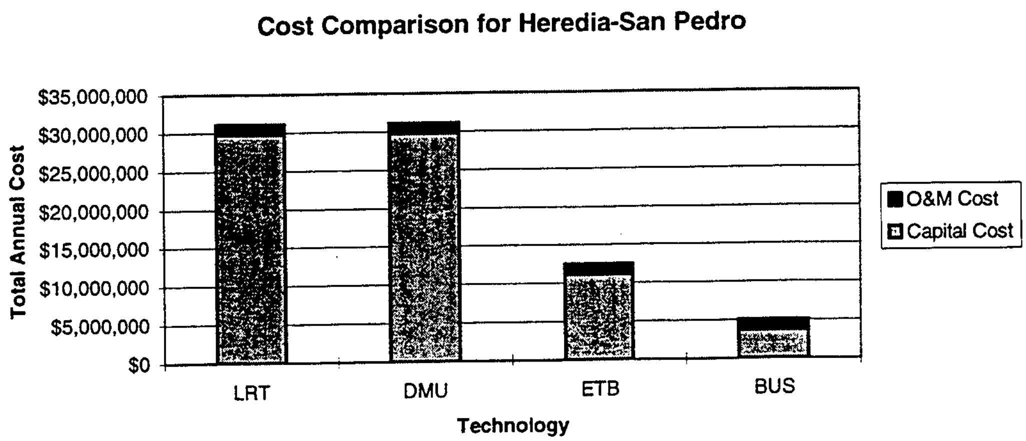
Technology	O&M Cost per Vehicle-Kilometer
LRT	$2.41
DMU	$2.21
ETB	$2.29
BUS	$1.23

For each segment (route) analyzed in the study, the expected annual vehicle-kilometers were multiplied by the above factor. It is clear that the O&M costs associated with operating buses are considerably lower than those for rail-based electric and diesel technologies (LRT and DMU) and for road-based electric buses (ETBs).

Cost Comparisons

Total, annualized capital and O&M costs vary considerably across the four technologies studied. Additionally, the ICF Kaiser team assumed that, for each segment, the technology is financed completely through debt (i.e. no equity investment) and that there is no government subsidy. The team assumed that all of the initial investment was obtained at 10 percent interest rate through a loan with a maturity in 15 years. Therefore, annual costs include both the capital and O&M costs, as well as the interest payments on the debt.

To show this variation, the chart below shows the individual capital (including interest) and O&M costs for each technology along the segment from Heredia to San Pedro.



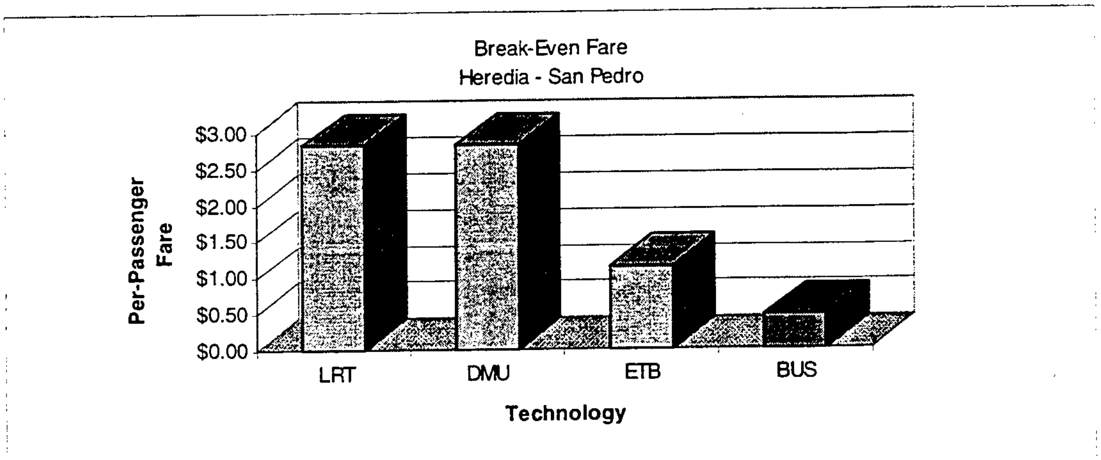
It is clear that LRT and DMU costs are quite costly even though, in the case of the LRT, the trackage materials were assumed to be used, perhaps purchased from a U.S. railroad that is changing or upgrading its track. Along this particular INCOFER right-of-way, the ETB costs are those for the capital, O&M and interest costs assuming the construction of a 2-lane paved surface, on which the ETBs can operate. However, this cost is over double that of bus technology since the ETBs themselves tend to be expensive item, typically built to order.

The ridership demand on each segment was calculated through the modeling exercise described in Chapter III. Therefore, as an example, in the Heredia-San Pedro segment, each of the above four technologies results in a different fare requirement for the 11 kilometers between the two end points. Under the assumption that each rider traverses the entire segment (note that true ridership demand would be determined carefully through screen-line data collection in any follow-on work for the selected technology and segment), the break-even fares required to cover all costs, including the financing costs, are in the same proportion as in the above chart. These break-even fares were calculated using a model, whose main screen is shown here:

Debt/Equity Ratio:	100%	Total Capital Cost:	$ 226,015,850
Interest Rate:	10%	O & M Costs:	$ 1,391,393
Term:	15 years		
Annual Payment:	$	Break Even Revenue:	$ 31,106,551
		Annual Ridership:	11,014,704
		Break Even Fee:	$
Technology:			
Segment:			

PPP Value:	0.6
Discount Rate:	15%

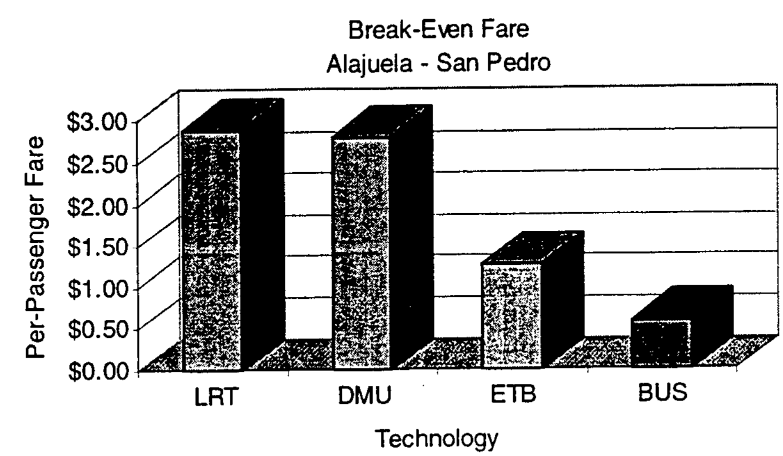
In the above case, the break-even fare is $2.82 (or almost 650 colones at 230 colones per dollar). Similarly, the total cost of each technology was calculated on each segment and the break-even fare was then determined. The break-even fare for each technology on the Heredia-San Pedro segment is shown in the chart below.



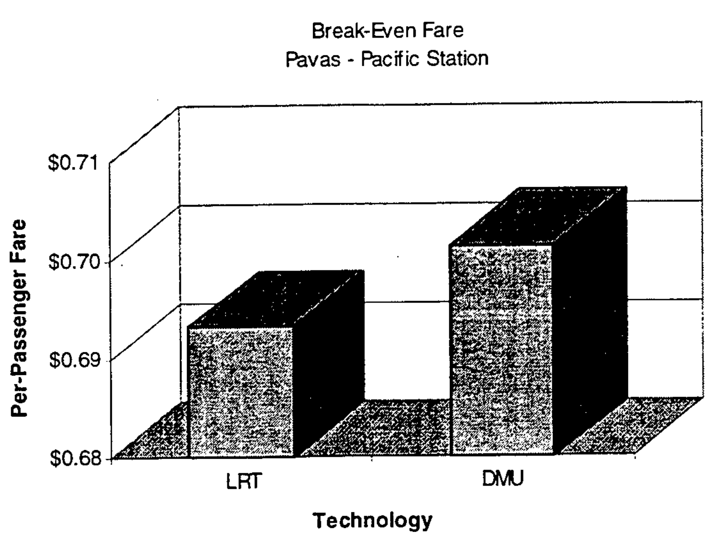
Clearly, the break-even fare is a function of the manner in which the project is financed. Greater equity participation by the investors, or a government subsidy of some size, could lower the annual costs, thereby lowering the break-even fares. However, the Costa Rican Government has made it clear that one of the objectives of the new San Jose transit system is to have it self-financed through the private sector. Therefore, we cannot assume any government subsidies for the operation of this segment, or any other segment, no matter what technology is deployed.

The model that calculates the required break-even fare, under user assumptions of debt/equity split, interest rate charged, term of the loan, etc., was provided to the Costa Rican team so that further analysis can be performed if desired.

The following series of charts shows the break-even fares, required to cover all capital, finance, and O&M costs, for other segments on which various technologies were evaluated. The purpose of displaying these charts here is to show to extent of the analysis. The details of the analysis, the calculations involved, and the results are part of the model delivered to the Costa Rican team at the end of the project.



Similarly, the break-even fare that would have to be charged, for example, to cover the total costs associated with the development and operation of a LRT/TRAM or a DMU service on the portion of the INCOFER Pacific Line from Pavas to the Pacific Station are shown in the following chart.

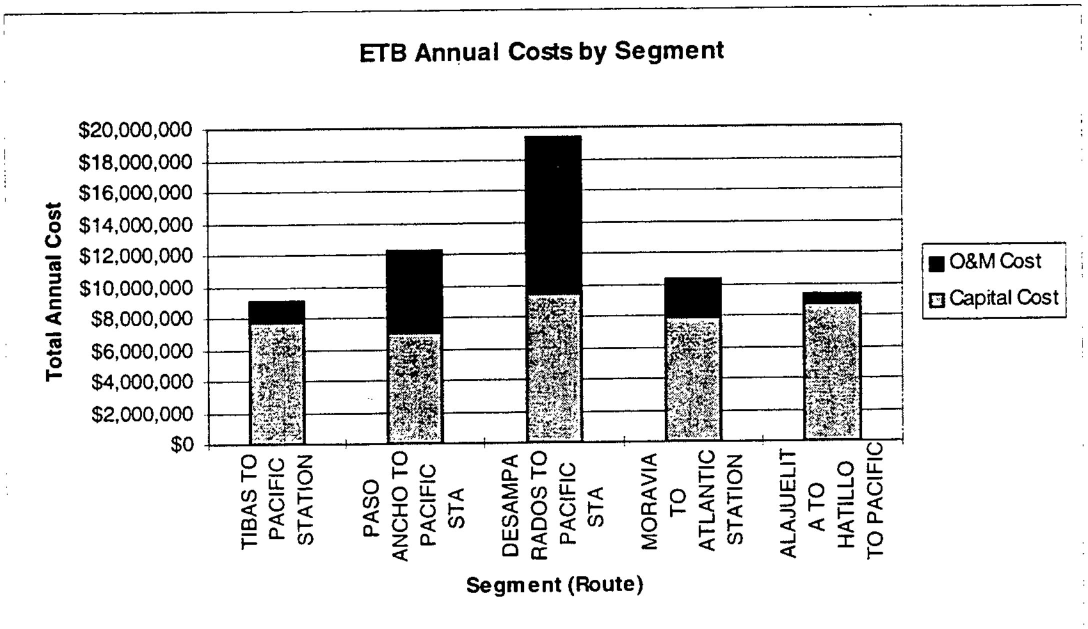


Clearly, the DMU is slightly more expensive, mainly due to its lower per-car capacity and the high maintenance costs. However, both are probably out of reach of the current passengers who take regular buses on this route, paying about $US0.20, or 40 colones in September, 1996, using an exchange rate of 200 colones per dollar.

For the shorter segments that were studied and considered as possible ETB routes,

- Tibas to Pacific Station
- Paso Ancho to Pacific Station
- Desamparados to Pacific Station
- Moravia to Atlantic Station
- Alajuelita - Hatillo - Pacific Station

using new ETB cars to serve these routes, similar capital and O&M costs were calculated, along with finance costs assuming 100 percent debt and a 15-year term on the loan. For these routes, the following chart shows the capital (including financing) and O&M costs.



In this case, the different O&M costs are due to the varying number of riders on each segment. Dense routes such as Desamparados to the Pacific Station (almost 47 million passengers per year, assuming all of the existing bus traffic switches to ETB service) will require more ETB service, more cars, and more usage of each car. This results in the following break-even fares for these five ETB potential routes:

Potential ETB Route	Break-Even Fare
Tibas to Pacific Station	$0.79
Paso Ancho to Pacific Station	$2.08
Desamparados to Pacific Station	$0.41
Moravia to Atlantic Station	$0.26
Alajuelita - Hatillo - Pacific Station	$0.55

(Note: The break-even fare for the Paso Ancho - Pacific Station line is so high because, based on the demand model, it is assumed that the potential ridership is considerably lower than the other lines, so that each passenger must bear a higher proportion of the total cost.)

It should be noted that the busway option, using the INCOFER ROW, is analyzed in greater detail in Chapter IX. The capital cost sheets and the related O&M data for each segment (route) and technology are included in Appendix V.

