APPENDICES

for the

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

Prepared for:
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APPENDICES

APPENDIX I

ENVIRONMENTAL ANALYSIS

I.1 Introduction

This chapter presents the results of the Environmental Feasibility Analysis (EFA) for the segments and technologies proposed as part of the transit system for San José. 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 such 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 90 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, the largest source of foreign currency for the country.

Motor vehicles are considered the main source of pollutant emissions in Costa Rica. All 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. These buses contribute 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 (TAQM) 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 TAQM. The general objectives of the TAQM 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 methodologies and areas of analysis included in the EFA considered the topics listed in Costa Rica regulation for environmental impact studies[1], supplemented by guidance documents prepared by the U.S. Environmental Protection Agency, the U.S. Federal Highway Administration, the American Public Transit Association, and international organizations such as the World Bank. The analysis of potential environmental impacts and the general definition of mitigation measures presented in this section draws from ICF Kaiser's experience in similar projects around the world

[1] Secretaría Técnica Nacional Ambiental, Ministerio de Ambiente y Energía. *Guía Básica para Elaboración de Estudios de Evaluación de Impacto Ambiental en Actividades de Desarrollo, Borrador Final.* Dic. 1995.

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 rest of this section is divided into three main sections. Section 4.2 presents the environmental consequences and mitigation measures for each component of the proposed San José transit system. The key environmental areas analyzed include air quality, traffic interference, utilities interference, visual impacts, noise, vibration, encroachment (i.e., structures and/or properties that have come to be located in areas to be used for the transit system), induced development, and energy requirements. Air quality benefits that may be caused by the implementation of electric options of the overall transit system are among the most important components of this analysis. Section 4.3 presents a summarized environmental comparison of the various alternatives and components of the system. Section 4.4 presents the environmental requirements in Costa Rica related to EIAs, and a discussion of additional studies recommended by the ICF Kaiser team for future phases of environmental analysis of the project.

This chapter draws on the detailed description in Chapter 2 of the various components and technologies included in the proposed San José transit system. To facilitate the presentation of the environmental analyses, most of the following discussion groups the system segments in two categories:

- Segments with routes along the INCOFER rail right-of-way (ROW); and
- Segments with routes that use existing streets.

The first group has ten segments, while the second group has six segments. Up to four technologies -- light rail train (LRT), diesel mobile units (DMU), clean-diesel buses, and electric trolley buses (ETB) -- are considered for the first group of segments. Up to three technologies are considered in the second group of segments -- Tram/LRT, clean-diesel buses, and ETB.

Table I.1-1 presents both groups with their corresponding segments and technologies. Chapter 2 presents additional details on the configuration and technical specifications of each segment and technology. Apart from the specific segments in the two groups above, some categories of environmental impacts merit a separate analysis for the proposed transfer stations. As described in Chapter 2, 28 transfer stations are proposed. At these transfer stations, commuters may change from one mode of transportation (e.g., car, bus, LRT) to a different mode of transportation (e.g., ETB, LRT, Tram). These transfer stations are larger in size and are expected to handle larger volumes of commuters than regular LRT or ETB stations.

Table I.1-1
Segments and Technologies Considered in the San José Transit System

	Technology/Approach			
Segment	**LRT**	**DMU**	**Bus**	**ETB**
INCOFER Rail ROW Routes				
Heredia to San Pedro	✓	✓	✓	✓
Alajuela to San Pedro	✓	✓	✓	✓
Alajuela to Cartago	✓	✓	✓	✓
San Antonio de Belén to Pacific Station	✓	✓		
Pavas to Pacific Station	✓	✓		
Ciruelas to Pacific Station	✓	✓		
Alajuela to Pacific Station (via Ciruelas)	✓	✓		
Alajuela to Pacific Station (via San Antonio de Belén)	✓	✓		
Atlantic Station to Pacific Station - Single Track	✓	✓		
Atlantic Station to Pacific Station - Double Track	✓	✓		
Street Routes				
Pavas to San Pedro (diametral)	✓		✓	✓
Tibás to Pacific Station			✓	✓
Paso Ancho to Pacific Station			✓	✓
Desamparados to Pacific Station			✓	✓
Moravia to Atlantic Station			✓	✓
Alajuelita - Hatillo - Pacific Station			✓	✓

I.2 Environmental Consequences and Mitigation Measures

This section presents the potential environmental benefits and negative impacts that may be caused by the construction, operation, and maintenance of the proposed segments of the San José transit system, for the various technologies analyzed. The evaluation of potential environmental effects has been divided in nine sections. Each section presents a brief description of the affected environment, a characterization of potential environmental consequences, and recommended mitigation measures commonly used in similar projects in other countries.

I.2.1 Area of Influence

This section briefly describes the regional and specific areas of influence considered for the analysis of environmental consequences. The objective of this description is to provide the reader a broad view of the areas crossed by each segment of the proposed transit system. Specific information on the urban environment around each segment is provided later in the appropriate impact analysis sections.

I.2.1.1 Regional Area of Influence

Costa Rica's total population is three million inhabitants. Most of the country has a rainy season from May to November and a dry season from December to April. Annual rainfall averages 100 inches nationwide. Temperature depends more on elevation than location, and the Central Valley where San José is located has an average temperature of around 72 degrees.

San José's Metropolitan Area includes four major cities: San José, Alajuela, Heredia, and Cartago. San José is located in the broad fertile valley of the Central Plateau. The political, economic, and cultural center of the republic, San José, was founded in 1737 but did not become the capital until 1823. San José's population is 1.2 million. Approximately ten miles northwest from San José on the General Cañas Highway is Alajuela, capital of the Province of Alajuela and one of the nation's most important cities. Alajuela is also a fertile fruit-growing region and an important center for lumber, sugar, coffee, and livestock. Its population reaches 575 thousand inhabitants. Heredia, in the center of the coffee district, is six miles from the capital. It has a population of approximately 305 thousand. The city of Cartago, once the capital of Costa Rica, is located 14 miles southeast from the capital. Currently, Cartago has 384 thousand inhabitants.

The city of San José and its metropolitan area are located in the central part of the country. Its socioeconomic importance is evident in the national context, because it includes 70 percent of the national transport, 80 percent of the economic activities, and 60 percent of the country's population, in only 4 percent of the national territory. Approximately 1.5 million person-trips take place every workday in downtown San José. Seventy percent of these trips use the public transportation system, which currently has approximately 1200 buses serving 125 routes and owned by about 50 private transportation companies. The other 30 percent of the person-trips in the metropolitan area use private cars. There are approximately 300,000 cars in the current fleet.

Because jobs are concentrated in San José, there is a daily movement of commuters into the city in the morning and out of the city in the evening. Severe traffic congestion is a common problem. The principal thoroughfare is Avenida Central, which becomes Paseo Colón (Route 1) on one side and Paseo Ruben Dario (Route 2) on the other, after it leaves the commercial section of the downtown area. This route is also the main highway that crosses the city of San José, called the Panamerican Highway (Routes 1 and 2). It connects San José with Nicaragua and Panamá. This highway is highly congested at peak hours. In addition, fourteen major corridors were determined to be used by daily commuters to enter the city of San José. For additional information on those 14 corridors, see Chapter 3. The beltway, called "circunvalación," surrounds the outside of downtown area. This beltway also faces severe traffic congestion problems during peak hours, mostly at the circles where it crosses other major streets. Chapter 3 presents more detailed information on current and projected traffic demand in the area of study.

I.2.1.2 Specific Area of Influence

This section presents a brief description of general urban environmental conditions for each segment of the proposed transit system and its specific area of influence. In order to facilitate the description, some of the segments presented in Table I.1-1 have been grouped as part of INCOFER's Atlantic and Pacific Lines. See Map 2-1 on Chapter 2 for the location of communities and other points of reference used in the following description.

INCOFER's Atlantic Line ROW. This route includes the first three segments of the transit system presented in Table I.1-1 (Heredia-San Pedro, Alajuela-San Pedro, and Alajuela-Cartago). The Atlantic Line runs in a Northwest-Southeast direction across the San José Valley and it connects the four largest cities of the San José Metropolitan Area: Alajuela, Heredia, San José, and Cartago. The Atlantic line had a railroad service connecting San José and the port of Limón in the Atlantic Coast until 1991. The new proposed transit system along this line would have 13 stations, five of which would be transfer stations where commuters could change transportation modes (see Chapter 2). Four technologies are considered in this ROW, as presented in Table I.1-1.

Proposed Stations Atlantic Line
Alajuela East
Río Segundo
San Joaquín
San Francisco
Heredia
Santo Domingo
Cuatro Reinas
Atlantic Station
San Pedro
Curridabat
Tres Ríos
El Alto
Cartago

The description of the areas along INCOFER's ROW is based on field visits to the sites and locomotive rides on the parts of the ROW that are currently accessible. The description of the corridor is qualitative. The term "low" development is mostly used in the case of areas with open space or croplands. "Highly" developed areas refer mostly to the downtown area of the cities located in the study area. "Medium" development corresponds to areas outside the cities, suburban areas, and newly developed areas.

The most important station along the Atlantic Line is the Atlantic Station. This station is located on Paseo de las Damas and the surrounding area is primarily commercial including movie theaters, bars, restaurants, hardware shops, etc. The station itself takes up approximately two blocks. It has equipment, yards, tracks, and a building currently used as a small train museum. Near the station, there are two bus stops, one urban and the other inter-urban.

From the Atlantic Station in the northwest direction, the ROW up to Santo Domingo begins with a residential character for approximately ten blocks, but it quickly changes to low-income residences, open areas, and industry. The Otoya neighborhood, which is located on the west side of the ROW two blocks after the Atlantic Station, has high-income households. After an underpass called the San Francisco Bridge, located approximately seven blocks beyond the

Atlantic Station on the ROW, the area includes mostly low-income houses, open space, and industry. Traffic levels and land values decrease.

From Santo Domingo to Heredia, the rail ROW crosses an area with coffee plantations and open space, very small urban density, little traffic, and medium land values. The railroad station at Heredia is a medium-size building with a small restaurant inside. It is located in downtown Heredia (see photo). The surrounding area is high-density residential. The next station is located at San Francisco, a small community with mostly low-income households, small streets, and low traffic levels. The Atlantic Line continues nothewest through an area of open space with low density, primarily used for coffee plantations.

The town of San Joaquín, where the next station in the northwest direction would be located has a high urban density and land value. It has a residential character with medium levels of traffic. From San Joaquín to Alajuela East, the area contains mostly green areas and open space with alternating coffee crops. Río Segundo is a small community crossed by the ROW. The Atlantic Line ends at the city of Alajuela, which is highly urbanized and has high property values.

From the Atlantic Station in the southeast direction, the rail ROW crosses an area that is highly urbanized with high traffic levels. The ROW runs very close to the University of Costa Rica. From San Pedro/University of Costa Rica to Curridabat, the area is highly developed, including some commercial areas but consisting mostly of housing. Traffic levels are high. From Curridabat to Cartago, the area contains mostly coffee plantations and open space until the line arrives at the city of Cartago, which is a highly urbanized like the other three major cities in the metropolitan area.

INCOFER's Pacific Line ROW. This route includes three segments of the transit system presented in Table I.1-1 (San Antonio de Belén-Pacific Station, Pavas-Pacific Station, and Ciruelas-Pacific Station). The Pacific Line runs in a Northwest-Southeast direction across the San José Valley, south of the Atlantic Line. The Pacific line had a railroad service connecting San José and the port of Caldera on the Pacific coast until 1995. The new proposed transit system along this line would have 11 stations, eight of which would be transfer stations where commuters could change transportation modes (see Chapter 2). Two technologies (LRT and DMU) are considered in this ROW, as presented in Table I.1-1.

Proposed Stations Pacific Line
Alajuela West
Molino
Ciruelas
International Airport
Ojo de Agua
San Antonio de Belén
Pavas
West of Highway 104
La Sabana
CNP
Pacific Station

The most important station along the Pacific Line is the Pacific Station. The station is comprised of approximately six blocks of railroad yards, track, and shops. On its western side, there are two coffee warehouses inside the station and medium-size houses and a parking lot outside the station. On the northern side, there is a small park and medium-size houses, giving the area a residential character. On the southern side, there is a maternity clinic and commercial areas. On the eastern side, there are some offices and small houses. Overall, this is a high-density area. Land value is medium-high because of its central location in the city. The traffic levels are high on the streets surrounding the station.

The area along the corridor from the Pacific Station to La Sabana is highly developed (mostly industrial), and land values range from medium to high. The rail ROW crosses two main streets; Calle 24 and Autopista General Cañas. La Sabana station is located next to the Metropolitan Park. This park is approximately nine blocks long and four blocks wide. It has mostly trees and green areas, but also includes a stadium, a museum, and a swimming pool. Areas in front of the park are commercial. Further south, the area becomes residential with high land values. Traffic levels are high along the Autopista Próspero Fernandez, which borders the park on its southern boundary.

From La Sabana to Pavas, the rail ROW runs through an industrial low-density area. The surrounding land use changes to higher-density low-income housing towards Pavas. Land values decrease going west as well. There are two important highway crossings, the Autopista Próspero Fernandez (a four lane highway) and the beltway (*circunvalación*). The area surrounding the proposed station at Pavas has high urban density, with mostly low-income residences and low land values.

From Pavas to San Antonio de Belén, timber, corn, dough, and gas industries can be found, followed by open space. In the open space area, the local Tobillas Bolaños Airport is located approximately 800 meter from the ROW. Land value is medium-low. Outside San Antonio, the area is mostly open space with disturbed vegetation and a few scattered low-income households. There are two borrow pits where sand is extracted, followed by a polo field and a luxury hotel (Marriot Hotel) near San Antonio. Land value is high outside San Antonio. The town of San Antonio is small, but has high density in its few blocks. Land value is medium with mostly medium-income households. San Antonio's Station is a medium-size train station, which is also used as a bus stop.

The area along the rail ROW from San Antonio to Ojo de Agua is mostly open space with disturbed vegetation, except for the town of San Rafael. Near this town, population density and land value are both medium. Ojo de Agua is a small town with medium to high density.

From Ojo de Agua to Ciruelas, the area is primarily open space with alternating onion crops. Population density is low, land value is medium, and traffic levels are very low. The area surrounding the proposed station at Ciruelas has low urban density, low land value, and low traffic levels. The existing station is surrounded by open space. It is a medium size station, with a large yard and maneuvering area.

Northwest Connectors Atlantic-Pacific Lines. The proposed San José transit system considers two potential connecting lines between the Alajuela station in the Atlantic Line and the Pacific Line. The first possible connection would go via Ciruelas using a ROW that belongs to INCOFER, with the exception of a few hundred meters between Molino and Alajuela. The second option would connect Alajuela and San Antonio de Belén through an entirely new ROW that would cross the International Airport via an underground tunnel.

The area crossed by the rail ROW from Ciruelas to Molino alternates between open space and low-income households. It is mostly a medium-density area with low land values. There are several pasture areas around the ROW with cattle. The town of Montecillos, located a few kilometers outside Molino, has a large number of squatters. Wheat coming from the Caldera Port in the Pacific coast is stored at the Molino station, which includes a storage area for grains. Buildings, houses, and paved streets have encroached into the rail ROW between Molino and Alajuela.

The corridor from Alajuela to San Antonio de Belén is mostly residential, with some industrial areas. The corridor presents mostly areas of medium density. Land values are medium. Most of the developed areas occur near Alajuela. The only sensitive receptors are two churches, the one in San Antonio and the one in San Rafael. However, it must be noted that INCOFER does not own a ROW in this corridor.

Southeast Connector Atlantic-Pacific Lines. As part of the proposed transit system for San José, the existing ROW between the Atlantic and the Pacific stations in downtown San José was considered in two options, either single- or double-track(see Table I.1-1). The ROW in this downtown area has high density, high land value, and high traffic levels in most streets. The area along this route has a commercial and residential character near both stations, but is primarily residential in the middle section. The ROW crosses several avenues of high traffic. For about six blocks, the existing track runs in the middle of Avenida Central with two lanes of high traffic on each side. The track has been paved over for several blocks.

Street Routes. As part of the system, six segments along existing street routes were considered. Three technologies compatible with existing urban transit were considered (see Table I.1-1). The area surrounding these corridors is described below.

The Pavas to San Pedro (diametral) route starts in its eastern point at Pavas, which is a low-income area. At the Metropolitan Park La Sabana, the route goes in westward direction to Route 1 (also known as Paseo Colón), a four-lane street. The surrounding area has a commercial character, with high urban density, high land value, and high traffic levels. Avenida 2 becomes a two lane street in the downtown area. The area along Avenida 2 has the highest density in the metropolitan area, land value is high due to commercial activities, traffic congestion is very high, and air pollution levels are high as well. Finally, the route goes along Paseo Ruben Dario, turning into a four lane highway outside the downtown area. The surrounding area is of commercial nature, with high density, medium land value, and high traffic levels. The Pavas-San Pedro route ends at the new, modern, four-level San Pedro Mall. The University of Costa Rica (UNA) is located eight blocks north of the Mall.

The route from Tibás to the Pacific Station would follow Route 5, which has four lanes. The Tibás area is commercial, with high density, and high land value. The corridor along Route 5 is primarily commercial with residences a few blocks behind the commercial area. Density is high most of the way, except for the area around Cinco Esquinas. Overall traffic levels are high in Route 5, except in Cinco Esquinas. The proposed street segment would then follow Calle

Central, a two-lane street. The area along this corridor is commercial, with the highest density in the metropolitan area, high land value due to commercial activities, high traffic levels, and high pollution levels.

From Paso Ancho to the Pacific Station, the area has high density. Downtown Paso Ancho is mostly residential, with little commerce. After the circle at the beltway, the area is both residential and commercial. Land value of the corridor is medium up to the Pacific Station.

The route that runs northward from Desamparados to the Pacific Station follows Route 209, which has four lanes and high traffic. Route 209 runs through a commercial area, with high density, high land value, and high traffic levels. After Plaza Viquez, a recreational center with swimming pools and green areas, the area along Avenida 22 is mostly residential. Avenida 22 has four lanes. The area has high density, medium land value, and moderate traffic levels.

The route from Moravia to the Atlantic Station starts at Moràvia, an area of new development with high density. From there, it follows Avenida Central in Guadalupe, which is a commercial area rapidly changing to residential a few blocks away from Avenida Central. The area has high urban density, and high land value because of its commercial activities. Traffic levels are high along this road's four lanes. The route then follows Calle 23, another four-lane street, eventually arriving at the Atlantic Station.

The route from Alajuelita to the Pacific Station starts in downtown Alajuelita, a commercial and residential area. This is a high density area, with high traffic levels. These same characteristics exist until the proposed route reaches Hatillo. After Hatillo, the corridor remains commercial and residential, but some light industry is present as well. Overall, this corridor has high urban density, high land values, and high traffic levels.

I.2.2 Air Quality

I.2.2.1 Current Air Quality Conditions

The availability of monitored ambient air quality data is for Costa Rica is limited. The study team identified two currently operating monitoring networks and some additional data from a special study on ozone.

Most of the air quality data presented in this report was measured by a network of six monitors in San José operated since 1993 by *Universidad Nacional* with ProEco. The site locations are as follows:

- **UNA** In the town of Heredia in front of the *Universidad Nacional*
- **ICE** Instituto Costarricense de Electricidad - *Sabana Norte "Bolivar Las Americas"* in front of the "*La Sabana*" near *calle Luisa*
- **H** - *Hospital San Jaun de Dios - Paseo Colon* and *Aprox. calle 16*
- **CR** - *Cruz Roja Costarriencense - Avenida 8* and *Calle 3* and *5*

- **MN -** *Museo de Nino* - Located at the northern end of *Calle 4* (north of Ave. 9)
- **T1** *Teatro Nacional* - *Avenida 2* between *Calle 3 and 5*

Table I.2.2-1 summarizes the spatial and temporal monitoring coverage for each of the following pollutants.

- Carbon monoxide (CO)
- Nitrogen dioxide (NO_2)
- Lead (Pb)
- Total suspended particulate matter (TSP)
- Particulate matter, smaller than 10 μm diameter (PM_{10})
- Ozone (O_3)

Table I.2.2-1
Summary of Ambient Air Quality Data for San José, Costa Rica
provided by *Universidad Nacional* with ProEco.

Sampling Site	CO	NO_2	Pb	TSP	PM_{10}	O_3	SO_2	Benzene	Xylene	Toluene
UNA										
1993										
1994				❖						
1995	❖	❖	❖	❖		❖		❖	❖	❖
1996	❖	❖	❖	❖	❖	❖	❖	❖	❖	❖
ICE										
1993		❖	❖	❖						
1994	❖	❖	❖	❖						
1995	❖	❖	❖	❖		❖				
1996	❖	❖	❖	❖	❖	❖	❖			
Hospital										
1993		❖	❖	❖						
1994	❖	❖	❖	❖						
1995	❖	❖	❖	❖		❖				
1996	❖	❖	❖	❖	❖	❖	❖			
Museo Nifio										
1993		❖	❖	❖						
1994		❖	❖	❖						
1995	❖	❖	❖	❖	❖	❖		❖	❖	❖
1996	❖	❖	❖	❖	❖	❖	❖	❖	❖	❖
Cruz Roja										
1993		❖	❖	❖						
1994	❖	❖	❖	❖						
1995	❖	❖	❖	❖		❖				
1996	❖	❖	❖	❖	❖	❖	❖			
Teatre Nacional										
1993		❖	❖	❖		❖				
1994	❖	❖	❖	❖		❖				
1995	❖	❖	❖	❖		❖		❖	❖	❖
1996	❖	❖	❖	❖	❖	❖	❖	❖	❖	❖

- Sulfur dioxide (SO_2)
- Benzene
- Xylene
- Toluene

The Ministry of Health also operates a network of five monitors at the following locations:

- Traffic police station in Cartago, near the main highway to San José, in the vicinity of a glass production factory (SO_2, opacity, TSP);
- Center of Child Education and Nutrition in Zapote (SO_2, opacity, PM_{10});
- Health Ministry in San José (SO_2, opacity, PM_{10}, ozone, CO);
- Cienfiel office in Uruca (SO_2, PM_{10}); and
- Center of Child Education and Nutrition in Alajuela (SO_2, TSP).

Because this network began operating less than a year ago, data were not available for this report.

The National Meteorological Institute, which currently collects surface meteorological data at a number of stations, is planning to initiate air quality monitoring at 2 permanent stations and 1 mobile station by the end of the year. Their target pollutants are carbon monoxide, carbon dioxide, oxides of nitrogen and oxides of sulfur.

The only other ambient pollutant measurements identified came from an ozone study reported by J. Valdes and others in the vicinity of the Hospital Nacionale de Ninos in San José between September, 1993 and May, 1994 (Valdez et al., 1996).

I.2.2.2 Comparison Of Monitored Values To Air Quality Guidelines And Standards

In order to better characterize air quality in the San José metropolitan area, this section compares the available monitored values discussed above, to Costa Rican guidelines, WHO guidelines, and U.S. standards for air quality.

Summary of Air Quality Guidelines and Standards

The World Health Organization has published air quality guidelines for CO, NO_2, Pb, O_3, SO_2, and toluene. These are summarized in Table I.2.2-2.

Table I.2.2-2
Summary of WHO Air Quality Guidelines

Pollutant	Averaging Time	Concentration
Carbon monoxide	15 minutes	100 mg/m^3
	30 minutes	60 mg/m^3
	1 hour	30 mg/m^3
	8 hours	10 mg/m^3
Nitrogen dioxide	1 hour	200 μg/m^3
	24 hours	150 μg/m^3
Lead	Annual	0.5 μg/m^3
Ozone	8 hours	120 μg/m^3
Sulfur dioxide	10 minutes	500 μg/m^3
	24 hours	125 μg/m^3
	Annual	50 μg/m^3
Toluene	1 week	260 μg/m^3

The United States has established National Ambient Air Quality Standards (NAAQS) for the primary purpose of protecting human health. These standards apply to six pollutants: CO, Pb, NO_2, O_3, PM_{10} and SO_2. The current NAAQS are summarized in Table I.2.2-3.

Table I.2.2-3
Summary of U.S. National Ambient Air Quality Standards (NAAQS)

Pollutant	Averaging Time	Concentration
CO	8 hour	9 ppm (10 mg/m^3)
	1 hour	35 ppm (40 mg/m^3)
NO_2	Annual	0.053 ppm (100 μg/m^3)
Pb	3 months	1.5 μg/m^3
PM_{10}	Annual	50 μg/m^3
	24-hour	150 μg/m^3
O_3	1 hour	0.12 ppm (235 μg/m^3)
SO_2	Annual	80 μg/m^3 (0.03 ppm)
	24-hour	365 μg/m^3 (0.14 ppm)

In addition, Costa Rica has total suspended particulate matter (TSP) guidelines of 80 $\mu g/m^3$ geometric annual average and 240 $\mu g/m^3$ 24-hour average; and an annual average ozone concentration guideline of 60 $\mu g/m^3$.