Conclusions - Cost Comparisons

It is clear from the cost analysis that the electric options are the most expensive in general, in terms of capital cost. Also, O&M costs per kilometer are higher for electric options than for buses, for example. The finance costs associated with each technology are also higher for the ETBs, DMUs, and LRTs because of their higher capital costs.

Based on these costs, it is reasonable from an economic viewpoint to consider options that

- are cost-effective in the short term
- help to improve San Jose air quality
- assist in reducing congestion in the downtown area and on access routes
- preserve the option to implement the cleanest technologies in the longer term.

Given that buses are clearly the cheapest option, but also more polluting than electric solutions, it is recommended that the Costa Rica team consider those options that start with a busway concept, transitioning to electric technologies such as ETB's or LRTs, or even battery powered buses, in the slightly longer term. Such an approach will help to relieve the congestion in San Jose and, at the same time, preserve the possibility of switching to cleaner transport modes when the fundamental economics of those modes becomes more favorable to Costa Rica.

Other Economic Costs and Benefits

The implementation of any major transportation infrastructure project generally will stimulate secondary and tertiary economic effects along the corridor. In particular, whether an improved rail service or a busway is considered for the INCOFER ROW (e.g. on the Heredia - San Pedro segment, as a starting project), other service businesses are very likely to develop along the route and at stations and transfer points. Typical among the services that are created are:

- Food and drink services
- Newspaper and magazine sales locations
- Snacks and quick foods
- Clothes cleaning services
- Gift shops (flowers, etc.)
- Bank offices, or Automated Teller Machines
- Parking facilities and related services (e.g. car washing, repair)

Such new businesses also create space for new advertising, assuming this is permitted by law.

Potential bidders for any of the concessions that might stem from the recommended options should consider the revenue potential from advertising (inside the vehicles, on other facilities that might be part of the concession) and from related services such as parking.

The electric options, such as the LRT and ETB, will generate a strong of positive economic effects that go beyond the above, more localized, economic developments. Since Costa Rica is rich in hydro-electric power, any reduction in the use of diesel buses will help to reduce Costa Rica's cost of importing foreign oil. This cost was $235 million in 1996, a substantial amount for the country. Reducing this cost will help to reduce the federal deficit, which, in turn will assist in the flight against inflation. Lower inflation, in turn, will help to increase real personal/household incomes, leading to greater levels of household consumption. The precise multipliers along each link in this chain are not well defined and depend on many factors, many of which are unique to Costa Rica; however, the linkage has been shown to be a real one, with significant economic benefits stemming from the reduction in oil costs.

In this regard, reducing Costa Rica's dependence on foreign oil has the effect of reducing the country's risk to supply fluctuations. This effect, too, is difficult to quantify but should be considered as a positive effect of moving to electric transport options that rely on more reliable, domestically produced energy.

Pro's and Con's of Each Technology

The following is a condensed list of the pro's and con's of each of the technologies reviewed in this study. Some of the aspects of this comparison are based on the legal, economic, and political realities facing Costa Rica at the time of the study.

The diesel multiple unit (DMU) option is not included here since its cost is nearly the same as that of an LRT and

Light Rail Train (LRT)	
Pro's	**Con's**
Very clean environmentally	The most expensive option generally
Large passenger capacity per car	Restricted to rail operations
Would rely on domestically produced energy	High maintenance costs
Many manufacturers: cars and parts	Requires track upgrade (INCOFER)
	Technology level could require local training or import of maintenance workers

Diesel Multiple Units (DMU)	
Pro's	**Con's**
Individually powered	High cost, comparable to LRT
Train marshaling is easier, more flexible	Requires diesel fuel, not reducing Costa Rica's oil imports
	Noisier than electric (LRT)
	Requires track upgrade (INCOFER)
	Restricted to rail operations
	Limited manufacturers: cars and parts
	Technology is being developed

Electric Trolley Buses (ETB)	
Pro's	**Con's**
Individually powered	High cost
Would rely on domestically produced energy	Limited number of manufacturers
Very effective in high-pollution areas	Higher mainenance costs compared to bus
	Current order lead time is 3 years
	Being phased out of most major cities that have improved their air quality in other ways
	Restricted movement side to side
	Potential power cut-off at cross-over's
	Capacity lower than rail

Clean Diesel Buses (Busway)	
Pro's	**Con's**
Individually powered, flexible routing	Relies on diesel fuel, not reducing Costa Rica's oil imports
Lowest cost option	Noisier than electric options
Could be implemented quickly	Particulate emission is still not as low as electric options
Paving part of the INCOFER ROW for buses still retains ability to implement LRT or ETB options	May require purchase of additional ROW in selected areas
Particulate emission level is lower than traditional buses	Lower capacity than rail
Technology is well understood in Costa Rica	
Paving of busway could be performed under the INCOFER laws, therefore not requiring extensive legal review	

A complete, detailed analysis of the busway, ETB, and LRT options is presented in Chapter IX where updated costs and other aspects of the project are reviewed.

VI. Investor, Operator, and Supplier Survey Results

ICF Kaiser examined the U.S. potential market for suppliers of equipment, various operators of rail systems, and other investors in order to determine the level of interest in urban transit projects in San José.

Purpose of Carrying Out the Survey

The objective of this research assignment was to interview United States' firms that would be interested in participating in the development of a commuter congestion solution for San José, Costa Rica. The survey focused on U.S. firms in order to perform a targeted analysis of potential firms that meet U.S. TDA contract requirements, as well as to substantiate or clarify previous concerns over the Costa Rican light rail project.

Parameters on the Size of the Test Universe

The test population was constructed from a database of attendees at a conference introducing the project which took place in February, 1996. This database was supplemented with an additional database of U.S. equipment manufacturers, operators, and construction companies, sourced from the Federal Railroad Administration. Over 30 rail industry representatives were contacted via telephone and telefax. Please review the questionnaire in the Appendix.

The global universe of potentially interested parties extends beyond the U.S. European, Far Eastern, and Latin American manufacturers may also be interested in the various options studied, including the busway.

Interview Results

Overall, the majority of respondents attending the February, 1996, conference found it interesting and well planned, although other attendees remarked that the conference was confusing. The responding test population included rail business leaders involved in:

- project and construction management,
- rail vehicles and electrification projects,
- electric cars,
- crossing surface producers,
- trains and light rail cars, and
- an export management company representing over 60 manufacturers.

Some of the respondents were not interested in rail passenger projects. However, they did indicate considerable interest in any rail freight opportunities in Costa Rica, and asked to be contacted should such opportunities develop. In particular, one respondent expressed interest in the San José - Caldera freight concession opportunity, which is not the focus of this study. The majority of respondents reported that Costa Rica was definitely on their radar screen, due to its low country risk, stable government, and proximity to large Latin American markets

The table below (Table VI-1) represents an average of scores received from respondents, and ranks the area of concern. A score of 5 indicates an issue that that is considered very risky, and alternatively, a score of 1 is an issue that is considered less risky by the respondents.

Table VI-1 Risk Assessment

Area	*Level of Concern: 1=Low, 5=High* Average score
Government subsidy policy is not clear	4.25
Not clear who's in charge in the CR govt	3.75
Don't understand the legal issues	3.50
Currency Risk	3.25
Fear of next Govt changing the rules	3.25
Project not yet well-defined	3.25
Political shake-up's	3.00
Government expropriation	2.75
Inflexible labor laws	2.00
OTHER:	
Includes - project control, material specs logistics, labor force, return on investment	

The chief concern is the Costa Rican government's policy on subsidies. Many respondents questioned the existence of any type of financial structure or support by CNFL. Related to this concern is the second leading issue, the clarification of a directing entity by the Costa Rican government to manage the project. Additionally, respondents also perceived legal risks associated with the project insofar as they did not understand, or were not aware of, the legal situation in Costa Rica as it relates to the development of a transit project. Some respondents reported concerns regarding the necessary legal work required to ensure direct management of the project, the rights of the concessionaire, and ultimately, the success of the project.

Other mid-level concerns include: currency risk and the fear of a new Costa Rican government "changing the rules." To some of the respondents, Costa Rica's exchange rate adjustment program is not well known, and, therefore, not having the correct information, they place Costa Rica into a high-risk category. Some respondents were troubled by the potential of a new government canceling CNFL (or other Government bodies') project agreements and potentially ceasing payments to the concessionaire. Other respondents, especially those attending the February, 1996, Conference, repeated their concerns regarding the project's clarity in mission and process, describing it as "too broad" and "unfocused". Political shake-ups were also a concern, however, most respondents felt that this would be unlikely in Costa Rica. A few respondents reportedly worry about a government expropriation in the future, and wanted to know what process would be installed to indemnify them for their efforts. Finally, few respondents worried about the potential risks caused by inflexible labor laws. Other risks suggested by the respondents include: project control, material specifications, logistics, labor force, and return on investment.

Respondents were also asked to respond to suggestions designed to reduce risk and increase the attractiveness of the Costa Rican Rail Project. Table VI-2 below illustrated the results of their average scores.

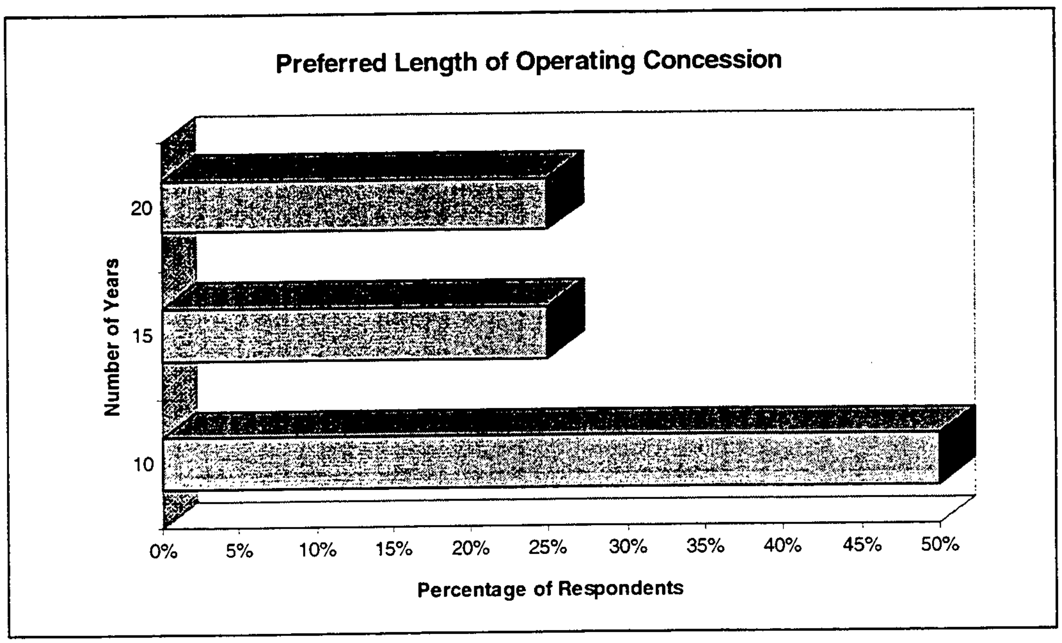
Table VI-2
Ranking of Suggested Actions

Suggestion	Level of Interest: 1=low, 5=high ***Average Score***
The Govt must provide a clear long-term transport plan for SJ and indicate its willingness to carry it out	4.50
Get The World Bank involved in order to cover some of the country (sovereign), political, and currency risks	4.25
Results of solid analysis of the local market must be provided in the RFB	4.25
CR Govt would set up an autonomous agency to deal with SJ transport development, making the contracting simpler and transparent	3.25
Operating concessions for a Light Rail Transit system would be granted for only 10 years but would be renewable based on performance	3.00
Have a U.S. Project Manager with experience in urban transit projects of this type	2.75

The number one action that appealed to the majority of respondents was the delivery by the Costa Rican government of a clear long-term transportation plan for San José, along with a commitment by the government to carry out this mission. The type of "business plan" of interest to the investors in the survey is one that would offer prospective investors a means to logically determine the risks and benefits of getting involved in any transit project. Other suggested actions included the involvement of the World Bank to assist in financing and guiding the project. The completion and delivery of a robust analysis of the local market and demand for light rail/public transit was another important element for many investors. Other actions ranked as mid-level included the establishment of an autonomous agency to deal with San José's transportation development, which would provide simpler and transparent contracting procedures. The length of time for an operating concession was also important to contractors. The installation of a experienced urban transit project manager would be another welcome action; however, most respondents did not believe this person had to be a U.S. citizen. Rather, the experience of the proposed project manager was paramount.

The length of the concession contract was important to most respondents. Most considered 10 years to be the optimum amount of time for the concession, with over 50% of the respondents selecting this time span. Some of the respondents based this answer on the current "vagueness" of the project, and would be willing to consider a longer operating period, if more information about the program was offered, along with a commitment from the government. Some respondents even suggested a guaranteed rate of return to influence concessionaires to consider longer operating time periods.

Chart VI-1 Operating Time Periods



Respondents opting for operating periods of 15 (25% of respondents) to 20 (25% of respondents) years, reported that "it takes time and risk to maintain systems consistently in order to affect a change in lifestyle" (i.e. introducing light rail, increasing ridership, and maintaining the market share are steps that take time).