The following sections discuss the monitored data for each pollutant species and note whether the available measured concentrations indicate values over WHO guidelines. There is not a WHO guideline for PM_{10}, so these monitored data are compared with the U.S. NAAQS. The data are also compared to the Costarican guidelines where applicable.

__Carbon Monoxide__

Table I.2.2-4 presents the annual mean CO values for the six monitoring sites in the San José area. Note that for 5 of the 6 sampling sites the 1996 annual average concentration appears to exceed the WHO guideline of 9 ppm for an 8-hour averaging time, suggesting that 8-hour average concentrations are in exceedance most of the time. In addition, the general trend of CO concentrations appears to be increasing.

Table I.2.2-4
Annual Mean CO Concentrations (ppm)

Location	1993	1994	1995	1996
UNA	--	--	11.0	9.5
ICE	--	7.1	11.3	11.0
Hospital	--	6.2	11.0	16.2
Museo Nino	--	5.4	7.0	3.6
Cruz Roja	--	7.7	13.0	13.2
Teatro Nacional	--	6.0	13.0	14.4

Source: *Universidad Nacional* with ProEco.

Table I.2.2-5 presents the maximum 8-hour average concentration at each station for 1996. Five of the six stations exceed the WHO guideline, with margins ranging from 80 percent to 160 percent.

Table I.2.2-5
Maximum 8-hour Average CO Concentrations (ppm)

Location	1996
UNA	16.7
ICE	16.1
Hospital	23.8
Museo Nino	5.2
Cruz Roja	20.0
Teatro Nacional	23.1

Source: *Universidad Nacional* with ProEco.

Nitrogen Dioxide

Table I.2.2-6 presents the annual mean NO_2 concentrations. None appears to exceed the U.S. NAAQS of 100 μg/m³.

Table I.2.2-6
Annual Mean NO_2 Concentrations (*μg/m³*)

Location	1993	1994	1995	1996
UNA	--	--	32.0	28.2
ICE	43.0	47.7	45.0	41.2
Hospital	52.1	62.3	49.0	50.5
Museo Nino	43.0	37.4	44.0	26.9
Cruz Roja	48.9	50.4	46.0	43.8
Teatro Nacional	61.4	77.1	54.0	50.0

Source: *Universidad Nacional* with ProEco.

Table I.2.2-7 presents the maximum 24-hour average NO_2 concentrations for 1996. None exceeds the WHO guideline of 150 μg/m³.

Table I.2.2-7
Maximum 24-hour Average NO_2 Concentrations (*μg/m³*)

Location	1996
UNA	42
ICE	56
Hospital	57
Museo Nino	42
Cruz Roja	55
Teatro Nacional	74

Source: *Universidad Nacional* with ProEco.

Lead

Table I.2.2-8 presents the annual mean Pb concentrations measured from 1993 through 1996. Two sites exceeded the WHO guideline of 0.5 μg/m³ annual average in 1995. However, concentrations at the Teatro Nacional site appear to have decreased in 1996.

Table I.2.2-8
Annual Mean Pb Concentrations (μg/m³)

Location	1993	1994	1995	1996
UNA	--	--	0.48	--
ICE	0.44	0.39	0.54	--
Hospital	0.43	0.38	0.45	--
Museo Nino	0.38	0.21	0.15	--
Cruz Roja	0.34	0.48	0.42	--
Teatro Nacional	0.71	0.63	0.51	0.38

Source: *Universidad Nacional* with ProEco

Particulate Matter

Total suspended particulate concentrations have been measured San José since 1993. Table I.2.2-9 presents the annual mean concentrations of TSP measured in the San José region. With the exception of one monitor in 1994, annual averages at all monitors exceed the Costa Rican annual geometric mean guideline of 80 µg/m^3, most by significant margins. (Note that the data presented are arithmetic averages, which are likely to be somewhat higher than the geometric means.) Moreover, the general trend appears to be increasing concentrations.

Table I.2.2-9
Annual Mean TSP Concentrations (*µg/m³*)

Location	1993	1994	1995	1996
UNA	--	--	280.2	187.0
ICE	138.1	137.1	213.2	246.7
Hospital	127.1	144.1	171.3	217.5
Museo Nino	93.1	71.0	123.0	159.0
Cruz Roja	128.3	146.0	241.4	271.7
Teatro Nacional	205.3	218.0	345.0	241.7

Source: *Universidad Nacional* with ProEco.

Monitoring for PM_{10} only began in 1996. Table I.2.2-10 summarizes the annual mean PM_{10} concentrations for 1996. As can be seen, the yearly mean values at five of the six sites exceed the U.S. NAAQS of 50 µg/m^3 (although two of those averages actually represent only a single month).

Table I.2.2-10
Annual Mean PM_{10} Concentrations (*µg/m³*)

Location	1993	1994	1995	1996
UNA	--	--	--	76.5
ICE	--	--	--	54.2
Hospital	--	--	--	64.0[1]
Museo Nino	--	--	--	24.0[1]
Cruz Roja	--	--	--	97.3[1]
Teatro Nacional	--	--	--	55.4

Source: *Universidad Nacional* with ProEco.
[1] Measurements made for one month only.

An issue not addressed by the available data pertains to secondary particulate matter, which is formed in the atmosphere from nitrate and sulfate emissions. No information was identified about the composition of the monitored particulate matter to determine the fraction that is of secondary origin. Beacuse secondary species take time to form, they are likely to show the highest concentrations somewhere downwind of the urbanized area, out of the range of the current monitoring sites. The high SO_2 concentrations observed in San José, suggest the potential for enhanced secondary particulate matter. Note that if secondary particulate matter is acidic, it can contribute to acid precipitation, which can be harmful to sensitive ecosystems.

Ozone

Ozone is a secondary pollutant that is formed in the atmosphere from ultraviolet light acting on volatile organic compounds (VOCs) in the presence of oxides of nitrogen (NO_x). Because of the radiation requirements, ozone concentrations typically display a diurnal pattern, with peaks occurring from midday to afternoon. Moreover, enhanced concentrations tend to occur in 2 to 3 day episodes, when stable meteorological conditions inhibit ventilation of the air basin.

Annual mean ozone measurements at network sites are presented in Table I.2.2-11. Only the UNA site in 1995 exceeds Costa Rica's annual average ozone guideline concentration of 60 $\mu g/m^3$.

Table I.2.2-11
Annual Mean O_3 Concentrations($\mu g/m^3$)

Location	1993	1994	1995	1996
UNA	--	--	88.0	39.8
ICE	--	--	51.0	38.6
Hospital	--	--	46.4	35.5
Museo Nino	--	--	52.0	43.3
Cruz Roja	--	--	53.5	31.5
Teatro Nacional	20.0	44.1	44.0	35.4

Source: *Universidad Nacional* with ProEco.

Table I.2.2-12 presents the maximum ozone concentrations for 1996. While the averaging time for the measurements is unclear, none exceed the WHO 8-hour average guideline concentration for ozone of 120 $\mu g/m^3$.

Table I.2.2-12
Maximum Ozone Concentrations ($\mu g/m^3$)

Location	1996
UNA	62
ICE	55
Hospital	47
Museo Nino	67
Cruz Roja	61
Teatro Nacional	45

Source: *Universidad Nacional* with ProEco.

Another ozone study reported measurements of ozone at the National Children's Hospital in San José from September 1994 to May 1994 (Valdez et al., 1996). Diurnal peaks were observed to coincide with the ultraviolet radiation peaks, at approximately midday. The maximum concentration was reported to be 120 $\mu g/m^3$, below the 1-hour average U.S. NAAQS.

The available ozone data is likely to be an inadequate indicator of potential ozone problems, however. Because, like secondary particulate matter, the formation of ozone in the atmosphere requires time to occur, peak values are expected to occur downwind of the urban area, rather than in the urban area itself. Note that ozone is known to have adverse effects on plant life, as well as human health, at sufficiently high concentrations, so that ecologically sensitive areas and agricultural areas downwind of San José are potentially at risk.

Sulfur Dioxide

Table I.2.2-13 presents the annual mean SO_2 concentrations for 1996, the first year of monitoring. Unfortunately, the data report is unclear about the concentration units, which may be ppb or $\mu g/m^3$. In any case, at least two of the six monitoring sites exceed the WHO guideline of 50 $\mu g/m^3$ (27 ppb) annual average.

Table I.2.2-13
Annual Mean SO_2 Concentrations ($\mu g/m^3$)

Location	1993	1994	1995	1996
UNA	--	--	--	55.2
ICE	--	--	--	21.6
Hospital	--	--	--	50.3
Museo Nino	--	--	--	28.1
Cruz Roja	--	--	--	40.4
Teatro Nacional	--	--	--	40.0

Source: *Universidad Nacional* with ProEco.

Summary of Monitoring Data

Monitoring data for San José and vicinity shows exceedances of Costa Rican guidelines, WHO guidelines, and/or U.S. NAAQS for CO, lead, TSP, PM_{10}, and SO_2. Available data is inconclusive for ozone and secondary particulate matter. Motor vehicle emissions are known to be major contributors to concentrations of each of these pollutants. Concentrations of TSP appear to be increasing, while there is some evidence that concentrations of lead are decreasing.

I.2.2.3 Transit Scenario Analysis for The San José Metropolitan Area (SJMA)

Air quality impacts for the San José Metropolitan Area (SJMA) from the proposed uses of the existing railroad right-of-way (ROW) and conversion of existing bus lines to electric trolley buses (ETB) include:

1. Reduced primary and secondary pollutants from decreased vehicle activity and increased presence of clean vehicle technologies;

2. Potential minor increases in electrical generation emissions;
3. Possible exacerbation or formation of emission "hot spots" at feeder stations;
4. Short term construction impacts on primary pollutant emissions and fugitive dust emissions; and
5. Potential entrained road dust reductions.

The scenarios investigated correspond to those presented in Table I.1-1. The emissions to the ambient air resulting from current transportation sources in the SJMA were estimated using several methods. Given the diverse population of vehicles in the SJMA, it is impracticable to arrive at an accurate estimate of gram/kilometer emission factors for each class of vehicles (e.g., cars, buses). Rather, literature on air quality studies performed to date in Costa Rica was examined in conjunction with other available data on vehicle emission rates, standards, and control programs. Based on engineering judgment and extrapolations from existing data, emission factors for the different segments of the onroad fleet were developed. Both current and future conditions were examined. Attention was focused on diesel transit buses, although estimates for the entire onroad fleet were developed to establish a baseline from which the relative importance of different air quality impacts could be assessed.

Some of the scenarios under evaluation could produce increases in electric utility emissions, should the available hydroelectric and geothermal capacity be unable to meet increased demand due to electrification of portions of the transportation sector. Although these impacts could not be evaluated quantitatively, given the uncertainties regarding changes that would occur in energy demand, they are noted in this study. We also note that short term construction impacts will result from some of the projects discussed in this analysis. A discussion of the nature of these impacts and possible mitigation measures is provided.

Current Contribution Of Onroad Vehicles and Urban Buses to Ambient Pollution in the SJMA

Onroad vehicle emissions representative of current (circa 1997) conditions were estimated from vehicle population data, activity assumptions, and emission factors. Emissions can be expected to increase over 10% per year from these values, given current projections of growth in vehicle usage, if no further steps are taken to clean up the vehicle fleet and reduce reliance on fossil-fueled vehicles. No data were available on the local mixture of cars, buses, and other vehicle types in the SJMA, so national averages were used. We feel that these overestimate the relative population of cars in comparison with transit buses. Therefore, while the numbers may provide a sense of how much pollution is being produced by transportation sources in the SJMA, they should not be used to apportion responsibility for this pollution among the different segments of the transportation fleet.

Although an annual vehicle Inspection and Maintenance (I/M) program was initiated in 1995, this program has not yet had time to produce substantial reductions in the onroad fleet rates. Furthermore, since lead was only recently removed from gasoline and new vehicle standards adopted, the relative proportion of vehicles with well-functioning emissions control systems is assumed to be small. Therefore, rates used in evaluating current emission levels are conservative and do not account for the reductions due to I/M and new vehicle standards.

Table I.2.2-14 summarizes estimated population and activity for the onroad fleet in the SJMA in 1997 and 2010 (the outermost year looked at in our analysis). These values are extrapolated from national estimates prepared by the Ministry of Environment and Energy (MEE, 1996). Lacking an estimate of what portion of the national vehicle population is operated in the SJMA, an estimate of 40% was used based on the residential population. Tables 4.2.2-15 and 4.2.2-16 summarize the emission rates assumed for gasoline and diesel-fueled vehicles, respectively in 1997, while Table I.2.2-17 provides the same information for controlled vehicles. These reflect the potential magnitude of emission reductions that could result from implementation of new vehicle standards. (Source: IPCC, 1995; EPA, 1993; EPA, 1995). Table I.2.2-18 provides annual emission estimates for both segments of the onroad fleet, based upon 1997 activity levels. Note that the vehicle class "Special Vehicles" in these tables refers to farm and construction equipment.

Table I.2.2-14
Summary of Population and Activity Estimates for 1997 and 2010 in the SJMA (MEE, 1996)

	Vehicle Population by Calendar Year	
Vehicle Class	**1997**	**2010**
Auto	65764	99588
Jeep	14239	17819
Microbus Familiar	7387	12054
Light Trucks	39110	55829
Heavy Trucks	9162	14147
Bus	2280	3338
Public Microbus	756	1263
Taxi	1153	1785
Special Equipment	6563	8425
Other	1859	2303
Motos	24502	34302
Total	172780	250853

SJMA (assumed 40% of National Population)

Table I.2.2-15
Emission Factors for Current Gasoline Vehicles (g/km)

Vehicle Class	NMVOC	CO	NOx	N2O	PM10	CO2	CH4	PM2.5
Auto	6.33	40.62	2.14	0.01	0.19	399.00	0.17	0.04
Jeep	6.33	40.62	2.14	0.01	0.19	399.00	0.17	0.04
Microbus Familiar	6.33	40.62	2.14	0.01	0.19	399.00	0.17	0.04
Light Trucks	8.54	44.55	2.63	0.01	0.21	466.00	0.17	0.04
Heavy Trucks	18.16	143.14	5.71	0.01	0.37	1165.00	0.37	0.26
Bus	18.16	143.14	5.71	0.01	0.37	1165.00	0.37	0.26
Public Microbus	18.16	143.14	5.71	0.01	0.37	1165.00	0.37	0.26
Taxi	6.33	40.62	2.14	0.01	0.19	399.00	0.17	0.04
Motos	6.50	23.80	0.19	0.00	0.09	186.00	0.33	0.03

Source: Particulate rates are from EPA, 1993 and 1995; all other rates are from IPCC, 1995.

Table I.2.2-16
Emission Factors for Current Diesel Vehicles (g/km)

Vehicle Class	NMVOC	CO	NOx	N2O	PM10	CO2	CH4	PM2.5
Auto	0.52	1.06	1.02	0.01	0.55	537.00	0.01	0.51
Jeep	0.52	1.06	1.02	0.01	0.55	537.00	0.01	0.51
Microbus Familiar	0.52	1.06	1.02	0.01	0.55	537.00	0.01	0.51
Light Trucks	0.83	1.61	1.45	0.02	0.57	559.00	0.02	0.53
Heavy Trucks	2.99	8.54	16.79	0.03	1.92	1249.00	0.10	1.80
Bus	2.99	8.54	16.79	0.03	1.92	1249.00	0.10	1.80
Public Microbus	2.99	8.54	16.79	0.03	1.92	1249.00	0.10	1.80
Taxi	0.52	1.06	1.02	0.01	0.55	537.00	0.01	0.51
Special Equipment*	3.90	16.30	50.20	0.08	1.92	3188.00	0.18	1.80

Source: Particulate rates are from EPA, 1993 and 1995; all other rates are from IPCC, 1995.
** rates are in g/kg fuel consumed*

Table I.2.2-17
Calendar Year 2010 Fleet Emission Factors (g/km)

Gasoline Vehicles

Vehicle Class	NMVOC	CO	NOx	N2O	PM10	CO2	CH4	PM2.5
Auto	0.66	3.14	0.50	0.02	0.03	200.00	0.02	0.04
Jeep	0.66	3.14	0.50	0.02	0.03	200.00	0.02	0.04
Microbus Familiar	0.66	3.14	0.50	0.02	0.03	200.00	0.02	0.04
Light Trucks	0.75	4.68	0.67	0.02	0.04	254.00	0.04	0.05
Heavy Trucks	1.57	8.43	2.64	0.01	0.11	832.00	0.10	0.09
Bus	1.57	8.43	2.64	0.01	0.11	832.00	0.10	0.09
Public Microbus	1.57	8.43	2.64	0.01	0.11	832.00	0.10	0.09
Taxi	0.66	3.14	0.50	0.02	0.03	200.00	0.02	0.04
Motos	2.20	13.20	0.53	0.00	0.03	160.00	0.15	0.02

Diesel Vehicles

Vehicle Class	NMVOC	CO	NOx	N2O	PM10	CO2	CH4	PM2.5
Auto	0.29	0.86	0.65	0.01	0.15	258.00	0.01	0.13
Jeep	0.29	0.86	0.65	0.01	0.15	258.00	0.01	0.13
Microbus Familiar	0.29	0.86	0.65	0.01	0.15	258.00	0.01	0.13
Light Trucks	0.42	0.98	0.76	0.01	0.17	358.00	0.01	0.15
Heavy Trucks	1.26	6.80	5.01	0.03	0.58	982.00	0.06	0.52
Bus	1.26	6.80	5.01	0.03	0.58	982.00	0.06	0.52
Public Microbus	1.26	6.80	5.01	0.03	0.58	982.00	0.06	0.52
Taxi	0.29	0.86	0.65	0.01	0.15	258.00	0.01	0.13

Source: IPCC, 1995 and EPA, 1995 for particulate rates

Table I.2.2-18
Total Gas and Diesel-Fueled Fleet Emissions (10^6kg/yr)
Estimated for the SJMA in 1997

	Gas Fleet	Diesel Fleet
NMVOC	21	2
CO	130	6
NOx	6	11
N20	0.2	0.3
PM	0.5	1.8
CO2	1200	1170
CH4	0.6	0.1
PM2.5	0.2	0.2

Only fugitive particulate emissions are estimated for these types of equipment, since exhaust rates are lacking. The class "Microbus Familiar" designates passenger vans. The class "Public Microbus" refers to mid-sized buses, capable of carrying fifteen to thirty passengers.

Transit Scenarios

Three types of transit scenarios were evaluated for the SJMA. They have the potential to produce the following impacts on air quality:

- reduced emissions from diesel transit buses
- additional bus idling emissions at transfer stations
- possible minor increases in electical generation emissions
- short-term construction impacts

To better understand the air quality impacts of different technologies, we first examined what emissions might be released into the atmosphere by a typical uncontrolled transit bus. On average, buses travel 55,000 km/year, or 151 km/day. Extrapolating from U.S. data (VRC, 1994), an average bus will spend 30% of its time in operation idling. Average bus speeds range near 32 km/hr (although average peak period speeds in downtown San José may be much slower). Thus, given nearly five hours of travel time during the day in which the bus is moving, an additional

1.5 hours may be spent in idle mode (e.g., waiting at stops). These assumptions were combined with the 1997 fleet emission rates to arrive at estimates of the potential emissions represented by a single bus, on a per day basis. These are shown in Table I.2.2-19. Since less than five percent of transit buses are gasoline fueled, the diesel bus emission factors were used in these calculations. Idling rates are based on MOBILE5b (EPA, 1993; EPA, 1996) and PART5 (EPA, 1995) values for an uncontrolled heavy-duty diesel fleet. For N2O, CO2, and CH4, the average cruise rates were converted to idle (g/hr) rates using their base speed of 31.4 km/hr.

Table I.2.2-19
Average Daily Per Bus Emissions (kg)

Mode	NMVOC	CO	NOx	N2O	PM10	CO2	CH4	PM2.5
Cruise	0.45	1.290	2.535	0.005	1.4	190	0.015	1.3
Idle	0.043	0.174	0.183	0.001	0.0081	0.059	0.001	0.0074
Total	0.493	1.464	2.718	0.006	1.4081	190.06	0.016	1.3074

Source: Particulate idle rates taken from EPA, 1995; other idle rates are from EPA, 1993 and 1996.

The underlying emission factors in these calculations contain considerable uncertainty. The recent implementation of I/M in the SJMA would be expected to provide some reductions in, at a minimum, the particulate portion of these emissions. Estimates of potential reductions that the Costa Rican I/M program may achieve are:

- 40% decrease in CO per gasoline vehicle
- 20-40% reduction in HC for gasoline and diesel vehicles
- 40% reduction in diesel particulates.

Note that the 40% diesel particulates reduction is comparable to the reduction achieved with current diesel bus retrofit kits. A U.S. manufacturer recently obtained EPA approval for a retrofit that can reduce particulate emissions by up to 80%, allowing vehicles to meet the U.S. 0.10 g/BHP-Hr standard.

As an indication of the range of uncertainty in the emission factor estimates for current vehicles, the idle particulate rate for pre-1988 heavy duty vehicles, taken from a small database of engines by a single manufacturer, was 5.37 g/hr, while the rate for 1994 and later vehicles was 1.004 g/hr. As a further indication of the potential range in values for the bus fleet, Table I.2.2-20 summarizes emission factors for current technology U.S. buses, based on the median of a small fleet tested on the a "real life" urban cycle.

Table I.2.2-20
Average Emission Factors (g/km) for Current Technology Buses with Operative Control Systems Certified to U.S. Standards on an Urban Test Cycle

THC	CO	NOx	CO2	PM
1.73	9.05	16.26	1717.34	1.44

Source: U.S. Industry Data

Combining the rates in Table I.2.2-20 with average daily activity per bus provides another estimate of per bus replaced emission reductions for comparison with the values developed with the IPCC rates, summarized in Table I.2.2-21.

Table I.2.2-21
Average Future Year Daily Per Bus Emissions (kg), Based on U.S. Test Data for Vehicles with Operative Control Systems

Mode	THC	CO	NOx	PM
Cruise	0.261	1.367	2.455	0.217
Idle*	0.043	0.174	0.183	0.0081
Total	0.304	1.541	2.638	0.2251

** No alternative idle rates were available for this analysis.*

As noted, transit bus idling emissions will be affected by development of the LRT or by a more efficient routing of existing bus traffic. Increased idling that occurs at transfer stations will be offset by decreased idling in the central business district, both because fewer buses will be routed there and because decreased congestion levels reduce idling for all vehicle classes. Average idling rates for current technology vehicles used in calculating the values in Table I.2.2-19 are based on MOBILE5b and PART5 estimates. The are summarized in Table I.2.2-22.

Table I.2.2-22(a)
Current Technology Gasoline-Fueled Vehicle Idling Rates (g/hr)

Vehicle Class	NMVOC	CO	NOx
Auto	88.72	1074.37	9.96
Jeep	88.72	1074.37	9.96
Microbus Familiar	88.72	1074.37	9.96
Light Trucks	88.18	1077.92	9.91
Heavy Trucks	236.79	2707.09	19.92
Bus	236.79	2707.09	19.92
Public Microbus	236.79	2707.09	19.92
Taxi	88.72	1074.37	9.96
Motos	106.13	439.02	0.88

(PM10 and PM2.5 idling rates were not available.)

Table I.2.2-22(b)
Current Technology Diesel-Fueled Vehicle Idling Rates (g/hr)

Vehicle Class	NMVOC	CO	NOx	PM10	PM2.5
Auto	3.71	13.38	6.62	N/A	N/A
Jeep	3.71	13.38	6.62	N/A	N/A
Microbus Familiar	3.71	13.38	6.62	N/A	N/A
Light Trucks	5.02	32.11	96.65	N/A	N/A
Heavy Trucks	28.76	115.99	122.09	5.37	4.94
Bus	28.76	115.99	122.09	5.37	4.94
Public Microbus	28.76	115.99	122.09	5.37	4.94
Taxi	3.71	13.38	6.62	N/A	N/A

Source: Particulate rates are from EPA, 1995; other rates are from EPA 1993 and 1996. (N/A = Not Available)

We next looked at the reductions in emissions that may be achieved by use of specific technologies along established transit routes. This was done by using demand numbers for each route, calculated as discussed elsewhere in this report, in combination with the emission factors for current diesel transit buses to calculate total emissions along each route. We then multiplied this value by the percent of existing buses that will be replaced by each technology (LRT, ETB, or clean diesel buses) to calculate the amount of emissions removed from the atmosphere by switching to a different type of transit. Some of the technologies we are considering, specifically DMUs and clean diesel buses, put out some emissions into the atmosphere. We estimated the amount of these emissions and used them to offset the emissions that will be removed by rerouting existing diesel buses from the specific transit routes. Table I.2.2-23 summarizes the diesel bus and clean diesel bus emission factors used in these estimates.