Other questions offered by respondents include:

- What is the decision making time period?

- How will the Costa Rican government or government entity work with the concessionaire?

- What is the source of project funds?

Conclusion

The majority of respondents interested in passenger rail and light rail projects indicated strong interest in the project, provided that:

- Costa Rican government documented its commitment for the project
- Funding sources were identified (World Bank)
- Focused project information was made available
- Market/feasibility studies were conducted and reported to potential investors

Other Opportunities

While researching the light rail project among U.S. suppliers and potential investors, ICF Kaiser located several parties that were very interested in Costa Rican heavy rail (freight) projects. These potential heavy rail investors proactively inquired about heavy rail possibilities in the country and ask to be contacted should a project develop. In the course of discussions with these U.S. firms, no specific mention was made of either the Atlantic or the Pacific line possibilities for concession, since these topics were outside the scope of the current contract. However, one U.S. firm was already aware of the possibility of a Pacific line freight concession and expressed a great deal of interest in knowing more about this opportunity.

Recommended List of U.S. Operators and Other Interested Parties

Several U.S. firms are directly involved in operating transit systems, including buses. The following U.S. firms are considered to be strong in this field.

U.S. Transportation Management Companies (operators)

Ryder/ATE Inc.
1 Centineel Plaza
705 Central Ave., Suite 500
Cincinnati, Ohio 45202
513-241-2200
Contact: Mr. Richard Claire

ATC/VANCOM Inc.
1 Mid-America Plaza, Suite 401
P.O. Box 7320
Oakbrook Terrace, IL 60601
603-571-7070
Contact: Mr. Terry Van Derr

Dave Transportation Services (bus only)
26111 Antonia Parkway
Rancho Santa Margarita, CA 92688
714-888-3283
Contact: Tim Collins

The following U.S. firms are generally involved in rail transport in foreign countries, as well as short-line investments in the U.S. Their interest in passenger services would have to be explored further.

Wisconsin Central Transportation Corp.
P.O. Box 5062
Rosemont, IL 60017
708-318-4600

Railtex International Holdings
4040 Broadway, Suite 200
San Antonio, TX 78209
210-841-7600

Kansas City Southern Industries, Inc.
114 West Eleventh Street
Kansas City, MO 64105
816-556-0303

Railroad Development Corp.
361 Mansfield Avenue
Suite 500
Pittsburgh, PA 15220
412-928-0777

OMNITRAX, Inc.
252 Clayton Street, 4^{th} Floor
Denver, CO 80206
303-393-0033
Pat Broe, President

RailAmerica
1800 Diagonal Road
Suite 600
Alexandria, VA 22314
703-683-7600

VIII - LEGAL ISSUES

1. Introduction.

Since the present study comprises an overall analysis of transportation options in the Greater Metropolitan Area of San Jose, it is altogether convenient to present here a summary of the most relevant Costa Rican laws effective at the time the study was completed regarding the possible transport alternatives being considered for implementation. In addition to this summary, this section includes some analysis of the laws which concern the two major options in the study; that is, the LRT and the Busway.

For the benefit of further detailed analysis of the legal framework associated with public transportation, we provide an Annex on legal issues, prepared by the Costa Rican team, which provides the basis for the writing of this chapter. Articles cited throughout the section can be found in the Annex.

2. Political Constitution

The Constitution of Costa Rica clearly establishes that only Congress can dispose of public assets, as is well defined in Article 121. The Constitutional Court has ruled that according to this Article, railways must remain under public control and ownership. This is the only constitutional article which mentions railroads and train services.

Comment: Since the Court´s opinion is limited to the control and ownership of railways, it is understood that any administrative procedure used to operate the railway services must follow the applicable legal framework, as analyzed below.

3. Legal Framework

3.1 Law 3503. Passenger Transportation Services.

This law provides the framework for concessioning public transport services to the private sector. The government agency responsible for the application of this law, the Ministerio de Obras Publicas y Transporte (MOPT), offers concessions through a bidding process. Presently such concessions have a seven year limit but can be renewed by MOPT. After MOPT awards a concession, the National Regulatory Agency must authorize the rate structure for each concessionaire.

Comment: This would be the applicable legislation for any option involving the use of buses (regardless of fuel type- clean diesel, gas, or electricity) as long as rail tracks (fixed routing) is not involved. Therefore, any trolley bus operating on the existing roads presently available to vehicles would be subject to this legislation.

3.2 Law 5066 General Railway Law.

This law established the legal basis for public ownership of the railway operations. (Previously, private companies partially owned and operated the railway system.) In regard to our interests, this law clearly establishes the State´s ownership of all existing Right of Way (Art. 4). It also indicated in Art. 10 that the Executive Branch is responsible for granting concessions to build and exploit railway systems, bound to approval by Congress.

3.3 Law 7001. Railway Company (INCOFER) Constitutive Law.

This law created the new public agency INCOFER, responsible for all railway operations. Its purpose is to strengthen the national economy by managing a modern railway transport system for both cargo and passengers (Art. 3). The legislation also gives INCOFER the responsibility of studying, executing, and managing any new railway that maybe integrated with the existing system in order to expand areas of development.

Art. 14 states that the Board of Directors of INCOFER can concede concessions to private companies or persons, and Art. 16 states that the Board can grant use permits on existing assets (infrastructure) to third parties as long as such use concerns or relates to activities within the nature of land and sea transportation, port operations, or customs.

Comment: From the two above laws concerning railway matters (5066 and 7001), we can conclude that with regards to the existing Right of Way (ROW) and associated facilities such as terminals, it is possible to grant permits or concessions to provide transport services. Certainly any such operation must comply with the procedures and requirements in order to obtain such permits or concessions.

3.4 Law 7593. National Regulatory Agency.

This recent law transforms the existing regulatory agency (over 40 years old) into the Public Services Regulatory Agency with expanded regulatory powers. Art. 5 describes the services under their responsibility, including transport of passengers and railway cargo. Both areas come under the supervision of MOPT. The law also indicates that in order to provide such public services, a third party must obtain a concession through the respective agency, and must still comply with Law 7593 (Art. 9).

3.5 Law 7404. General Public Works Concession Law.

This law was recently passed to unify all procedures for the concessioning of public works. Unfortunately, it takes a very light and insufficient approach to public services. For this reason the National Congress is presently considering reforms to the existing law. The proposed reforms include a new section allowing services associated with particular public works to be contracted to third parties. While it is prudent to wait for final approval by Congress in order to know the exact wording of sections pertaining to public transport, we include in the Annex a synthesis of the present law and the expected changes, in order to allow an understanding of the future possibilities with this legal framework.

3.6 Law 7494. Administrative Contracting Law.

Recently the contracting procedures that all Government agencies must follow were reformed and simplified by this law. The reform provides a more flexible alternative to the public sector with regards to procurement of goods and services. For example, Art. 3 allows a government agency to use any contractual arrangement provided in the existent legal framework in order to satisfy a public need. We include in the Annex some comments that clarify the purpose of this legislation.

4. Conclusions and Recommendations.

Our main interest at this time is the utilization of the railway Right of Way for buses and trolleys, as well as for an LRT or similar technology. In the case of the latter option, it is clear that any transport means which utilizes a rail system is acceptable, regardless of the type of fuel used (diesel, gas, or electricity). Here the Government institutions involved in handling and granting a concession contract would be MOPT and INCOFER.

Regarding the use of the ROW for buses and trolleys, INCOFER must remain the responsible agency as they are the rightful owners under Costa Rican law. However, they would be able to publish a bid and select a concessionaire to operate a busing enterprise.

In other words, the ROW can be used for technologies such as:

- LRT/TRAM
- DMV
- ETB
- Buses

Allowing the use of the ROW by an exclusive concessionaire, who would share the ROW with INCOFER in a train operation on the existing tracks, definitely retains INCOFER´s ownership and access to the ROW, as required by law.

This scheme can be developed by using Art. 3 of Law 7494 through a joint venture approach with INCOFER, for example. In this case INCOFER would obtain a permit from the Executive Branch, based on Law 5066. In accordance with Law 7593, such a permit would have to be granted by MOPT, and rates approved by the Regulatory Agency.

VIII. Seminar/Workshop Results and Recommendations

Introduction

Decisions on what type of mass transit to implement, and in which form, are always difficult since they are complex and politically charged. Additionally, in San José, as in all major cities considering a change in its type of transit system, there are many groups involved in the decision. In the case of San José, concerned and/or interested parties include:

- the Costa Rican Government
- MOPT, the Ministry of Transport and Public Works
- INCOFER, the railway
- CNFL, the national power distribution company
- Municipality of San José (city government)
- INVU, Instituto Nacional de Vivienda Urbanismo
- Camaras de Transportistas

Each of the above entities was represented at a two-day seminar/workshop co-sponsored by ICF Kaiser, on 16-17 April, 1997, at the Hotel Bougainvillea in Santo Domingo de Heredia outside San José. Over 40 individuals attended.

Purpose

The purpose of the workshop was to present the economic and environmental analysis results by ICF Kaiser and to determine, based on these results, which of the various solutions analyzed is the most favorable from the perspective of this broad audience.

Methodology

To determine the preference of the group as a whole, it was broken into five work groups each of which was given a set of data concerning each of the segments (corridors) and the various technologies being considered. The full set of these data is reproduced in the Appendix as "Data Provided to Each Workshop Group", and a sample appears on the following page.

Each group was then asked to evaluate each of the combinations of corridors (segments) and technologies in terms of six (6) criteria:

1. Economics (cost)
2. Environment (positive impact after implementation)
3. Feasibility of Early Implementation (considering project size, politics, etc.)

4. Reduction in Oil Imports
5. Legal Considerations (difficulty of implementation, complications, etc.)
6. Rider Appeal (consumer satisfaction with the system)

Each group was asked to provide weights as percentages to the above 6 criteria in a such a way that the total of the weights was 100%. Separately, each group then scored every corridor/technology combination using the scale of 1 to 9.

The following table shows the results of the weights applied to the 6 criteria. Economics or cost was generally considered the most important criterion for selection, nearly double and second ranking criteria, environment.

No.	Criterion	Range	Average	Final Rank
1	Economics (cost)	28-50	32.5	1
2	Environment	15-20	16.2	2
3	Feasibility of Early Implementation	5-16	11.2	5
4	Reduction in Oil Imports	10-15	11	6
5	Legal Considerations	6-25	15.2	3
6	Rider Appeal	5-24	13.8	4

Interestingly, legal considerations were ranked third, possibly in view of the well-publicized, prolonged discussions of the Bernardo Soto toll road concession project between the Costa Rican Contraloria (in effect, the attorney general of Costa Rica) and the winner of the concession. See Chapter VII.

(As a point of interest, the ICF Kaiser team also scored the same sheets, working as a single group. The consulting team also ranked economics first, but put rider appeal second, which is more in line with U.S. experience. This may show, indirectly, that in Costa Rica it is the ability to provide reliable, safe, reasonably quick transit that is of greatest interest to the consumer and not other factors such as comfort or noise level, for example.)

Each score (1-5) was ranked in accordance with the importance of each criterion. Then totals were calculated for each corridor/technology option.

Results

Once the working groups had submitted their review sheets, ICF Kaiser compiled the results. No individual group results were shown to the audience. The results were then displayed the second day of the Workshop. These results are shown below in which the highest group-ranking of each corridor and technology is shown.

San José Transit System Components - Selected by Workshop Groups

Segment	Technology/Approach LRT	DMU	Busway	ETB
Heredia to San Pedro	X	X	X	⊕
Alajuela to San Pedro	⊕	X	X	X
Alajuela to Cartago	X	X	X	⊕
Pavas-Sabana-Paseo Colon- Av. Segunda-San Pedro/UCR *(diametral)*	X		⊕	X
San Antonio de Belen to Pacific Station	⊕	X		
Pavas to Pacific Station	⊕	X		
Ciruelas to Pacific Station	⊕	X		
Alajuela to Pacific Station (via Ciruelas)	⊕	X		
Alajuela to Pacific Station (via San Antonio de Belen)	⊕	X		
Atlantic Station to Pacific Station	⊕	X		

where ⊕ indicates the selected option.

In the cases of the five potential lines for ETB implementation, the group clearly selected ETB since this was the only option. Of the five lines, the Desamparados - Pacific Station route received the most "votes" or the highest ranking, probably in view of the high demand in this route.

Later, ICF Kaiser presented to the group that the capital cost, generally speaking, is half as much for a clean diesel busway option along an existing line, compared to the capital cost of an electric trolley bus. Given that most groups ranked economics as the most important single criterion for selecting an option, it is likely that, had this cost information been known to the group, they would have selected the busway option for each of the five ETB candidate routes.

Some of the results are incompatible, clearly, insofar as the first three corridors/segments are overlapping. In these segments of the INCOFER right-of-way, the seminar participants clearly preferred the use of an electric trolley bus on a paved busway. In other words, the lower cost of a busway option as opposed to a pure rail-based option, had a significant effect in this decision, while the environmental advantages of an ETB over a clean diesel option also entered into the decision making, at least for two of the segments, as shown above.

Additionally, it should be pointed out that the difference in scores between the ETB on the busway and the LRT was quite small and certainly within the realm of acceptability for an option evaluation process such as this.