The current level of emissions along each route, without incorporating the impacts of new technologies, are summarized in Table I.2.2-24. These represent the amount of emissions that could be removed if all buses were removed from a particular transportation corridor. Alternatively, they reflect the level of emissions the population will continue to be exposed to if no changes are made.

The clean diesel bus rates shown in Table I.2.2-23 are an approximation of the emission reductions that can be achieved with new technologies, assuming that buses have been retrofitted so as to achieve emissions consistent with proposed U.S. technologies. They approximate the level of emissions that may be seen from clean diesel buses. However, there is a significant amount of variation in the emission levels of clean diesel buses, since there are many types of technologies that may be used to reduce the emissions of pollutants into the air. Such technologies include changing engine timing, adding on catalyst treatment systems or particulate traps, and switching altogether from diesel fuels to alternatives, such as compressed natural gas. Depending on the actual technology chosen for a clean bus fleet, the impacts on local emissions and air quality may be greater or less than these estimates.

Table I.2.2-23
Existing Levels of Emissions Produced by Buses along Designated Transit Routes

Emission Factors (g/km)	NMVOC	CO	NOx	N2O	PM10	CO2	CH4	PM2.5
Current (1997) Diesel Bus:	2.99	8.54	16.79	0.03	1.92	1249.00	0.10	1.80
Clean Diesel Bus (with controls):	1.26	6.80	5.01	0.03	0.58	982.00	0.06	0.52

Table I.2.2-24
1997 Annual Emissions (kg) Released by Buses Along the Proposed Transit Routes

Bus Route	NMVOC	CO	NOx	N2O	PM10	CO2	CH4	PM2.5
Heredia-San Pedro	7428	21216	41712	74	4769	3102937	248	4471
Alajuela to San Pedro	28762	82150	161511	288	18469	12014741	961	17315
Alajuela to Cartago	49129	140322	275879	492	31547	20522567	1643	29576
San Antonio to Pacific Station	8198	23415	46035	82	5264	3424553	274	4935
Pavas to Pacific Station	8161	23309	45827	81	5240	3409111	272	4913
Ciruelas to Pacific Station	8478	24214	47607	85	5444	3541497	283	5103
Alejuela to Pacific Station (via Ciruelas)	10396	29695	58382	104	6676	4343052	347	6259
Alejuela to Pacific Station (via San Antonio)	8850	25277	49696	88	5683	3696931	295	5327
Atlantic Station to Pacific Station	732	2091	4111	7	470	305858	24	440
Tibas to Pacific Station	1627	4648	9139	16	1045	679855	54	979
Paso Ancho to Pacific Station	773	2209	4344	7	496	323195	25	465
Desamparado to Pacific Station	9492	27111	53303	95	6095	3965192	317	5714
Moravia to Alantic Station	6212	17744	34887	62	3989	2595244	207	3740
Alajuelita-Hatillo-Pacific Station	3777	10788	21210	37	2425	1577856	126	2273
Pavas to San Pedro (diametral)	12280	35075	68959	123	7885	5129856	410	7392
Total	164300	469272	922609	1648	105503	68632451	5494	98909

We compared the relative improvement in emissions from the different techno-logies studied by looking at how many kilograms of particulates would be removed from the air along the transit corridors annually due to removal and/or rerouting the current diesel buses. The reductions in PM emissions are shown in Table I.2.2-25. The compari-sons for selected corridors are presented graphically in Figures 4.2.2-1 and 4.2.2-2.

Table I.2.2-25
Particulate Reductions Achieved by Each Technology
Along the Designated Corridors (kg/yr) (Based on 1997 conditions)

Segment	LRT	DMU	Clean Buses	ETB
Heredia-San Pedro	9539	9504	6365	9539
Alajuela to San Pedro	36938	36802	17208	27334
Alajuela to Cartago	27131	20616	11583	17035
San Antonio to Pacific Station	8001	5951	0	0
Pavas to Pacific Station	8489	6268	0	0
Ciruelas to Pacific Station	7403	5512	0	0
Alejuela to Pacific Station (via Ciruelas)	6542	4891	0	0
Alejuela to Pacific Station (via San Antonio)	6024	4520	0	0
Atlantic Station to Pacific Station	940	939	0	0
Tibas to Pacific Station	2090	2080	1448	2090
Paso Ancho to Pacific Station	993	0	662	993
Desamparado to Pacific Station	12190	0	8454	12190
Moravia to Alantic Station	7978	0	5510	7978
Alajuelita-Hatillo-Pacific Station	4851	0	3255	4851
Pavas to San Pedro (diametral)	74126	0	50210	74126

The emission reductions achieved with LRT and ETB scenarios are generally equivalent on each segment. Exceptions occur when the ETB is incapable of the same capacity as is achieved by the LRT, and thus does not displace the same number of diesel buses. Busway emission reductions are approximated as the difference between current urban bus emission levels on each segment and 2010 diesel bus factors (assuming new technologies). The assumption is that conversion of the ROW would be accompanied by conversion of the portion of the fleet using the ROW to cleaner technology buses. This is an optimistic assessment of the impact of conversion to a busway. DMU reductions correspond to removal of current technology buses and the addition of emissions reflecting those emitted by DMU engines while operating in the corridor.

Appendix 4.A presents an evaluation of the contribution to ambient pollutant levels along roadway intersections that might be attributed to urban buses, under generic modeling conditions.

FIGURE 4.2.2-1:
SAVINGS IMPACT OF TECHNOLOGIES ON PM

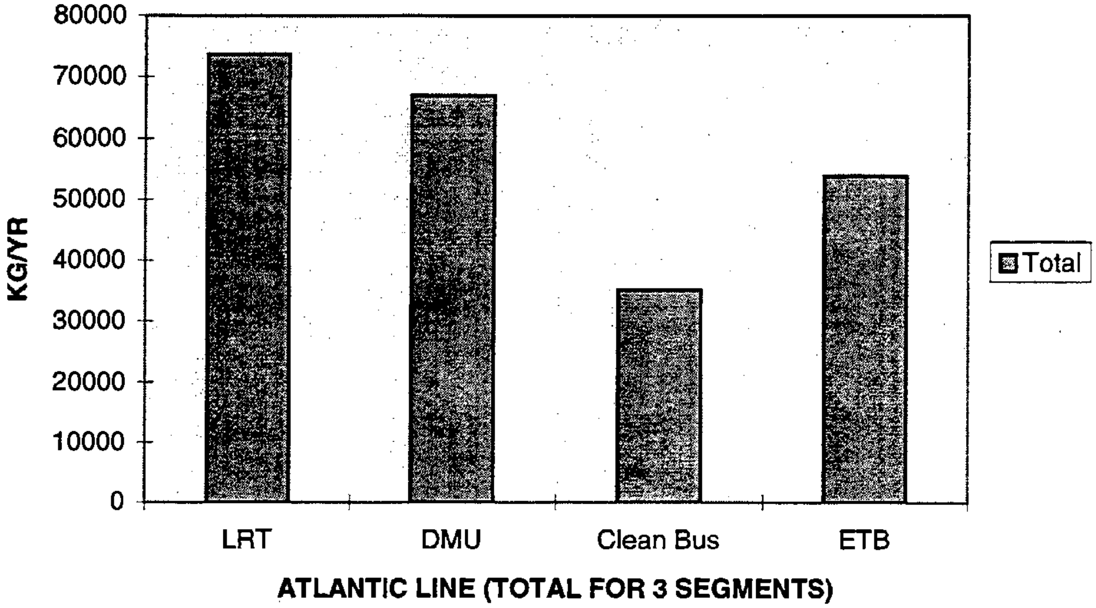
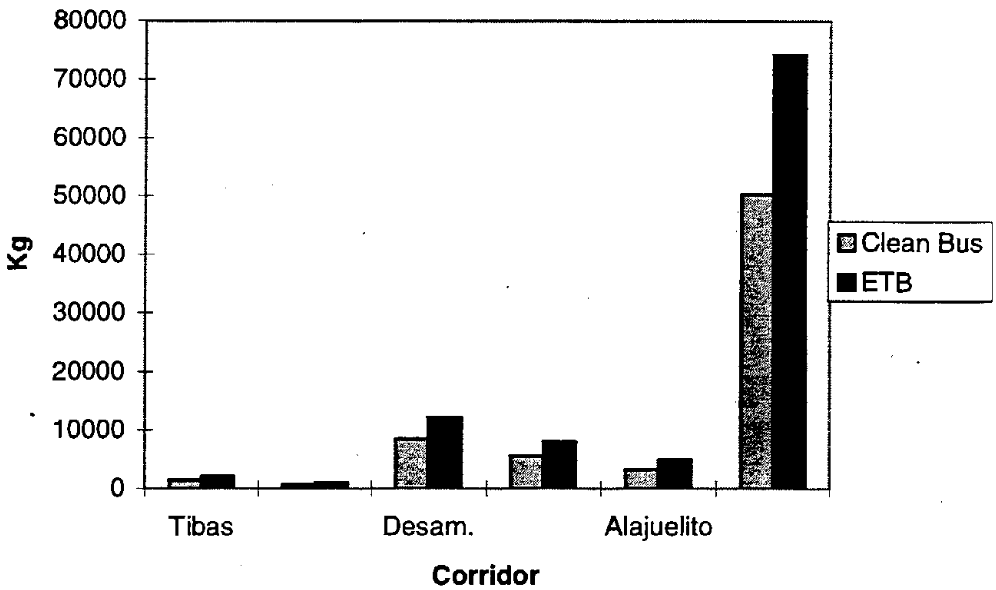


Figure 4.2.2-2
PM Emissions Removed (kg/yr)



I.2.2.4 Air Quality Impacts of Construction

Any air quality impacts associated with the proposed construction of the transit systems are expected to be short-term and relatively minor. Heavy construction is a source of dust emissions that may have a substantial temporary impact on local air quality. Emissions during construction can be associated with land clearing, drilling and blasting, ground excavation, cut and fill operations (i.e., earth moving), and construction of a particular facility (i.e., transfer stations). Dust emissions will vary from day-to-day, depending on the level of activity, the specific operations, and the prevailing meteorological conditions. The quantity of dust emissions from construction operations is proportional to the area of land being worked and to the level of construction activity and is dependent on various factors, including the vehicle speed and weight, average number of wheels per vehicle, surface texture and moisture conditions.

To the extent construction occurs during the rainy season (May to December), the long rain periods will have a positive impact on the control of pollutants usually resulting from normal construction equipment and related activities. The high humidity and frequent rain during that season would serve to disperse the emissions of PM_{10}, $PM_{2.5}$, and other pollutants. During the dry season of January to April, any construction related activities will substantially increase the level of PM_{10} and $PM_{2.5}$ concentrations due to the pollutants generated by the heavy machinery and the movement of soil. Due to the use of heavy equipment, CO, VOCs and NOx can also be expected to increase slightly but not as significantly as particulates. These construction-related emissions would be temporary, would likely affect only those areas very near the construction site, and would cease to exist once construction is completed. The California Air Resources Board uses an average construction dust rate, assuming control through watering of the site, of 0.60 ton/acre-month or 134.51 metric ton of particulates produced per sq. km. per month of construction activity.

<u>Mitigation for Air Quality Impacts</u>

Measures to mitigate air quality impacts associated the construction and operation of the transit system are recommended below. The mitigation measures discussed in this section are proven techniques for improving air quality. These type of regional strategies have been utilized in the United States and other countries to minimize vehicle emission impacts. The mitigation measures relating to construction activities are proven techniques to reduce particulate emissions.

<u>Measures to Limit Potential Construction-Related Impacts</u>

As described, air quality impacts during the construction stage are expected to be temporary in nature and will cease to exist once the construction is complete. Nevertheless, certain practices should be followed during this period in an effort to keep localized impacts to a minimum. Frequent light watering and the periodic application of suppressants to keep the road dust under control is an important strategy to implement during the construction phase.

Wet suppression and wind speed reduction are two common methods used to control open dust sources at construction sites, because a source of water and material for wind barriers tend to be readily available at construction sites. Because of the large quantity of precipitation that occurs in Costa Rica, wet suppression will naturally occur during most of the year. For example, on unpaved roads a reduction in emissions will result from precipitation on days with more than 0.254 millimeters (mm) of rain. Based on Costa Rica's average monthly rain fall, emissions will be naturally controlled throughout the majority of the year. During the dry months of January through April, measures to mitigate dust emissions will be required in order to minimize air quality impacts. Table I.2.2-26 summarizes recommended mitigation measures by construction operation type.

Table I.2.2-26
Recommended control measures for construction activities during dry season.