Conclusion

We can conclude from the workshop exercise that a busway option was viewed as having many benefits, especially economic ones, but that the group also felt that the LRT was viable and desirable although expensive. Using an ETB on the paved busway was viewed as environmentally cleaner than using clean diesel buses on the same thoroughfare.

The data indicate that the group considered the ETB and clean diesel bus options as having many of the same capital cost elements, including the paving of the right-of-way and that, therefore, the only cost difference was in the vehicles. In fact, of course there is a much higher capital cost associated with the ETB option since it must be electrified using overhead catenaries, the signaling is more complex, etc., and, at the same time, the carrying capacity is lower than the clean diesel bus option. Based on the cost per passenger kilometer, the clean diesel busway option is clearly preferable over the ETB on the busway in the short term.

However, in the long term, the workshop clearly prefers electric options such as ETB or LRT, given their positive environmental benefits. As secondary and tertiary benefits of such electric options are better understood in the future, including such items as the macroeconomic benefits stemming from reduced oil imports and air quality improvements, electric technologies will clearly be more viable, available, and economic.

Therefore, when examining the group's point of view and preferences concerning the use of the INCOFER right-of-way for high capacity transit, we conclude that a *dual* approach can be taken and that this is acceptable to the representatives in the workshop:

1. Initiate immediately the construction of a rail-in-road busway and the provision of bus service using clean diesels along two corridors:
   - Heredia - Curridabat
   - Pavas - Pacific Station

2. Preserve the option, in the longer term, to convert the busway into a traditional LRT service on the Alajuela - Cartago corridor

with all operations provided by the private sector.

The capital and operating and maintenance costs of each solution are outlined in Chapter IX.

IX. Revised Costs for Busway, ETB, and LRT Projects

Introduction

Following the seminar/workshop and the presentation of the results to the group, the ICF Kaiser team focused particularly on the capital and operating cost estimates for the two busway corridors on the INCOFER ROW, and on the longer-term LRT project which would involve the conversion of the busway back to a railway from Alajuela to Cartago and Pavas to Pacific Station.

In this review, the goal was to

- decrease the costs as much as possible without sacrificing each project's safety or implementation schedule
- provide creative ways to purchase the required capital items (e.g. use second hand rail and other track materials for the LRT)
- suggest other design and construction options
- adapt the costs to Costa Rica, especially the labor-intensive portions
- think of alternative financing structures

It should be pointed out that the final financing structure is not the subject of this study. In any case, it will have to be negotiated by the bidders for the concessions.

It is important to reiterate that the ultimate goal of the integrated transit system for San Jose has both a short-term and a long-term component. These are as follows:

Short-Term Goal	Long-Term Goal
Expand commuting capacity and start to provide relief from air pollution	Move to electric transport options

The busway option is purely a short-term solution. It has the advantage of not being too expensive and also maintaining the option, longer-term, of moving to electric transport options, such as battery-powered buses, ETB's or an LRT.

General Description of Busway

The following presents a general description of the concept and operation of the busway. The description includes the busway operation, future rail service, busway/roadway intersection signaling, and bus garage/parking facilities. This description of the busway constitutes basic input for the infrastructure capital cost estimates described below as "Busway Financial Analysis."

The busway consists of two concrete lanes, one lane for each direction of travel, with the existing railroad track left exposed in its current physical condition. Wherever possible, the busway will be approximately 15 meters in width; 4 meters for each bus lane, 4.5 meters for the railroad, and 1.5 meters for each shoulder on each side of the bus lanes. Where the right-of-way is restricted at bridges, a single lane constructed of timbers will allow buses to drive down the center of the bridge. Timbers, rather than concrete or asphalt, are used to avoid excessive weight on the bridge structure. At bus stations, the track will also be embedded in timbers (much like a timber railroad/roadway crossing) for a distance of 120 meters in order to allow one bus to pass another which is stopped at the station should it be necessary.

Stations will generally consist of a platform and a canopy. The station platform will be 1.25 meters wide and 120 meters long. The station canopy will be 110 meters long, 4 meters high, and approximately 2 meters wide in order to provide waiting passengers with some protection from wind, rain, and hot sun.

Appropriate drainage will be incorporated into the busway and stations to prevent flooding of the railroad, bus lanes, and stations.

Articulated buses will operate over the busway on the right-hand lane in the direction of travel. Buses traveling in either direction may pass other buses at stations by using the center land provided by the timbers encasing the railroad track. Buses will enter and leave the busway primarily at each terminal at the ends of the busway. However, buses could be allowed access to the busway at designated intersections with important feeder roadways provided, of course, that the articulated buses can negotiate such feeder roadways. Otherwise, smaller feeder buses will provide service to and from the stations located on the busway. Each bus driver will be responsible for the safe operation of their buses on the busway including maintaining adequate braking distance; obeying posted speed limits; and being alert for passengers at stations, trespassers on the right-of-way, and private automobiles attempting to drive on the busway.

Concrete barriers and/or highway guard rails will be installed along the busway right-of-way between intersections with roadways. The barriers are intended to discourage intrusions onto the busway. The busway will also be patrolled either by local authorities or hired security personnel and violators will be warned or cited.

SIGNALING

Traffic signals will be provided at busway/roadway intersections and at the approaches to bridges or at other locations where the busway is restricted to a single lane (see Figures IX-1 and IX-2). Busway/roadway intersections will be equipped with a typical green-yellow-red traffic light facing the oncoming lanes of automobile traffic in

Figure IX - 1
Costa Rica Study
Typical Busway Signaling
(Not to Scale)

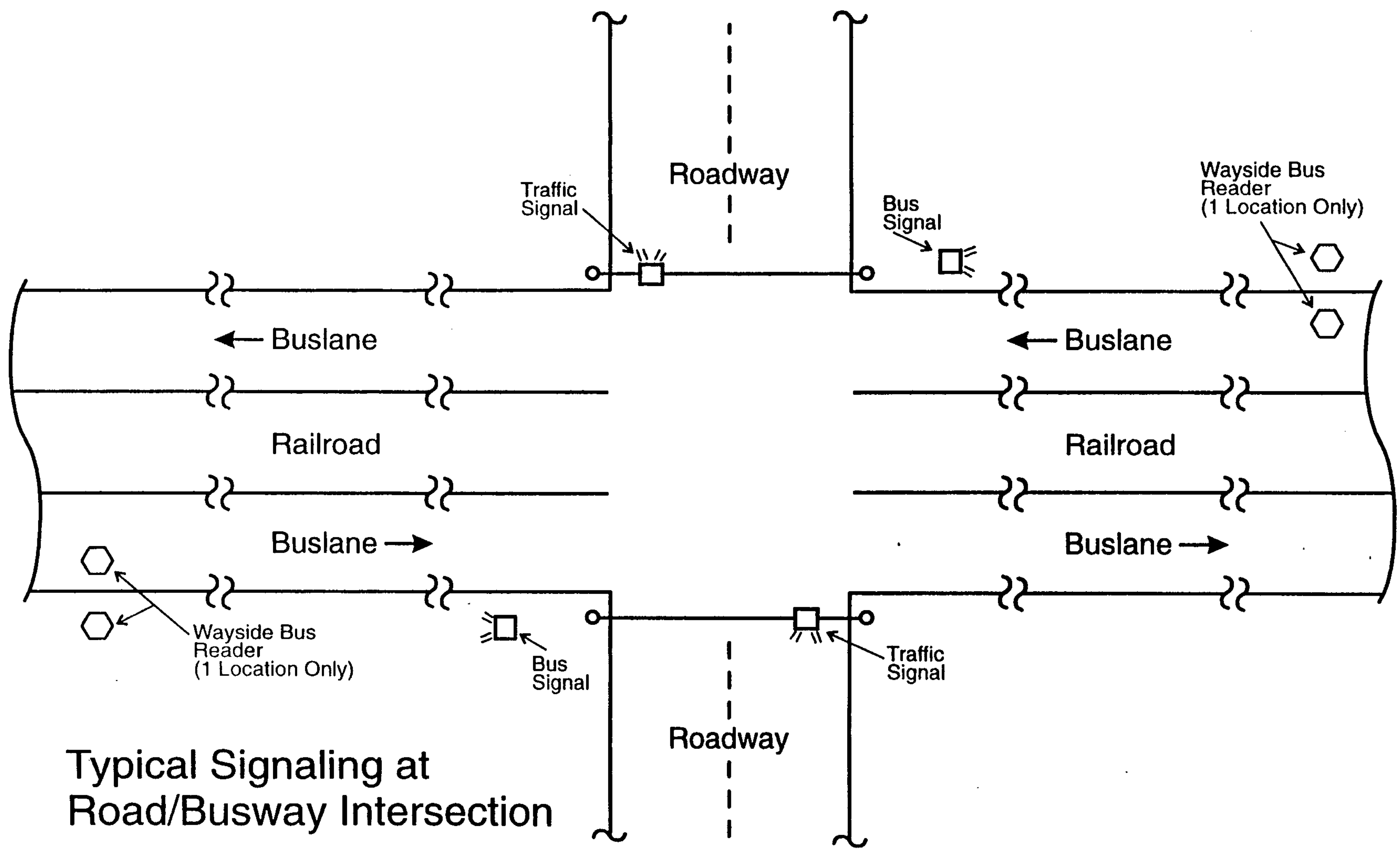
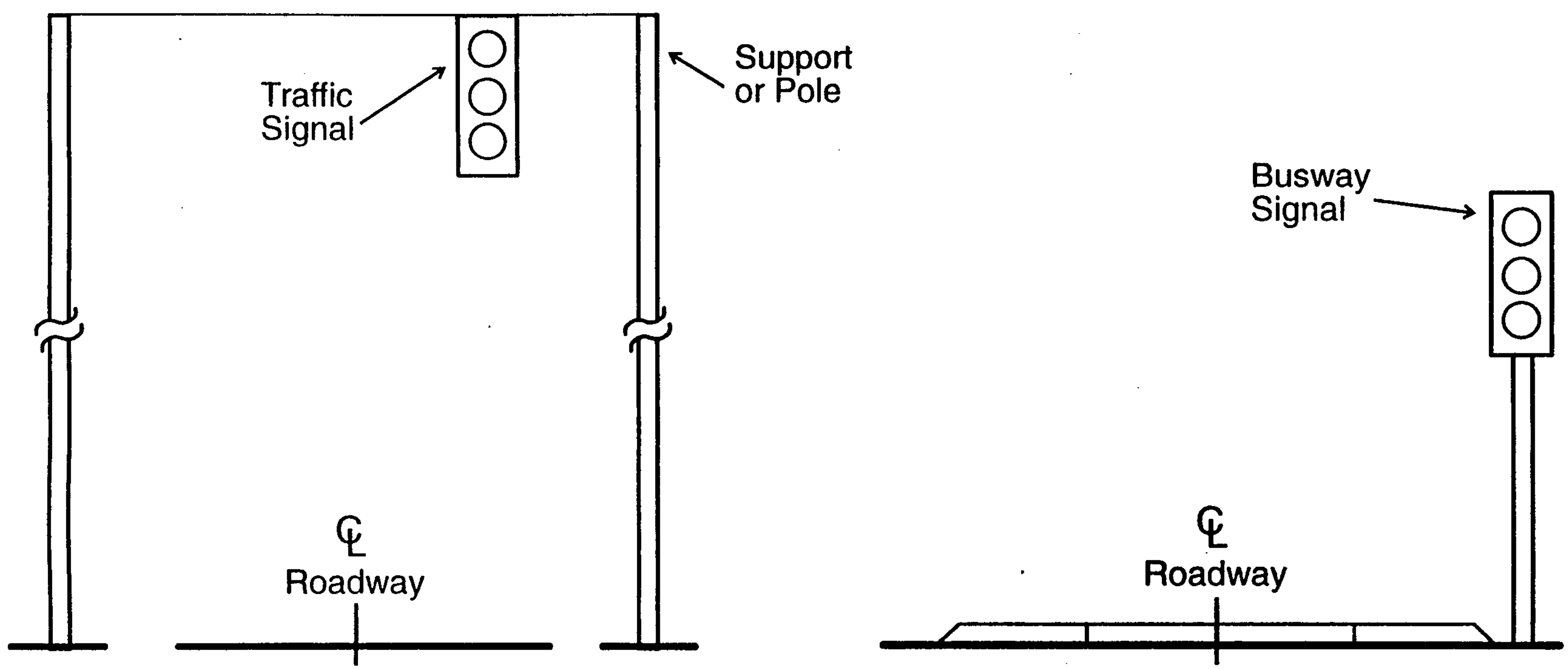


Figure IX - 2
Costa Rica Study
Typical Busway Signaling
(Not to Scale)



Typical Roadway Traffic Signal at Road/Busway Intersection

Typical Busway Signal at Road/Busway Intersection or Before Single Lane Busway each direction and a green-yellow-red light facing each oncoming bus lane. Oncoming buses will typically have priority over automobile traffic but, a bus may have to stop if another bus has passed the intersection and the timing is such that the traffic light has just turned green.

It is currently envisioned that a computerized system of passive transponders aboard the buses and active wayside readers on the busway will control the signaling at roadway intersections (and at bridges and other single lane locations on the busway). As a bus approaches an intersection, it passes the wayside reader (located either in the bus lane or at the side of the busway) which then cycles the traffic light at the intersection to a red signal. After the bus crosses the intersection (based upon either a time delay circuit or the bus passing another wayside reader), the traffic signal changes to green. The traffic signal for the automobile traffic will normally remain green unless an approaching bus triggers the system, calling for a red roadway signal. The active wayside readers for the busway will be located away from the intersection at a distance which considers the bus speed limit, busway gradient, safe-braking distance for a loaded bus, reader and traffic signal response time, and any other variables which may need to be incorporated. Warning signs and pavement markings will be provided for roadway traffic in approach to busway crossings.

The green-yellow-red signal aspects facing the busway will convey the following information and meaning to bus drivers:

- GREEN - the signals for automobile traffic are red. Proceed through the intersection.
- YELLOW - the automobile traffic signals are changing from green to red. Proceed at reduced speed, prepared to stop before the intersection.
- RED - the automobile traffic signals are green or are changing to green. Stop before the intersection.

The signals in approach to bridges or other single bus lane locations are similar in operation to those at roadway intersections except there is only one signal in each direction for the busway. The first bus to pass a wayside reader in approach to a single lane receives a green signal while a bus going in gthe opposite direction receives a red signal. After the first bus passes the single lane, the other bus receives a green signal to proceed. Note that if it is desired to give priority to buses traveling in the peak direction, the signaling system would have to be more complex and the cost would be higher. The wayside readers will be located as close to the single lane as possible in order to prevent an accident if two buses passed wayside readers at the same, or almost the same, time. The allowable bus speed limit will also be reduced when approaching single lane locations. The signal information and meaning conveyed to bus drivers will be as follows:

- GREEN - The signal at the other end of the single lane is red. Proceed over the single lane.

- YELLOW - The other signal is changing from green to red. Proceed at reduced speed, prepared to stop before the single lane.

- RED - The other signal is green or is changing from red to green. Stop before the single lane.

BUS GARAGE/PARKING FACILITIES

Because the new buses operating over the busway will be articulated (there are no articulated buses operating in the greater San José metropolitan area at this time) and will burn clean diesel (currently, clean diesel is often contaminated by mixing it with lower grade fuel) some new or additional servicing, maintenance, and parking facilities may be required because existing facilities are probably not adequate for the new buses. As a minimum, the following new or additional facilities will be required:

- adequate space for maneuvering and parking articulated buses;
- adequate clean diesel fuel storage tanks and pumping equipment with spill protection, detection, and cleanup capability;
- service and maintenance pits and bus lifts which are capable of accommodating the new articulated buses;
- washing equipment and water recycling system or retention/treatment of waste water capability if the new buses are hand washed;
- storage space for the inventory of new tools, parts, components, and supplies;
- office space, training room, and employee facilities (restrooms, locker rooms, driver reporting area, etc.) for the new articulated bus operation; and
- proper servicing, maintenance, and repair facilities for oil changes, lubrication, transmission servicing and maintenance, air conditioning system servicing and maintenance (if applicable), diesel engine maintenance and repair, and other such activities as may be required for servicing and maintaining the fleet of new articulated buses.

It is envisioned that some or all of the required new facilities will be located at the existing Pacific Station and railroad shop site. The use of the existing site will minimize costs as a new site will not have to be acquired and some maintenance capability and equipment already exists because of the work currently being performed on railroad rolling stock.

At the Heredia terminal station, the operational facilities which are required consist of the following:

- Turnaround space for articulated buses. This could be as simple as "driving around the block" on adequate streets;
- Parking space for buses which are waiting for their next departure time or are laying over during the night in order to be readily available for the morning rush; and
- Space for supplies and trash for cleaning the interior of buses.

No clean diesel fueling facilities are needed at the Heredia terminal as buses which are to lay over will be fueled at the Pacific (or some other) facility just prior to their last outbound run.

FUTURE RAILROAD OPERATIONS

When it becomes desirable to operate rail passenger service over the busway route, the following options (there are probably others as well), or a combination of these options, should be considered:

1. Rebuild the railroad track (new ballast, ties, rail, etc.) in its existing location and initiate diesel powered rail passenger service over the single track. Note that with a single track and limited passing track capability (sidings could be installed in one of the bus lanes at stations when the railroad is rebuilt), the level of service which can be provided is essentially limited to peak direction traffic with some off-peck service. The rebuilding of the railroad track will be performed at night and/or during off-peak hours in order to minimize the impact upon bus service. After rail service is implemented over the entire route, a second railroad track can be constructed in place of one of the bus lanes.
2. Remove a portion of one of the bus lanes from service and construct a new railroad track in place of the bus lane. This will, of course, result in some disruption of bus schedules as the new track would create a single lane busway. Unless the new track, or portions of the new track, were embedded, the busway would eventually become a single lane for the entire length with the exception of passing lanes at stations.
3. Terminate the busway at the next station from a terminal station or other station and construct new double track in place of the bus lanes. Either feeder buses or a temporary alternate route for the articulated buses will be necessary in order to provide service to the original terminal station. This process is repeated until approximately one-half of the route is new railroad track. At this point, rail passenger service will be implemented to provide service in conjunction with bus service over the route. This will be somewhat inconvenient as passengers will have to transfer between the train and bus with the bus portion of the trip becoming increasingly shorter as railroad construction progresses.
4. Cease bus operations over the busway while a new double track railroad is constructed. Bus service will be operated over alternate routes until the

construction of the railroad is completed. The use of the articulated buses may have to be restricted if they cannot negotiate the alternate routes. In this case, shorter buses may have to be purchased in order to provide an acceptable level of service.

Once diesel powered passenger service is operating over double track in the entire corridor, the railroad can be electrified at any time in the future.

Busway Financial Analysis

ICF Kaiser re-estimated the capital costs for two busway corridors:

- Heredia - San Pedro
- Pavas - Pacific Station

The first corridor was selected partially based on the desire to use the INCOFER ROW to the east, beyond the Atlantic station, and to capture the high-density region of population.

Changes in the assumptions included:

- Decking the bridges with timber (also a weight limit consideration)
- Purchasing 160 to 180-passenger articulated buses from a competitive supplier
- Assumed 20% profit and General and Administrative costs is built into most items, except for signaling systems Item 4. Therefore, all items were reduced by multiplying by .8 except for the signaling equipment.
- Reduced the number of intersections to 35 as more realistic for the Heredia-San Pedro segment
- Contingency of 25% was applied to all items except item 4 (traffic intersection signal). This item's contingency was calculated at 10%.
- Reduced the unit cost of Item 4 to $100,000 to reflect the simplified nature of the signaling requirements in Costa Rica.
- Eliminated all track-related costs from the sheet, since the project assumes no changes to the existing track infrastructure.
- Assumed that ICF Kaiser and local government engineers finish the design part of the project jointly in the next 3-4 months.

Additionally, some changes to the bus service capital and operating cost assumptions:

- Reduced the number of buses to 23 required for Heredia to San Pedro to reflect changes in operating assumptions even in the face of higher ridership demand (7,000 passengers during peak hour)
- Added 15% Internal Rate of Return to the total annual cost
- Lowered Operating Costs to reflect change in route distance stopping at San Pedro instead of going to Curridabat (14 to 11 km)

- Changed the O & M cost split for DBMT vs. Bus System to 25%/75%.

In this early stage of development, the project calls for a contingency factor of 25%; however, only 10% was used for the purchase of the traffic intersection signals since there is little risk in this particular capital item. In all such projects, the risk is lowered after considerable design is completed; in this case, we anticipate that the contingency can also be lowered after additional discussions with CNFL and local highway engineers in San José.

The following two pages show the capital cost estimates for the two busways. The bolded costs have been adjusted for Costa Rica; these consist of capital items which contain a high degree of local content.

After adjusting for the lower Costa Rica labor costs and after annualizing the direct capital costs based on the assumed lifetimes of each item shown in the previous two tables, the following shows the separate annual capital costs, the annual operating and maintenance costs, and the total for each of the two proposed busways.

Segment	**Total Capital Cost**	**Cost/km**
HEREDIA TO SAN PEDRO	$9,563,400	$869,400
PAVAS TO PACIFIC STATION	$7,846,470	$776,878

Under the assumptions of :

- a dual concession (see Chapter X) in which the developer of the busway (DBMT) receives a toll from the bus operator(s) that is sufficient to cover his annual capital and O&M costs plus a 15% rate of return on total capital
- A sharing of the O&M costs between the DBMT and the bus operator(s) in a 25/75 proportion
- Both the DBMT and the bus operator finance 100% of their capital costs through a 20 year loan at 10%
- Annual ridership is 11,000,000 passenger trips
- The DBMT covers $201,000 of O&M and the bus operator(s) cover $602,000

then the break-even fare on this segment for the bus operator and the DBMT is US$0.30 or 69 colones at 230 colones per dollar.

SEGMENT: HEREDIA TO SAN PEDRO
HIGHWAY ONLY

ROUTE KM = 11.0

ITEM	COST CATEGORY	QNTY	UNIT	UNIT COST	TOTAL COST	CR ADJ	ADJUSTED COST	REMARKS	LIFESPAN (YEARS)	ANNUALIZATION FACTOR	ANNUALIZED COST
3	CONCRETE BUSWAY - 2 LANE	11.0	KM	$363,600	$3,999,600		$3,999,600	Unit costs are typical in CR	10	0.1993	$796,929
4	**TRAFFIC INTERSECTN SIGNALS**	**35**	**EACH**	**$100,000**	**$3,500,000**	**8**	**$2,100,000**		30	0.1523	$319,830
	CONCRETE HIGHWAY CROSSINGS	**35**	**EACH**	**$2,400**	**$84,000**	**8**	**$50,400**		10	0.1993	$10,042
5	**REHAB BRIDGE, + WOOD DECK**	**9**	**EACH**	**$48,000**	**$432,000**	**8**	**$259,200**	AVG LGTH= 30 M	10	0.1993	$51,646
6	**NEW CULVERT**	**1**	**EACH**	**$8,000**	**$8,000**	**8**	**$4,800**	SAN AGUSTIN	30	0.1523	$731
7	**NEW CROSS DRAINAGE**	**33**	**EACH**	**$2,000**	**$66,000**	**8**	**$39,600**	3 PER KM	30	0.1523	$6,031
8	**NEW STATION - TERMINAL**	**2**	**EACH**	**$40,000**	**$80,000**	**8**	**$48,000**		30	0.1523	$7,310
9	**NEW STATION - INTERMEDIATE**	**5**	**EACH**	**$12,000**	**$60,000**	**8**	**$36,000**		30	0.1523	$5,483
10	**REHAB EXISTING STATION**	**1**	**EACH**	**$80,000**	**$80,000**	**8**	**$48,000**	ATLANTIC STATION	30	0.1523	$7,310
11	COMMUNICATIONS SYSTEMS	0	BUS	$20,000	$0			COVERED BY BUS OPERATORS	15		
12	FARE COLLECTION EQUIPMENT	0	BUS	$10,000	$0			COVERED BY BUS OPERATORS	15		
13	NEW BUS GARAGE/PARKING	0	BUS	$50,000	$0			COVERED BY BUS OPERATORS	30		
14	NEW CLEAN DIESEL BUS	0	EACH	$210,000	$0			COVERED BY BUS OPERATORS	12		
15	RIGHT-OF-WAY - URBAN		HA		$0						
16	RIGHT-OF-WAY - RURAL		HA		$0						
							ADJUSTED TOTAL				
	SUBTOTAL				$8,309,600		$6,585,600				$1,205,313
	DESIGN, CONSTRUCTION MGT, ETC.			20%	$1,661,920		$1,317,120				$241,063
	CONTINGENCY (on total cost)			25%	$1,967,880		$1,660,680				$361,594
	TOTAL AND AVERAGE COST PER KM				$11,939,400		$9,563,400				$1,807,970

	PER KM COSTS	
SUBTOTAL	$755,418	$598,691
TOTAL	$1,085,400	$869,400

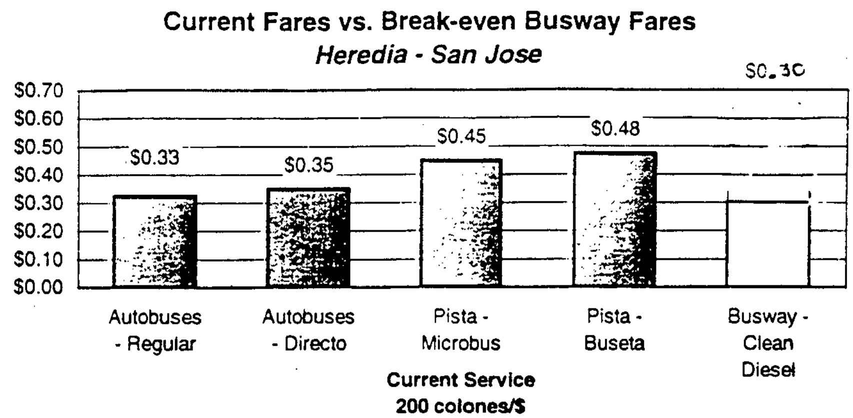
SEGMENT: PAVAS - PACIFICO - ATLANTICO STATION ROUTE KM = **10.1**