Construction Operation	Recommended Measure
Debris Handing	Wind Speed Reduction, Wet Suppression
Truck Transport of Materials	Wet Suppression, Paving, Chemical Stabilization
Bulldozers	Wet Suppression
Pan Scrapers	Wet Suppression
Cut/Fill Material Handling	Wind Speed Reduction, Wet Suppression
Cut/Fill Haulage	Wet Suppression, Paving, Chemical Stabilization
General Construction	Wind Speed Reduction, Wet Suppression, Early Paving of Permanent Roads

Based on the level of precipitation and use of dust reducing control measures during the dry season, the impacts from particulate matter emitted during construction activities will be relatively small. If control measures are not implemented during the dry season, construction related activities will increase the level of particulate in areas very near the construction site. These emissions would cease as soon as construction is completed.

I.2.3 Traffic Interference

One of the main objectives of the proposed San José transit system is the improvement of traffic conditions in the metropolitan area by providing an efficient mass transport system, reducing the number of buses and cars needed for circulation, reducing commuting time, reducing commuting time, and reducing congestion in the main streets and avenues of the city. These anticipated significant benefits of the project are discussed in Chapter II.

Nevertheless, the construction of a transportation infrastructure project in an urban environment can interfere temporarily with the existing traffic and transit system. The construction of any of the components of the proposed transit system may have the potential to interfere with traffic flow and circulation, intensifying congestion levels, creating additional bottlenecks, and reducing the levels of service at numerous intersections. Similar problems may occur during operation if no advanced traffic management planning is undertaken.

This section presents a general description of the existing traffic system in the specific area of study, including the physical characteristics of the road and street network, as well as traffic conditions along the proposed system's segments. It evaluates potential traffic interference impacts and proposes general mitigation measures for further consideration. The section also highlights the critical intersections and roadways that experience high levels of congestion over significant periods of time. These critical intersections and roadways are the most likely to experience the most significant traffic interference impacts during the construction (and possibly operation) of the transit system.

Potential traffic interference impacts were identified in this EFA through preliminary field reconnaissance. This information may be useful for the more detailed traffic interference impact analysis that should be part of the Environmental Impact Assessment (EIA) for the selected segments and the preferred technology.

I.2.3.1 Rail ROW Segments

Any of the four technologies considered as potential options to serve the rail ROW segments -- LRT, DMU, ETB or Busway system -- would use the existing rail ROW as an exclusive operations corridor. Therefore, the potential traffic interferences that could be caused during construction and operation would occur at intersections between the rail ROW and existing streets.

Baseline Information

As part of this EFA, a preliminary assessment of the number of street crossings of the rail ROW was performed, both for the analysis of potential traffic interference, and for the preparation of cost estimates, since the LRT and DMU options would have gates and warning devices at each of these crossings. The number of crossings was counted in the field by the Instituto Costarricense de Ferrocarriles (INCOFER) for some segments. For other segments, where the rail line or the ROW are not in good condition (e.g., the San Pedro-Cartago segment), the number of crossings was determined based on land use maps. There are approximately 150 street crossings in total for all the ROW segments considered. Table I.2.3-1 presents the number of crossings for each individual segment.

Table I.2.3-1
Number of Street Crossings along the Rail ROW Segments

Rail ROW Segment	Number of Crossings
Heredia to San Pedro	31
Alajuela to San Pedro	61
Alajuela to Cartago	85
San Antonio de Belén to Pacific Station	38
Pavas to Pacific Station	23
Ciruelas to Pacific Station	43
Alajuela to Pacific Station (via Ciruelas)	53
Alajuela to Pacific Station (via San Antonio de Belén)	41
Atlantic to Pacific Station (double and single track)	18

The EFA team performed a qualitative assessment of the traffic congestion levels at the most important interchanges along the various rail ROW segments of the proposed San José transit system. This assessment was developed through field visits and a limited number of interviews of users. A more detailed and quantitative analysis is recommended for later phases of the environmental analysis of the project.

In general, the interchanges of rail ROW segments and streets outside the downtown San José area experience low traffic volumes. The most important exceptions occur in certain ROW segments that are currently used by vehicle traffic in Heredia and Alajuela. In downtown San José, the rail ROW crosses a number of highly congested roadways and four-way street intersections. Furthermore, the connector between the Atlantic and Pacific Stations is located along streets used by vehicle traffic. Table I.2.3-2 presents a summary of the baseline information collected for analysis of potential traffic interference impacts for the various ROW segments. For each segment along the rail ROW, this table presents the critical intersections or roadways, a qualitative assessment of their traffic levels, and additional comments related to traffic conditions. Map 4-1 presents the location of the main interchanges and streets that could be potentially affected by traffic interference.

For the purpose of this qualitative assessment, existing traffic levels have been divided into three basic categories: High for continuously high traffic and congestion levels, especially during peak hours; Medium for moderate traffic levels with occasional congestion at peak hours; and Low for low levels of traffic and congestion. Again, a quantitative traffic monitoring program is recommended as part of the EIA to determine actual impacts. The qualitative assessment presented in this report may guide the selection of monitoring points.

Potential Traffic Interference Impacts during Construction

The implementation of any of the four possible technologies for the rail ROW will not involve any unusual or particularly dangerous construction types, procedures, or locations that will pose any significant safety impacts in terms of fleet traffic and/or pedestrian traffic. However, the construction of these systems is expected to require a series of temporary lane and street closures. Some construction activities will cause short-term traffic interference where temporary detours, reduced roadway capacity, and traffic restrictions (e.g., slow traffic speeds, sudden stops to allow for construction equipment movement) are expected.

The construction of the LRT or DMU systems will require the removal of track grade and ballast replacement in the rail ROW segments. In areas where the ROW has been paved over and the old rail tracks have been removed, the pavement will have to be torn out, the rail replaced, and the roadway paved back around the new rail tracks. The construction of each 3 - 5 kilometers section will approximately take less than eight months. The LRT system construction is expected to take more time than the DMU system construction, as posts for the overhead wires will have to be placed after the trackwork has been completed. Complete construction of the LRT or DMU system is expected to take 2.5 to 3 years.

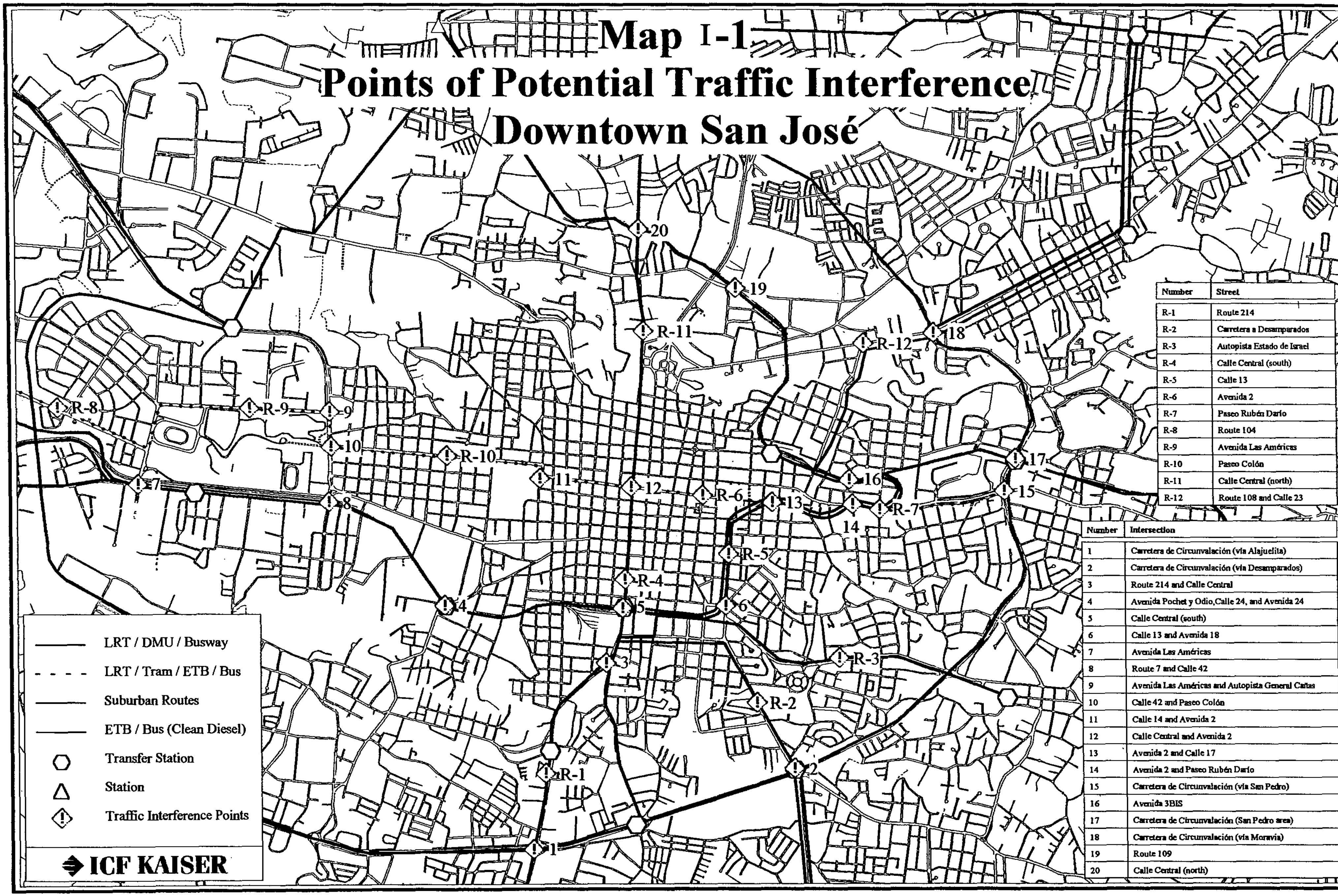
Construction activities at intersections and roadways for the Busway system are expected to take less time than for the LRT, DMU, or ETB systems. The only construction activity related with the Busway system is the paving of the ROW segments. Most of the paving will have to be

Table I.2.3-2
Baseline Information for Potential Traffic Interference Impacts Along the Rail ROW Segments

Area	Critical Intersections or Roadways*	Qualitative Traffic Levels	Comments
Atlantic Line			
Cartago to Curridabat	None	Low	Route 233 is crossed by the ROW in Cartago, but it is not considered a critical traffic area. There are few street crossings along this segment of the ROW.
San Pedro to Atlantic Station	Carretera de Circunvalación [Map: 18]	High	Carretera de Circunvelación is part of the beltway system with large traffic circles at major intersections. This particular area of the beltway serves traffic entering and exiting San José.
Atlantic Station to Santo Domingo	Route 109 [Map: 19] and Calle Central (north) [Map: 20]	High	Route 109 serves traffic from northeast San José, especially the areas of Moravia and Guadalupe. Calle Central feeds most of the north-south traffic movement and serves the Tibas surrounding areas.
Santo Domingo to Heredia	None	Low	Few street crossings.
Heredia town center	Route 3 and Avenida 10	Medium	Route 3 is one of the primary roads serving traffic in and out of Heredia from the southeast. ROW runs through ten four-way intersections in Avenida 10 (narrow two-lane street).
Heredia to Alajuela	Route 3	Medium	ROW crosses Route 3 three additional times. This section of Route 3 is the primary road serving traffic to and from western Heredia and southern Alajuela.
Pacific Line			
Pacific Station to La Sabana	Intersection at Avenida Pochet y Odio, Calle 24, and Avenida 24 [Map: 4], and the Intersection at Route 7 and Calle 42 [Map: 8]	High	First intersection connects the three main street corridors that serve the southwestern areas of San José. Second intersection connects main arteries of incoming and outgoing traffic from northwestern and southwestern San José.
La Sabana to Pavas	Avenida Las Américas [Map: 7]	Medium to Low	Avenida Las Américas serves traffic in Pavas, Excazú, and its surrounding areas. Towards Pavas there are several individual street crossings.
Pavas to Alajuela (via Ciruelas or San Antonio de Belén)	None	Low to Medium	Few street crossings.
Atlantic to Pacific Station (Southeastern Connector)			
Pacific Station to Avenida 2	Calle Central (south) [Map: R-4] and the Intersection of Calle 13 and Avenida 18 [Map: 6]	High	Calle Central is one of the principal north-south corridors in San José. It serves Alajuelita, Hatillo, Paso Ancho areas. The arterials of Autopista Estado de Israel and Carretera a Desamparados meet in Calle 13. These street corridors serve Desamparados, Zapote, and their surrounding areas.
Avenida 2 to Atlantic Station	Intersection at Avenida 2 and Calle 17 [Map: 13], Avenida 2 [Map: R-6], Intersection at Avenida 2 and Paseo Ruben Darío [Map: 14], and Paseo Ruben Darío [Map: R-7]	High	ROW runs in the middle of Ave. 2 with two lanes of high traffic on each side for six intersections. Ave. 2 is a one-way avenue moving traffic from west to east. ROW also runs in the middle of Ave. Central for two intersections. Ave. 2 and Ave. Central serve most of the traffic moving towards San Pedro, Cartago, and their surrounding areas.