HIGHWAY ONLY

ITEM	COST CATEGORY	QNTY	UNIT	UNIT COST	TOTAL COST	CR ADJ	ADJUSTED COST	REMARKS	LIFESPAN (YEARS)	ANNUALIZATION FACTOR	ANNUALIZED COST
3	CONCRETE BUSWAY - 2 LANE	10.1	KM	$363,600	$3,672,360		$3,672,360	W/SIDE BARRIERS	10	0.1993	$731,725
4	**TRAFFIC INTERSECTN SIGNALS**	**23**	**EACH**	**$100,000**	**$2,300,000**	**8**	**$1,380,000**		30	0.1523	$210,174
	CONCRETE HIGHWAY CROSSINGS	**23**	**EACH**	**$2,400**	**$55,200**	**8**	**$33,120**		10	0.1993	$6,599
5	**REHAB BRIDGE, + WOOD DECK**	**4**	**EACH**	**$60,000**	**$240,000**	**8**	**$144,000**	AVG LGTH= 30 M	30	0.1523	$21,931
6	NEW CULVERT	0	EACH	$10,000	$0				30		
7	**NEW CROSS DRAINAGE**	**21**	**EACH**	**$2,500**	**$52,500**	**8**	**$31,500**	3 PER KM	30	0.1523	$4,797
8	**NEW STATION - TERMINAL**	**1**	**EACH**	**$50,000**	**$50,000**	**8**	**$30,000**		30	0.1523	$4,569
9	**NEW STATION - INTERMEDIATE**	**2**	**EACH**	**$15,000**	**$30,000**	**8**	**$18,000**		30	0.1523	$2,741
10	**REHAB EXISTING STATION**	**1**	**EACH**	**$100,000**	**$100,000**	**8**	**$60,000**	PACIFIC STATION	30	0.1523	$9,138
11	COMMUNICATIONS SYSTEMS	0	BUS	$20,000	$0			ON BUS & WAYSIDE	15		
12	FARE COLLECTION EQUIPMENT	0	BUS	$10,000	$0			FAREBOX ON BUS	15		
13	NEW BUS GARAGE/PARKING	0	BUS	$50,000	$0	8			30		
14	NEW CLEAN DIESEL BUS	0	EACH	$210,000	$0			CAPACITY = 180	12		
15	RIGHT-OF-WAY - URBAN		ACRE		$0						
16	RIGHT-OF-WAY - RURAL		ACRE		$0						
							ADJUSTED TOTAL				
	SUBTOTAL AND AVERAGE COST PER KM				$6,500,060		$5,368,980				$991,676
	DESIGN, CONSTRUCTION MGT, ETC.			20%	$1,300,012		$1,073,796				$198,335
	CONTINGENCY (on total cost)			25%	$1,605,018		$1,403,694				$265,977
	TOTAL AND AVERAGE COST PER KM				$9,405,090		$7,846,470				$1,455,988

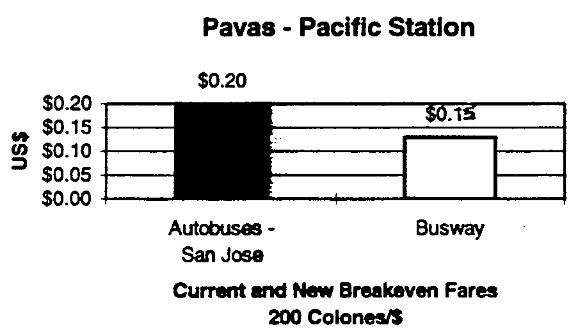
	PER KM COSTS	
SUBTOTAL	$643,570	$531,582
TOTAL	$931,197	$776,878

Assuming the annual costs above, the break-even fares on the two busways are easily in line with current fares. This is shown in the following chart for Heredia-San Pedro.



On the Heredia - San Pedro line, charging U.S.$.30 per person is lower than the existing fares.

For the other busway, between Pavas and the Pacific Station with an extension to the Atlantic Station, the following chart indicates that the break-even fare is well below the current fare.



Part of the reason for this relatively low break-even fare is the estimated high demand in this corridor. However, as in the Heredia - San Pedro case, even if the demand is only half of the estimates for 1997, doubling the fare to U.S.$.30 would still be close to the existing fares.

Also, it is worth noting that the current fares are based on MOPT reported fares for Pavas - San José, with terminal points inside the city, not at the Pacific Station. Therefore, many people may have to take a shuttle service from the Pacific Station to other points in the downtown area, adding to their fares. But at $U.S.13 per person (as a break-even fare), this add-on fare would be acceptable.

ETB and LRT Financial Analysis

In the interest of reducing the cost of INCOFER ROW improvement projects, the ICF Kaiser and the Costa Rica teams worked together to determine ways in which the capital costs could be reduced for

- running ETBs on the busway
- implementing an LRT service on the ROW.

ETB Costs

To determine a realistic cost estimate of developing the busway for use by clear electric trolley buses, the construction cost for the pavement was reduced (as in the case of the above analysis for the busway construction). The number of ETBs needed to carry the same number of passengers assumed in the bus example above is greater than the number of buses in view of their per-car carrying capacity and the operating assumptions.

The per-unit capital cost of an ETB unit was assumed to be $600,000. The details of the capital costs are shown in Appendix V.

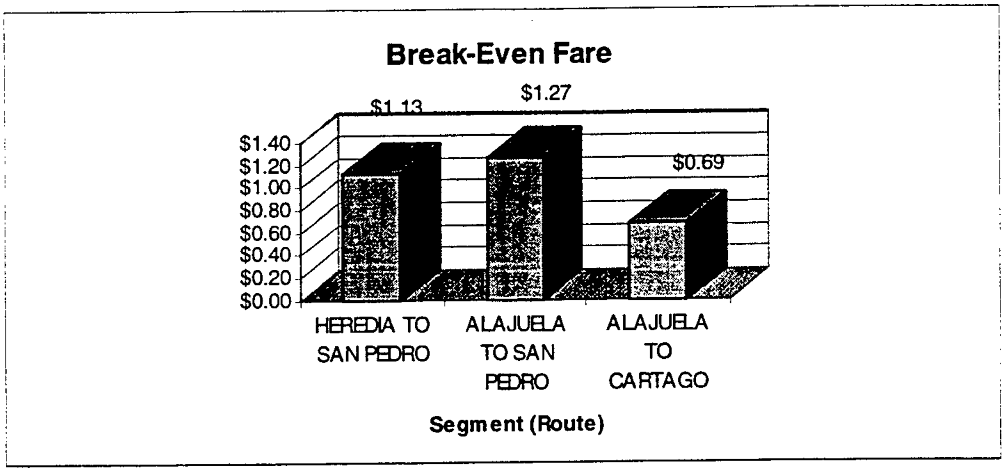
The per-unit capital cost assumption was based on the fact that, in the U.S., the most recent order for ETBs (by San Francisco) included both single cars that were priced at $510,000 each and articulated cars priced at $730,000 each. It may be possible to obtain lower prices through

- negotiation
- volume discounts
- extending the production of another city's ETB order
- reducing the safety equipment or other features

but it should be noted that, as a general rule, ETBs are not in favor and are typically being phased out. In Boston, for example, only half of the existing fleet is in operation at any point in time, while the rest are in repair. (Note: however, Boston recently ordered new ETBs that are dual electric-diesel vehicles, to be used in above- and under-ground routes.)

Operationally, ETBs require turning facilities and garages at the end terminals of the paved route, and this adds to the capital cost.

Based on the above assumptions and those of the dual-concession idea in which the entire capital cost is taken as debt and the operating costs are split between the busway developer and the ETB service operator in a ratio of 25/75, the break-even fare required to be charged on each of the three potential route along the ROW are shown in the chart below.



At 230 colones per dollar, these fares translate into the fares shown below.

Segment (route)	Beak-even Fare (colones)
Heredia to San Pedro	260
Alajuela to San Pedro	291
Alajuela to Cartago	158

The lower fare on the longest route (Alajuela to Cartago) results from the considerable increase in ridership that exceeds the proportionate increase in capital (and O&M) costs.

Deploying ETBs on the busway would involve both the capital cost of the new vehicles and the installation (and protection over time) of the overhead catenary system. The switch from a clean diesel bus service to ETBs could be made in stages over time, through a concessioning process. Once the thoroughfare is paved and made available to regular buses, the conversion of ETBs would be relatively straightforward. The environmental benefits would be substantial, in line with the reduction in emission (mainly particulates) from the buses along the ROW.

LRT Costs

Putting a full LRT service in place along the ROW is clearly the most expensive option. The trade-off between the LRT and DMU options is shown to be insignificant in capital cost terms, and LRT is the preferred option over DMU when environmental considerations are taken into account.

Even when used track is purchased, as in the capital cost chart in Appendix V, at a price of $400,000 per kilometer including concrete ties, the capital cost per passenger is considerably higher than the ETB option above, and certainly higher than the bus option.

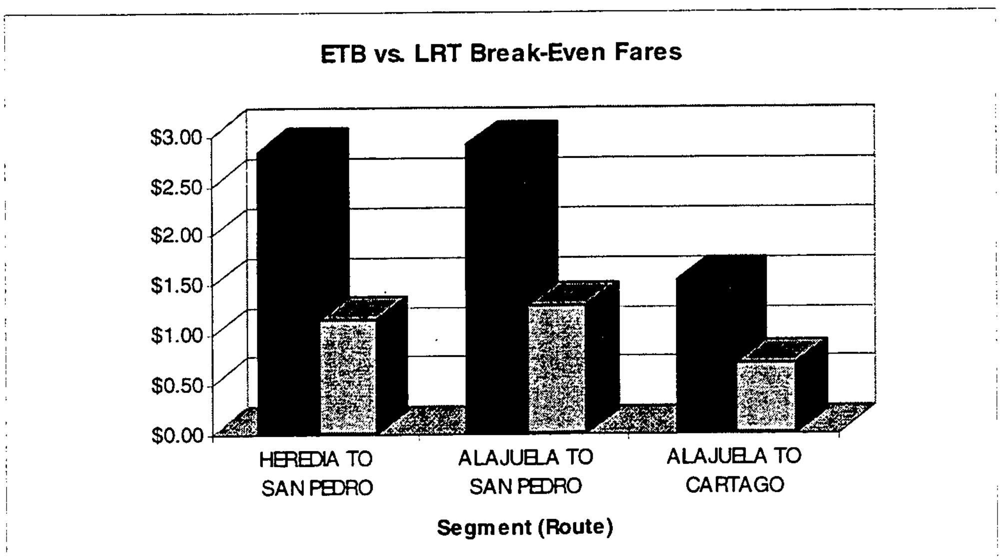
The chart below shows the resulting break-even fare required to cover the annualized capital cost, interest cost assuming 100 percent debt financing, and, basically, the same assumptions that were made for the ETB and busway cost analyses above.

Segment	New LRT				
	Annual Cost	O&M Costs	Required Revenue	Annual Ridership	Break Even Fee
HEREDIA TO SAN PEDRO	$29,715,157	$1,391,393	$31,106,551	11,014,704	$2.82
ALAJUELA TO SAN PEDRO	$53,709,871	$5,112,819	$58,822,690	20,397,600	$2.88
ALAJUELA TO CARTAGO	$73,971,532	$9,924,320	$83,895,852	55,456,800	$1.51

These fares, assuming no Government subsidy, are extremely high by comparison to current bus fares on the same segments. Even the informal services on these routes do not charge this much at the present time. These fares translate into the following fees in colones:

HEREDIA TO SAN PEDRO	650
ALAJUELA TO SAN PEDRO	663
ALAJUELA TO CARTAGO	348

These fares are clearly out of range of current riders based on fare data from MOPT for current bus service. And they are considerably lower than the comparable fares for ETB service, as shown in the following chart.



In the future, the shift to an LRT operation should still be considered as viable for several reasons:

- the overall cost to Costa Rica is lower when the reduced oil imports is taken into consideration (of course, this argument also applies to ETBs which use domestically produced power)

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- technology is always changing and there may be new advances in building light weight LRT cars that are as strong as the heavier ones manufactured today
- production of large numbers of cars could bring down the capital cost
- it may be possible to place an order at the end of another city's production run

X. Concession Approach

This segment of the report outlines the recommended strategy to be used by the Costa Rican Government to attract qualified proposals for the clean diesel busway project.

General

Over the last 20 years in the U.S. and in other Latin American nations undergoing large privatization efforts including concessioning of public services, transit projects have become considerably more complex. The traditional competitive bidding procedure, in which a construction contractor is selected based simply on the lowest bid, has been shown to be inappropriate and has been replaced by more sophisticated approaches that offer greater opportunity to a proposer. Such factors as

- vendor funding and financing
- World Bank participation to mitigate risks
- vendor resources and qualifications to perform on time
- designs available in the marketplace
- vendor proprietary designs
- reliability and lifetime (of contract) variations
- vendor experience in operating other transit systems
- desire to reduce existing subsidies

have become considerably more important to city and national governments whose goal is to provide an improved public transit service at the lowest cost, using environmentally improved technology. These factors, therefore, have created new ways to go about the concessioning process.

In transit system bidding today, there are three basic competitive procurement methods in use, depending on the complexity of the project. These are:

- Formally advertised competitive bids
- Two-step competitive bids
- Competitive negotiated procurement (Request For Proposal, RFP)

There are many names, terms, and descriptors used to define procurement methods, but, in general, they are all forms of the above three types. So long as the procedures for carrying out the procurement are clear, and are included into the solicitation documents, then the procurement process can be said to be fair, competitive, and transparent.

Each of these approaches is described below.

Formally advertised competitive bids

This rather simple form of procurement is typically used when purchasing construction equipment or a well-defined service. The specifications of the project must be completely defined, including all details such as the level of quality, delivery time, vendor experience, etc. Typically, the projects using this procurement approach are small in scale, and the buyer does not place any value on alternative approaches to the problem that might be suggested by the vendor.

In view of the nature of the projects for which this type of procurement is appropriate, the bids are based solely on price, and the lowest price wins the job. Clearly, for Project X, this approach is inappropriate.

Two-step competitive bids

This procedure is similar to the one above, except that potential vendors are first pre-qualified in a separate step. In effect, following the advertising of the two-step procurement which includes the project specifications, terms and conditions, qualification requirements and proposer instructions, a short list of qualified firms is prepared after reviewing each proposer's Technical and Management proposals (not including price bids).

This method has the advantage that, during the first step, the buyer can hold a "bidders' meeting" to discuss the project and the requirements specified in the original project announcement. At this meeting, it is possible for potential bidders to provide input into the project, perhaps suggesting different approaches to the procurement and, most importantly, advising the buyer of issues that are most important to the investor/contractor community; such issues may be extremely important, since they reflect the interests and concerns of the marketplace in a free and open discussion. For example, important aspects of the bidding process, such as the inclusion of the evaluation criteria, would be caught in the first step of this two-step process.

After the Step 1 meetings are concluded, the buyer deliberates to decide whether any changes should be made to the contract provisions. If so, an amendment is prepared and sent to all proposers. At this stage, each proposer is given the chance to change his proposal, having been notified in detail where his Technical and Management proposal either falls short, needs embellishment, requires clarification, or should be changed in view of the revised project specification. After the revised proposals are received, they are evaluated according to the criteria already published, and the ones that are deemed to be responsive to the requirements from responsible vendors are put on a short list. At this point, every firm on the short list is asked to submit a price proposal; the ones that did not qualify for the short list are notified and told why. The rejected vendors are given an opportunity to receive a hearing or de-briefing, but they are not allowed to submit bids.

The final selection of the winner is based, then, purely on price since each vendor's proposal is considered equal in all other aspects. A particular vendor who provides something extra at this stage is not given higher marks in the ranking since the opportunity to embellish the project and enhance it in any way was already provided in Step 1.

Because of the complexity of the clean diesel busway project and the need to seek the highest value from the contractor/operator community in its bids, we do not recommend this two-stage process.

Competitive Negotiated Procurement

This approach is by far the most flexible since it does not ask for bids, as such, for the project. Rather the award is based on price and other evaluation criteria, clearly specified in advance, that are in the best interest of the buyer. This approach is the best in large, complex projects such as the clean diesel busway project, involving vendor qualifications, price, and so forth but also an expression of *value* to the buyer. This approach is most appropriate in those projects in which the proposals could not be evaluated as being equal, as in the above two procedures, because each proposal is likely to have different values to the buyer.

This approach is also best in projects in which it is viewed as being either impossible or not desirable to provide the complete, final design specifications in advance. Doing so, it is felt, would limit the proposers too much and result in proposals that are not the most creative, may not "optimally" fit the Costa Rican environment, and could prevent the proposers from carrying out final designs or suggesting off-the-shelf design solutions.

For example, if Costa Rica were to specify in the RFT the carrying capacity of a bus, this specification might restrict some proposers from providing alternative, more creative solutions in terms of operating plans, numbers of buses, alternative fuels, etc., and the resulting proposals, although more "equal" since they all provide for buses of the specified capacity, could be viewed as limiting the options for the buyer. Similarly, making such a specification in the RFT might also eliminate from the procurement some proposers of off-the-shelf systems whose design and development costs have already been written off. Therefore, the opportunity for significant cost reduction is maintained if the procurement is left open.

Differences in design approach can be evaluated in terms of total cost, value, quantity and other costs which could be outside the contract. Therefore, "responsiveness" of the proposers to the RFT is not part of the evaluation process. All proposers are free to, and in fact, encouraged to, take exception and make conditions which, if acceptable to the buyer, are evaluated in terms of the particular evaluation criterion (or criteria) which they affect.

The evaluation criteria typically used in competitive negotiated procurements for complex projects include the qualifications of the proposer, since the success or failure of a project like the clean diesel busway project could be affected by the past experience of a vendor in similar projects. Additionally, financial resources available to the proposer ought be considered, as well as physical resources, should be used in evaluating the responsibility of a proposer; also, these may affect the price. The RFT should set out minimum requirements for:

- qualifications (experience or firm and individuals)
- financial resources (financial commitment, equity considerations, etc.)
- physical resources (personnel, equipment, tools and facilities)

so that initial proposals can be tested on a pass-fail basis.

In the competitive negotiated procurement, vendors are asked to submit two documents: (1) a Technical and Management (T&M) proposal, and (2) a price proposal. No mention of price or financing arrangements should be made in the T&M proposal. The evaluation of the T&Ms must proceed without any knowledge of price or financial proposals. The criteria used in the evaluation of the T&Ms must be those specified in the project announcement for proposals.

The names of the vendors submitting T&M proposals can be made public. However, confidentiality of all proposal information and of the evaluations must be maintained so that true competition among the proposers can be maintained throughout the process, through the Best and Final Offers stage (BAFO). Following the initial evaluation of the T&Ms, the selection committee in Costa Rica determines a competitive range of proposals and the proposers are sent notices asking for clarifications, expansions, or elimination of irrelevant aspects of their T&M proposals. Any T&M proposal that is not deemed to be "un-awardable" or not correctable, would not be considered to be in the competitive range. Those proposers eliminated at this stage in the process are notified and given a chance for a hearing and a de-briefing.

The proposers who are within the competitive range are then asked to carry out negotiations with the selection committee against the contract requirements. A date is set for the termination of negotiations, and all proposers are then asked to submit BAFOs through an addendum to the RFT. Any changes to the requirements can also be specified in this addendum, and the proposers are expected to submit BAFOs that are basically the same as the original proposals, addressing the addenda through proposal addenda, for example. The BAFOs are then evaluated using the same criteria used in evaluating the original proposals.

Once major advantage of the competitive negotiated procurement method is that it permits some flexibility in evaluating price proposals, reflecting the likelihood that these proposals are likely to be quite creative themselves. Indeed, for complex projects such as the clean diesel busway project, it would be nearly impossible to evaluate all price proposals purely using a score that reflects the size of the price. Vendor financing and vendor equity can be proposed and evaluated in a subjective manner along with the final price itself. In the face of different price and financing proposals from difference vendors, a net present value calculation is made by the selection committee. In concession contract, some form of vendor equity is commonplace. Valuing these aspects of the price proposal in dollar terms can be helpful to the selection committee in selecting the least-cost proposal.

Table X-1 below summarizes the evaluation factors typically used in each of the three procurement methods described above. For the clean diesel busway project, the third method is preferred and recommended, competitive negotiated procurement.

Table X-1

Evaluation Factor	Procurement/Contracting Method		
	Competitive Bid	**Two-Step Competitive Bid**	**Competitive Negotiated Procurement**
Approach	**Pass/Fail** Responsiveness to Fixed Specifications	**Pass/Fail**-Responsiveness to Common Denominator Specification from Step 1	**SCORED**: Varies-Negotiable, Exceptions & Conditions allowed
Product	**Pass/Fail** Responsiveness to Fixed Specifications	**Pass/Fail**-Responsiveness to Common Denominator Specification from Step 1	**SCORED**: Varies-Negotiable, Exceptions & Conditions allowed
Vendor Qualifications	**Pass/Fail** Fixed Responsibility Requirements	**Pass/Fail**-Common Denominator Responsibility Rqmnts from Step 1	**Pass/Fail & Scored** Common Denominator Responsibility Rqmnts from Negotiations
Financial Resources	**Pass/Fail** Fixed Responsibility Requirements	**Pass/Fail**-Common Denominator Responsibility Rqmnts from Step 1	**Pass/Fail & Scored** Common Denominator Responsibility Rqmnts from Negotiations
Physical Resources	**Pass/Fail** Fixed Responsibility Requirements	**Pass/Fail**-Common Denominator Responsibility Rqmnts from Step 1	**Pass/Fail & Scored** Common Denominator Responsibility Rqmnts from Negotiations
Price	**Varies - Scored**	**Varies - Scored**	**Varies - Scored**
Other Financial Considerations	Not Applicable	Not Applicable	Varies - Scored
Vendor Financing	**Varies - Scored**	**Varies - Scored**	**Varies - Scored**
Vendor Equity	**Varies - Scored**	**Varies - Scored**	**Varies - Scored**

For both the short-term busway and the longer-term LRT projects, ICF Kaiser recommends using the competitive negotiated procurement procedures outlined above.

The complexity of each project, coupled with the potential novelty of the busway project, encourage the use of this general approach.

Concession Approach for the Clean Diesel Busway Project

This project involves two parts:

1. Designing, constructing and maintaining the paved busway, and
2. Operating clean diesel buses or other clean technologies such as electric buses on the busway

Both functions are to be carried out by the private sector, and the companies given the concessions (2 in all) should be selected in a free, open, transparent, and international procurement process using the competitive negotiated procurement procedure described above.

The structure of each concession must first be defined. There are many options in this regard including the following:

- Build, Operate, Transfer (BOT)
- Build, Operate, Maintain (followed by transfer or not) (BOM/T)
- Design, Build, Operate, Maintain (DBOM)
- Design, Build, Maintain, Transfer (DBMT)
- Design, Build, Maintain, (DBM) with operation provided by another private firm

among others. Each of these approaches has its own advantages and disadvantages. In the case of the clean diesel busway project, it would appear that the DBMT approach is the optimal one for this procurement. Also, it is the objective of the Costa Rican government to remove itself as much as possible from the provision of public transport services, especially those involving a subsidy requirement.

However, the clean diesel busway has several peculiarities that need to be addressed:

INCOFER, as the "owner" of the infrastructure, will likely have to lease the infrastructure to a private company for the design, construction, maintenance and transfer (DBMT) of the new paved busways. For economies of scale, it is recommended that there be one bidding process for the construction of both busways (Heredia-San Pedro and Pavas-Pacific) and that the design, construction and long term maintenance of the busways be awarded to a single company unless the Government decides to begin with The Heredia-San Pedro line first as a demonstration project. The bidding should be both local and international. The bidding document must contain the evaluation criteria so that the potential bidders understand the criteria for proposal evaluation; these criteria should include at least:

- Company background, qualifications, and experience
- Reliability (delivery) in past, similar projects
- Experience in maintaining highways, and especially in maintaining rail-in-road structures
- Quality of the maintenance portion of the proposal (specifics to be defined)
- Ability to start and finish early
- Alternate suppliers
- Guarantees
- Individuals assigned to the project, management organization
- Use of local Costa Rican contractors
- Price

The concession approach for the clean diesel busway is different from that for the LRT (longer-term) because the added flexibility of buses brings with it several institutional and operational questions that need to be addressed before a final Request for Tender can be drafted and submitted to the international marketplace for consideration. These questions/issues are outlined below with comments.

Issue	Comment (ICF Kaiser)
The design, build, maintain, transfer company must be paid for its work over time. Who will provide this funding?	Private bus operators should pay a fee for the use of the infrastructure (busway) and for its maintenance.
What are some payment options for the use of the infrastructure?	Private bus operators could pay a toll per bus per day, based on expected ridership and operating hours. Alternatively, they could pay a flat monthly fee for infrastructure use that is checked against the number of buses operated during the month; this requires careful monitoring of each operator.
What toll collection processes might be used?	A feasible but cumbersome process is to stop each bus for payment. Secondly, each bus could be bar-coded either on its top or its side so its entrance and exit from the busway is recorded electronically; a fee could be charged per bus-kilometer. Thirdly, a negotiated flat monthly fee per bus could be negotiated between the bus operator(s) and the infrastructure maintainer; this would require careful monitoring.

Issue	Comment (ICF Kaiser)
Over what time period will most design, build, maintain companies request payment?	Probably 20 years, but this should be a negotiated point in the bidding for the design, build, maintain portion of the job.
Is it possible for the design, build, maintain company to align with a bus operator to provide a DBMT service?	This should be a possibility, defined in the Request for Tender. However, to date, no such combinations have been formed to the knowledge of ICF Kaiser.
With so many cross-overs, how can the busway be dedicated solely to use by authorized vehicles?	Indeed, there will have to be careful monitoring of the busway to prevent "pirates" from making free use of the thoroughfare. A high fine might be imposed to discourage such use, coupled with reliable enforcement.
Would the design, build, maintain company actually own the infrastructure?	Probably not. Instead, it would probably lease it from INCOFER which is the rightful "owner" of the right of way. (See Art 9. Law 7404)
Could the same bus operator bid for both operating concessions (Heredia-San Pedro and Pavas-Pacifico)?	Yes. However, cross-subsidization between the two businesses should be discouraged, unless the operator has solid financial grounds for doing so, particularly during the start-up phase of the operation.
To what extent would a bus operator be allowed to use his buses on other routes, either in San José or elsewhere?	Given that Costa Rica is interested in improving air quality generally, then the expanded use of such improved technology should be encouraged. However, this should not be done to the detriment of service to the passengers on the busway.
With what institution would the DBMT negotiate the terms and conditions of his DBMT contract?	He would negotiate the lease of the ROW with INCOFER (most likely), with the bus operators for the level of tariff charged for use of the infrastructure, and then submitted to ARESEP, the National Public Service Regulatory Institution..