(*) Map numbers correspond to interchanges shown in Figure 4-1. Map R-numbers correspond to streets shared by rail ROW and vehicle traffic; these streets are shown in Figure 4-1. Interchanges with no number are outside the area shown in Figure 4-1.

Map I-1
Points of Potential Traffic Interference
Downtown San José



Number	Street
R-1	Route 214
R-2	Carretera a Desamparados
R-3	Autopista Estado de Israel
R-4	Calle Central (south)
R-5	Calle 13
R-6	Avenida 2
R-7	Paseo Rubén Darío
R-8	Route 104
R-9	Avenida Las Américas
R-10	Paseo Colón
R-11	Calle Central (north)
R-12	Route 108 and Calle 23

Number	Intersection
1	Carretera de Circunvalación (via Alajuelita)
2	Carretera de Circunvalación (via Desamparados)
3	Route 214 and Calle Central
4	Avenida Pochet y Odio,Calle 24, and Avenida 24
5	Calle Central (south)
6	Calle 13 and Avenida 18
7	Avenida Las Américas
8	Route 7 and Calle 42
9	Avenida Las Américas and Autopista General Cañas
10	Calle 42 and Paseo Colón
11	Calle 14 and Avenida 2
12	Calle Central and Avenida 2
13	Avenida 2 and Calle 17
14	Avenida 2 and Paseo Rubén Darío
15	Carretera de Circunvalación (via San Pedro)
16	Avenida 3BIS
17	Carretera de Circunvalación (San Pedro area)
18	Carretera de Circunvalación (via Moravia)
19	Route 109
20	Calle Central (north)

done in the areas outside San José where the ROW is exclusive (meaning only rail track currnetly exists). Some rail ROW segments, such as those in Heredia and Alajuela, have already been paved; therefore, paving around these areas for the Busway system is probably unnecessary. Each section of 3 - 5 kilometers long will take less than four months to construct. The complete Busway system is expected to be constructed in one to two years.

The construction of the ETB system in the Alajuela to Cartago ROW segment will require the paving of this ROW segment and the placement of posts for the overhead wires. Just as for the Busway system, most of the paving will have to be done in the areas outside San José where the ROW is exclusive. Some rail ROW segments, such as those in Heredia and Alajuela, have already been paved; therefore, paving in these areas for the ETB system is probably unnecessary. Each section of 3 - 5 kilometers long will take approximately six months to construct. The complete ETB system is expected to be constructed in two to three years. The placement of posts for the overhead wires will likely require temporary lane closures on street corridors shared with the ROW.

In areas outside downtown San José, where the ROW segment is exclusive, potential traffic interference impacts are expected to be minimal. In areas outside downtown San José where part of the rail ROW is non-exclusive, as it is in Heredia and Alajuela, construction is expected to close at least one lane of the roadways and will probably last a few weeks. This is the case for Avenida 10 in Heredia and the numerous Route 3 crossings in Heredia and Alajuela.

Traffic interference impacts during construction are expected to be significant but temporary in downtown San José. Highly congested intersections and roadways are expected to be affected by temporary lane or street closures due to construction. Construction work in main intersections is expected to be completed in about a week. The intersections and individual street crossings that are expected to experience temporary detours or reduced roadway capacity include:

- Avenida Pochet y Odio, Calle 24, and Avenida 24
- Route 7 and Calle 42
- Avenida Las Américas
- Calle Central (north and south crossings)
- Calle 13 and Avenida 18
- Avenida 2 and Calle 17
- Avenida 2 and Paseo Ruben Darío
- Carretera de Circunvelación

The ROW segment that may cause the greatest traffic interference impacts is the Southeastern Connector. The Connector runs in the middle of Avenida 2 with two lanes of high traffic on each side for six blocks and then runs in the middle of Paseo Ruben Darío for two intersections. Avenida 2 and Paseo Ruben Darío are the principal street corridors used for East-West traffic in downtown San José, especially traffic moving towards San Pedro, Cartago, and their surrounding areas. If this segment is double tracked, its construction will require the closure of several sections of Avenida 2 and Paseo Ruben Darío for several weeks. If a single track is used, its construction will require lane closures for a few weeks.

In summary, the dedicated ROW segments will not experience highly significant traffic impacts from construction. However, particular sections of the ROW segments that are shared with the general traffic in highly congested intersections and roadways are expected to experience temporary impacts. Traffic interference impacts will also vary depending on the preferred transit system. Construction activities are expected to last longer for the LRT/DMU/ETB systems than for the Busway system. Although, construction activities of the LRT or DMU system along the Southeastern Connector will probably be the most significant ones across the rail ROW segments.

The downtown San José area experiences very high levels of pedestrian traffic. Almost 70 percent of the metropolitan area population uses the public transportation system, and these trips require pedestrian walks for an additional distance. Therefore, pedestrian activities compose a large number of the overall traffic demand for additional capacity. Significant impacts are expected to occur to pedestrian traffic during construction, specially in areas adjacent to the proposed system's stations or where there are large numbers of pedestrian crossings, such as the Atlantic Station and Avenida 10 in Heredia.

Recommended Mitigation Measures during Construction

Potential traffic interference during construction may be significant at certain interchanges and specific street blocks, but it will be temporary. As the design effort and construction plan development proceeds for any of the proposed transit systems, the preparation of a detailed transportation management plan for project construction is recommended. This management plan should be developed in close coordination with the municipal governments and the Ministry of Public Works and Transportation (Ministerio de Obras Públicas y Transporte), as these agencies would play an important role in the implementation of the plan.

The traffic management plan for project construction should carefully analyze individual street functions or roles within the context of the overall system. Fortunately, San José has a well organized street grid system where different alternative routes can be utilized during the construction phase if lane and street closures are required. The management plan should try to maintain maximum transit capacity for all alternative routes.

Other recommended mitigation measures to be considered in the transportation management plan include:

- Limit lane and street closures during non-peak hours or at night, if possible;
- Street closures should be required only where and when they are absolutely necessary to permit safe construction;
- Implement traffic safety maintenance measures to minimize all risks (e.g., traffic restriction measures, hiring personnel dedicated exclusively to direct traffic, coordinate with police department, etc.);
- Notify all community areas that will be affected by construction activities beforehand about construction work locations, dates, and hours and possible street or lane closures;

- Maintain local access and emergency vehicle access throughout the construction phase, as necessary;
- Provide adequate signals and lighting to reduce the possibility of traffic and pedestrian accidents during construction;
- Provide safe pedestrian access; and
- Promptly repair streets that may be damaged by traffic of heavy construction equipment.

Potential Traffic Interference Impacts during Operation

The operation of any part of the proposed transit system for San José would result in an improvement of traffic conditions, as discussed in Chapter 3. However, the system would introduce a new set of vehicle units along new corridors, which may have the potential to interfere with existing vehicle movement patterns in San José. Even though these impacts may not be of significant nature, their duration is long-term, and it is necessary to implement certain mitigation measures to reduce their effect on the overall transportation network of the city. For example, the operation of the proposed transit system may (depending on the final design and specifications of the segments and technology selected):

- Add a new signal phase at major intersections that could probably reduce the amount of green time available to other traffic;
- Reduce the amount of travel lanes available to the general traffic;
- Add new permanent traffic restrictions which might divert traffic into presently uncongested arterials; and
- Increase pedestrian traffic along the transit corridors and stations.

Traffic impacts are expected to be minimal across the dedicated ROW if the appropriate signal and passive controls (e.g., stop signs and gates) are in place. One important consideration is that LRT/ DMU/ETB/Busway vehicles are expected to operate at relatively high speeds along the dedicated ROW. Where the alignment departs from exclusive-use ROW, there exists a higher potential for conflict between the proposed systems' operations and pedestrian and vehicular traffic. This is the case for the ROW segments shared with motor vehicle traffic along Avenida 10 in Heredia and the numerous street crossings in Heredia, Alajuela, and downtown San José.

Significant added delay and interference could occur on the ROW intersections and roadways within the downtown San José area. Concentrations of automobiles and buses on some of the very narrow streets (approximately 7 meters from curb to curb) in the downtown area can create severe traffic congestion and bottlenecks. Intersections or individual street crossings where traffic interference impacts could be significant include:

- Avenida Pochet y Odio, Calle 24, and Avenida 24
- Route 7 and Calle 42
- Avenida de las Américas
- Calle Central (north and south crossings)

- Calle 13 and Avenida 18
- Avenida 2 and Calle 17
- Avenida 2 and Paseo Ruben Darío
- Carretera de Circunvalación

Recommended Mitigation Measures during Operation

The mitigation measures recommended to minimize potential traffic interference impacts during operation of the proposed transit system can be integrated into a long-term comprehensive transit-traffic operations plan for the whole city. The key objective of this plan would be to increase the effective traffic capacity of streets. This long term comprehensive operations plan should be developed in close coordination with the municipal governments and the Ministry of Public Works and Transportation (Ministerio de Obras Públicas y Transporte) as these agencies would play an important role in the implementation of the plan.

The transit-traffic operations plan could incorporate elements of other initiatives currently under consideration by the government, such as an improved traffic light system for the city. The proposed transit system analyzed in this project includes as part of the proposed specifications, the placement of active or passive controls at intersections (depending on the technology). The integration of these signals with the citywide system would greatly enhance the effectiveness of both.

Pedestrian activities are expected to increase under any of the alternatives, particularly where many patrons will walk from the transfer stations, the LRT/DMU/ETB/Busway stations, and suburb-to-suburb bus stations to their destinations. The potential for conflict between pedestrian movement and system operations will require the implementation of an educational program and clear signalization to safely direct pedestrian traffic to designated crossings. While LRT/DMU/ETB/Busway operating speeds will be no greater than those of cars and trucks, pedestrians will have to be aware of the presence of the new system.

Operation of the any of the four proposed technologies must not eliminate necessary land-use or emergency vehicle access. The track design allows emergency vehicles to cross them at any point. However, it is recommended that the comprehensive operation plan includes a detailed plan for accident or emergency situations. Such a situation in a complex system like the LRT or DMU may cause more disruption to operational services than one caused by a bus incident today.

I.2.3.2 Street Segments

The street segments analyzed in this EFA run through downtown San José's principal street corridors and intersections. One important difference between the potential effects caused by rail ROW segments and street segments is that the latter will not operate in an exclusive corridor. Therefore, the potential traffic interferences that would be caused during construction and operation of street segments would occur not only at intersections, but also along roadways that could be potentially congested.

Baseline Information

As described in Section 4.2.3.1, the team performed a qualitative assessment of the traffic congestion levels on the most important streets and interchanges along the various street segments. Table I.2.3-3 presents a summary of the baseline information collected for analysis of potential traffic interference impacts for the various street segments. For each street segment, this table presents the critical intersections or roadways, a qualitative assessment of their current traffic levels, and additional comments related to traffic conditions. Map 4-1 presents the locations of the most important street and interchanges that could be potentially affected.

Table I.2.3-3
Baseline Information for Potential Traffic Interference Impacts Along Street Segments

Area	Critical Intersections or Roadways*	Traffic Levels	Comments
From Pavas to San Pedro			
From Pavas to La Sabana	Route 104 [Map: R-8], Avenida Las Américas [Map: R-9], and intersection of Avenida Las Américas and Autopista General Cañas [Map: 9]	High	These main corridors serve Pavas and its surrounding areas.
From La Sabana to the San Juan de Dios Hospital	Calle 42, Intersection of Calle 42 with Paseo Colón [Map: 10], and Paseo Colón [Map: R-10]	High	Traffic from Alajuela, Escazú, and Pavas uses the connection between Calle 42 and Autopista General Cañas to Paseo Colón and Avenida 10. Paseo Colón is one of the main corridors serving traffic to and from western San José.
From the San Juan de Dios Hospital to the National Theater	Left turn at intersection of Calle 14 with Avenida 2 [Map: 11], and Avenida 2 [Map: R-6]	High	Large bus transfer stations located close to intersection of Calle 14 and Avenida 2. Avenida 2 experiences high traffic levels throughout most of the day.
From the National Theater to San Pedro	Avenida 2 [Map: R-6], the intersection of Avenida 2 and Paseo Ruben Darío [Map: 14], Paseo Ruben Darío [Map: R-7] and the intersection at Carretera de Circunvelación [Map: 15]	High	Avenida 2 and Paseo Ruben Darío are the principal street corridors used for west to east traffic movement in San José.
Other Street Segments			
Tibas to Pacific Station	Calle Central (north) [Map: R-11] and intersections of Calle Central with Avenida Central and Avenida 2 [Map: 12]	High	Calle Central is a two lane street, primarily used for north-south traffic movement in downtown San José. Ave. Central and Ave. 2 are two of San José's most congested avenues.
Paso Ancho to Pacific Station	Calle Central (south) [Map: R-4]	High	Calle Central (south) serves most of the traffic from southwestern San José to Calle Central.
Desamparados to Pacific Station	Intersection at Carretera de Circunvelación [Map: 2]	High	Carretera de Circunvelación experiences high levels of traffic, especially during rush hours.
Moravia to Atlantic Station	Intersection at Carretera de Circunvelación [Map: 18], Route 108, and Calle 23 [Map: R-12]	High	Route 108 and Calle 23 are two of the primary streets serving the northeastern areas of San José.
Alajuelita - Hatillo - Pacific Station	Intersection at Carretera de Circunvelación [Map: 1], Route 214 [Map: R-1], Intersection of Route 214 and Calle Central [Map: 3], and Calle Central (south) [Map: R-4]	High	This corridor primarily serves the southwestern area of San José.