This type of dual concession would require close coordination between the DBMT company and the bus operator. Proposals should be submitted separately, even though it is likely, and encouraged, that DBMT companies discuss their economic plans with potential private bus operators during the bidding process in order to be assured that there will be a commitment by the private operator to provide funding; otherwise, it may be necessary to seek a revenue guarantee from either the Costa Rican Government or another financial institution.

In raising capital to support the design and construction of the busway infrastructure, the DBMT company could seek participation by the bus operator itself, as an equity partner. Conversely, if the bus operator needs a capital infusion (for example, to purchase the more expensive clean diesel buses), then the DBMT firm might be a source of such investment capital. These cross-discussions should not be prohibited.

Any such joint contracting would clearly affect the tariff to be charged by the DBMT for infrastructure use.

International lending for the DBMT company might also be sought. The World Bank may be a source of sovereign risk coverage or even of guarantees. Similarly, the Inter-American Development Bank might serve this role. Potential DBMT's should be encouraged to seek assistance from such institutions.

Economic Analysis of the Dual Concession Option

Using the dual concession option described above has several advantages.

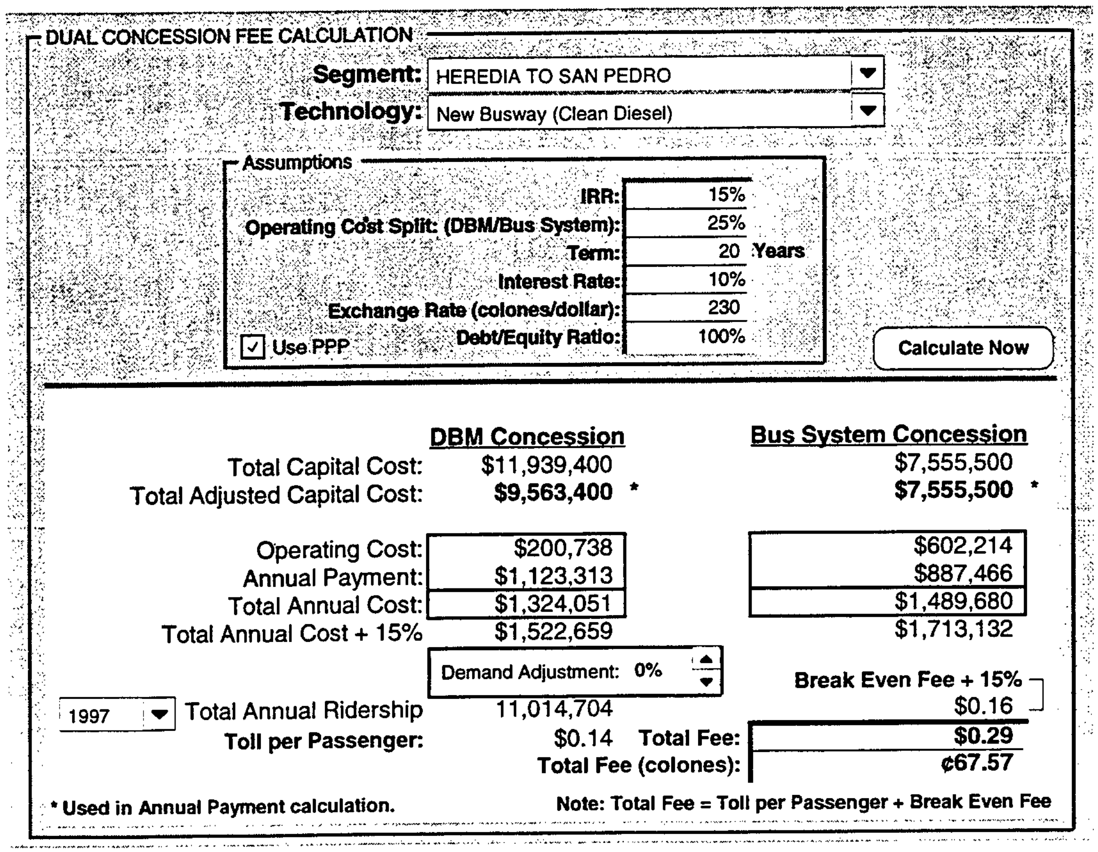
- It permits the busway to be built under the INCOFER set of laws
- It can be started soon
- The selection of a concessionaire, who designs and builds the busway, should not be a complicated process and may proceed quickly
- Once completed, the busway may be opened for use by existing buses to help relieve congestion
- Design and structure of bus service concessions can proceed, following either the existing laws or new versions of the current laws.

The economic analysis of the dual concession option is based on the following assumptions

- The selected DBMT firm finances its capital costs entirely through debt
- The term of the loan is 20%, the interest rate 10%
- The DMBT and the bus operator(s) split the O&M costs of the entire operation: 25% for the DBMT, 75% for the bus operator(s)
- The DBMT seeks 15 percent internal rate of return (when equity is provided and, hence, the debt percentage is lowered, the 15 percent IRR is assumed to apply to the entire project, not just the equity portion)
- The number of buses required on the Heredia - San Pedro line is 23; 70 buses would be required on the Pavas-Pacifico-Atlantico line
- The design for the Heredia - San Pedro line is presented in Appendix VIII
- The bus operator(s) will seek a 15% profit from fares.

These assumptions can be changed in the model that was delivered to the Costa Rica team. For example, the sharing of O&M costs between the DBMT and the bus service operators can be altered; perhaps interest rates will be higher; the demand figures, here based on the ICF Kaiser demand analysis described in Chapter III, can be changed as new information comes from other studies or from ongoing operations.

Under the given assumptions, the screen below shows the key results of these assumptions. This is the screen from the cost model developed by ICF Kaiser.



The calculation of the break-even fare and the toll per passenger is based on the "Total Adjusted Capital Cost" which is the total cost, including design and project management fees plus a contingency, adjusted for Costa Rica.

Each passenger would be charged a fee of US$0.29 (68 colones) to make the trip. This is comprised of a US$0.16 fee to cover the operating costs of the bus operator(s), including a 15% profit, and a US$0.14 fee paid to the DBMT as a toll to cover his capital, financial, and operating costs.

Concession Approach for the LRT Project

Given that trains are naturally restricted in their movement and the ROW is clearly in the hands of INCOFER, some of the issues raised above for the busway are automatically solved in the LRT case, such as the question of monitoring usage and preventing pirates from entering and using the infrastructure. The preferred approach to offering LRT passenger service on either one of the two busway routes is more traditional, and there are many examples of this form of concessioning in the world.

For the LRT, we recommend that a DBMT structure be used. The winner of the concession must design, build, operate, maintain, and transfer the LRT(s). When it is deemed feasible and desirable to convert the busway into an LRT operation, the winner of the concession contract must (i.e., rail installation on gravel base) convert the ROW back to a sole use by an LRT; therefore, there are some design and construction components to be taken into account.

The higher capital costs of the LRT, compared to the busway option, would be borne by the winner of the concession, although he would be free to bring in other investors and international institutions who could assist in the financing. The Costa Rican Government generally will not subsidize directly the LRT operation. However, other forms of indirect subsidy might be feasible, such as reduced electricity costs, favorable tax treatment, etc., that must be negotiated directly with the Government. In general, it has been the experience of the ICF Kaiser team that the Government is extremely open and flexible to new ideas and approaches.

Several of the railway operating firms from the U.S. mentioned in Chapter VI may be interested in pursuing the LRT option when it is deemed feasible. ICF Kaiser recommends that contact with these firms, and with other firms, be made as soon as possible so that these firms can begin discussions of their requirements in carrying out a DBMT concession in San José.

The following Chapter XI: Recommendations and Next Steps indicates work to be done in order to initiate and complete the start-up of the busway, in terms of design and building, and service provision.

XI. Recommendations and Next Steps

Summary of Recommendations

The ICF Kaiser recommendations to carry out the long-term development of the integrated mass transit system outlined in Chapter II and to achieve the long-term objective of having a clean, electric passenger transport system in San José are:

Recommendation	Comment
Utilize the INCOFER right-of way to provide clean diesel bus service over two key routes: Heredia - San Pedro Pavas - Pacific Station	These routes have high commuter density, and construction can be started soon. It also begins to relieve congestion and reduce particulate emissions.
Concession to the private sector each of the above corridors in a dual fashion: Design-Build-Maintain Transfer (DBMT) Bus service	This is consistent with the Costa Rican Government approach to stimulating private investment in providing public transit services, and eliminating subsidies.
Establish a transit-oriented agency, or commission with the authority and responsibility to make key decisions concerning the above concessions projects, at least.	Such an agency could act simply as a coordinator with other Government groups involved in the concession process. Having such an agency would make the process appear smoother and simpler to the potential concessionaires.
Preserve the long-term option of converting these busways to strict rail operations using a light rail transit solution (electric), by keeping the rail exposed and available.	The LRT solution is the most environmentally advantageous but also the most expensive. The time for conversion can be selected by the Government. Also, by keeping the rail exposed and available, there should not be a constitutional issue concerning control of the right-of-way.

Under the above recommendations, it is assumed that MOPT would be responsible in establishing the bus operator concessions, perhaps in conjunction with INCOFER; also, it is assumed that INCOFER would be in charge of the DBMT concession. The details and the legal issues will have to be discussed in greater detail, although initial conversations indicate that there are no serious legal barriers that might hamper or damage this concession approach.

The short-term timetable for the key tasks to be undertaken through May, 1998, are outlined in the attached spreadsheet starting in June, 1997, assuming that the Costa Rican Government decides to proceed with the suggested busway concession approach.

The longer-term LRT concession would be a traditional DBMT (design-build-operate-maintain and transfer) for a 20 year period. The LRT concession would likely cover the full line between Alajuela and Cartago since the expected industrial and population growth along this corridor will probably make it more attractive to the investors if the entire 43 kilometers is included in the concession.

Financially, the busway option is clearly preferred over the more expensive LRT or DMU options on the right-of-way. In this regard, the required fares on the busway are more in line with what commuters are paying today, especially in view of the growing market which typically charges 60 percent more than the published bus fares on comparable routes, as mentioned by representatives of the bus operators. Therefore, the acceptance of the busway is likely to be immediate.

Pursuing the busway option has several other benefits:

- It can be started quickly
- The concessioning for the DBMT can be handled in a traditional fashion
- The bus concession can be moved ahead quickly
- If handled correctly, there should be no direct subsidy required from the Government that would benefit from the busways
- It starts to solve San José's complex transit problems and, at the same time, puts in place a long-term solution which can be implemented over time
- The fares are in line with the current economic situation in Costa Rica

Schedule

If the above recommendations are agreed by the end of June, 1997, and if the financial interest of the international banking community can be established quickly, it should be possible to award a concession contract to a winner on at least one of the two busways in the first quarter of 1998. ICF Kaiser anticipates that work could also begin in that quarter. Meeting this timetable will be difficult and will depend on carrying out the following next steps.

Next Steps

The following steps should be taken in order to meet the above schedule.

Step	Description
1	Legal review of busway concession idea • DBMT • bus operator
2	Final review of technologies including electric
3	Government approval of project

Step	Description
4	Establish bid evaluation criteria
5	Start to eliminate encroachments on ROW
6	Review/revise demand data
7	Write RFT(s)
8	Set up data room, San José
9	Promote and market concession(s)
10	Invite and hold 2-day seminar
11	Receive proposals
12	Evaluate bids
13	Shor tlist potential winners
14	Negotiate with short list
15	Ask for Best and Final Offers
16	Select winner
17	Contract signing
18	Start construction

The proposed schedule for these next steps is shown in the following page.

Next Steps
Schedule

STEP		MONTH - 1997, 98 Jun-97	Jul-97	Aug-97	Sep-97	Oct-97	Nov-97	Dec-97	Jan-98	Feb-98	Mar-98	Apr-98	May-98
1	Legal Review of busway concession	■											
2	Final review of technologies incl. electric	■											
3	Govt approval of Project	■											
4	Establish bid evaluation criteria		■										
5	Start to eliminate encroachments on ROW		■	■									
6	Review/revise demand data		■	■									
7	Write RFT(s)			■									
8	Set up data room, San Jose				■								
9	Promote and market concession(s)				■	■							
10	Invite and hold 2-day seminar						■						
11	Receive Proposals							■					
12	Evaluate bids								■				
13	Short list potential winners								■				
14	Negotiate with short list									■			
15	Ask for Best & Final Offers									■			
16	Select winner										■		
17	Contract Signing										■		
18	Start construction												■