(*) Map numbers correspond to interchanges shown in Figure 4-1. Map R-numbers correspond to streets shared by rail ROW and vehicle traffic; these streets are shown in Figure 4-1. Interchanges with no number are outside the area shown in Figure 4-1.

Potential Traffic Interference Impacts during Construction

The implementation of the clean-diesel bus option for any of the street segments will not result in serious traffic interference during construction because no significant infrastructure additions are needed. The implementation of the Tram or the ETB options will require the construction of rails for the first case, and posts and overhead power catenaries for both. The construction of this support infrastructure will require a series of temporary lane and street closures. Some construction activities will increase the potential for traffic interference where temporary detours, reduced roadway capacity, and traffic restrictions (e.g., slow traffic speeds, sudden stops to allow for construction equipment movement) are expected.

The construction of the ETB system across the street segments will require the placement of posts for the overhead wires. Trucks will be necessary to dig holes for the posts across the segments. Resulting traffic interference would be localized and temporary. Each section 3 - 5 kilometers long will take approximately one month to construct. The construction of the LRT system along the Pavas to San Pedro segment will require the pavement to be torn out, the rail replaced, and the roadway paved back around the new rail tracks. Posts for the overhead wires will have to be placed after the trackwork has been completed. Construction of each 3 - 5 kilometers section is expected to be completed in approximately three months.

Traffic interference impacts during ETB or LRT construction are expected to be intense but temporary along the street segments. Severely congested intersections and roadways are expected to be affected by temporary lane or street closures due to construction. Construction work in each main intersection is expected to be completed in about a week for the ETB or LRT system. The roadways that are expected to experience temporary detours or reduced roadway capacity include:

- Route 104
- Avenida Las Américas
- Calle 42
- Paseo Colón
- Calle 14
- Avenida 2
- Paseo Ruben Darío
- Calle Central (north and south)
- Route 108
- Calle 23
- Route 214

The implementation of the Tram technology in the street segment from Pavas to San Pedro may cause the greatest traffic interference of all segments. The use of ETB along this segment would also cause traffic interference but to a lesser degree. This street segment currently serves all traffic movement to and from eastern and western San José. Compared to the other street segments, the segment from Pavas to San Pedro experiences continuous high levels of congestion during peak hours. The number of street lanes across this segment vary frequently.

Also, this segment is characterized by its numerous sharp street turns and important intersections, such as:

- Avenida Las Américas and Autopista General Cañas
- Calle 42 and Paseo Colón
- Calle 12 and Avenida 2
- Avenida 2 and Paseo Ruben Darío
- Intersection at Carretera de Circunvalación

Other significant traffic interference may occur at interchanges between the proposed street segments and the beltway system, if the ETB option is selected. The proposed street segments cross the Circunvalación at several locations, including the main intersections via Alajuelita, Desamparados, San Pedro, and Moravia.

The downtown San José area currently experiences high levels of pedestrian traffic. Significant impacts may occur to pedestrian traffic during construction, especially in areas adjacent to bus terminals and pedestrian walkways, such as Avenida 2 for the Pavas to San Pedro segment and Avenida Central for the Tibas to Pacific Station segment.

Recommended Mitigation Measures during Construction

The implementation of an ETB or Tram system along any of the proposed street segments has the potential to cause traffic interference to some degree. This interference during construction may be significant at certain interchanges and specific blocks, but it will be of temporary nature. A traffic management plan with mitigation measures similar to those discussed for the rail ROW segment impacts in Section 4.2.3.1 is recommended to minimize potential impacts during construction. The implementation of the clean-diesel bus option would not require mitigation measures as no new significant infrastructure is required.

Operation Phase

The operation of a bus, ETB, or Tram system along the proposed street segments would not have potentially significant traffic interference impacts, as they would run a system that is more efficient than the current system, thereby potentially reducing traffic congestion. An adaptation period is expected where some confusion might occur among users of the system. An information campaign is recommended to facilitate the transition to a new system.

The operation of any of the technological options considered need to be integrated into a citywide traffic management plan to increase their effectiveness in reducing traffic congestion and improving air quality in San José. This plan should also consider the needs of pedestrian in the downtown area and their use of the system and transfer stations, in order to optimize efficiency.

I.2.4 Utilities Interference

Utility systems in San José are owned by both public (local government/municipal) and private entities. Table I.2.4-1 characterizes the ownership nature (private or government) of public utilities in San José, including potable water, sewers, storm and clear water drains, street lights, traffic lights, electricity, telephone and communications, and cable television. San José does not have a gas pipe distribution network.

Table I.2.4-1
Utility Companies in San José Metropolitan Area

Utility	Company	Private	Public
Electricity	CNFL (Compañía Nacional de Fuerza y Luz) ICE (Instituto Costarricense de Electricidad)	✓	 ✓
Potable water	A y A (Instituto Nacional de Acueductos y Alcantarillados)		✓
Sewer	A y A (Instituto Nacional de Acueductos y Alcantarillados)		✓
Storm drains	A y A (Instituto Nacional de Acueductos y Alcantarillados)		✓
Street lights	**TO BE COMPLETED**		
Traffic signals	**TO BE COMPLETED**		
Telephone	ICE (Instituto Costarricense de Electricidad)		✓
Cable TV	**TO BE COMPLETED**		

The construction of an infrastructure project like the proposed San José transit system in an urban environment has the potential to interfere with existing utilities. Some utility lines would need to be relocated during construction. The replacement and/or relocation of utilities could disrupt traffic, where the utilities are located in streets. Construction activities also could result in unplanned, inadvertent, or accidental disruptions of utility service. All these types of impacts are common in infrastructure development projects and are usually of short duration.

One important consideration in this project is the existence of numerous overhead cables in downtown San José, and the potential interference with the catenaries needed for the ETB and LRT/Tram systems. Currently, CNFL has a program to change the overhead cables in the downtown area to underground cables. The program focuses not only on electric cables, but also on telephone cables, traffic lights, data transmission cables, and cable television. CNFL started the program along Central Avenue and the streets that cross it. Progress is slow due to the inherent difficulties of the process.

Table I.2.4-2 presents a relative comparison of the potential interference with overhead cables (electricity, telephone, and others) by technology for each segment of the proposed transit system.

Table I.2.4-2
Potential Interference with Utilities Distributed by Overhead Cables

Segment	Technology/Approach LRT	DMU	Bus	ETB
INCOFER Rail ROW Routes				
Heredia to San Pedro	L	N	N	L
Alajuela to San Pedro	L	N	N	L
Alajuela to Cartago	L	N	N	L
San Antonio de Belén to Pacific Station	L	N		
Pavas to Pacific Station	L	N		
Ciruelas to Pacific Station	L	N		
Alajuela to Pacific Station (via Ciruelas)	L	N		
Alajuela to Pacific Station (via San Antonio de Belén)	L	N		
Atlantic Station to Pacific Station - Single Track	H	N		
Atlantic Station to Pacific Station - Double Track	H	N		
Street Routes				
Pavas to San Pedro (diametral)	H		N	H
Tibás to Pacific Station			N	H
Paso Ancho to Pacific Station			N	H
Desamparados to Pacific Station			N	H
Moravia to Atlantic Station			N	H
Alajuelita - Hatillo - Pacific Station			N	H
Relative degree of interference: H: high; M: medium; L: low; N: not significant. Empty cells for technologies not considered for a given segment				

I.2.4.1 Rail ROW Segments

The use of the existing rail ROWs implies that potential impacts to utilities are not as significant as if a completely new ROW in an urban area were required. Utility lines were built taking into consideration the existing rail ROW. Furthermore, NEW cut and fill operations that have a HIGH potential for utility interference are expected to be minimal.

Each of the various technologies considered in the rail ROW segments is expected to pose a similar threat of interference to utilities distributed by underground networks. Earth moving and base grading activities that may disturb such utility lines will be needed for any technology (i.e., construction of rail tracks for LRT and DMU, or paving of the ROW for buses and ETB). However, for overhead utilities, the two electricity-based technologies (LRT and ETB) will require relocation of overhead cables. The average height for cables on the LRT is 19.5 feet, and 15 feet for the ETB cables. The bus and DMU options will only require relocation of cables below standard clearance height (4m for buses and 5m for DMU) for these technologies.

In those segments where the ROW crosses open areas (see Section 4.2.2.2 for a detailed description), utility interference will be minimal. In those segments that cross towns (e.g., downtown San José, Alajuela, Heredia), there is a greater potential for utility interference.

A few stormwater inlets (for street drainage) located along the ROW would require relocation of a few meters. Some water and sewer lines may be temporarily disrupted during construction. No relocation of overhead traffic lights is expected to be necessary, as there are no traffic lights across the ROW. For the two electric technologies considered in the ROW segments (LRT and ETB), telephone and other cables would need to be relocated away from the track in the downtown area, in between the Atlantic and the Pacific Stations for the LRT and on Highway 5 for the ETB, to allow placement of catenaries for the new electric transportation system.

The larger transfer stations in the rail ROW options would use existing facilities (e.g., the Atlantic and Pacific stations), so the potential for utility interference is greatly reduced, compared to the case of new facility construction. The new stations that will be built along the rail ROW options will be small in size and minimal in their function (i.e., they do not include buildings or ancillary facilities), so the potential for utility interference is minimal.

I.2.4.2 Street Segments

The construction of the infrastructure needed for the Tram and ETB technologies considered in these segments will require the relocation of a substantial number of overhead electric and communication cables. These cables are common in most streets in downtown San José (see Photo IC-1 at Appendix IC) and a carefully designed program will be needed for relocation of the overhead system to an underground system in those areas crossed by the six street-based segments of the proposed transit system (Pavas-San Pedro, Tibás-Pacific Station, Paso Ancho-Pacific Station, Desamparados-Pacific Station, Moravia-Atlantic Station, and Alajuelita-Pacific Station). The bus option in these segments will not require overhead cable relocation.

Another utility sector that will be impacted is the traffic light system. Traffic lights are located on overhead cables across the streets in the downtown area. Their approximate height is seven meters above ground.

I.2.4.3 Mitigation Measures

The construction of any segment of the proposed transit system will require some relocation of utilities. All attempts should be made to minimize potential impacts, particularly disruptions to service. As the project moves into design phase, more detailed information on utility relocations should be collected, so specific mitigation measures can be designed. The recommended mitigation measures to minimize impacts on utilities include:

- Early design and implementation of a relocation plan for overhead cables (below clearance height) that cross selected transit system routes, if electric-based technologies are used;
- Advanced planning during final design to avoid or minimize interruptions in utility services to customers;

- Close coordination with utility companies to identify potential problems and conflicts early in the process, and to provide opportunities to resolve them prior to construction;
- Coordination with utility companies regarding future expansion plans to minimize interruptions to the transit system once it starts operation;
- Careful scheduling of disruptions and prior notification of adjacent properties that would be affected by temporary service cut-offs;
- Tandem relocations of lines wherever and whenever possible;
- Construction and relocation of utilities during off-peak usage hours;
- Encouragement to construction contractors to exercise care and precaution to prevent disruptions of service through contract specifications and terms; and
- Definition of emergency response procedures in consultation with utility providers to ensure quick and effective repair of any inadvertent or accidental cuts in service.

Other mitigation measures should be specified as part of the final design effort of the selected segments and technological alternatives.

I.2.5 Visual Impacts

This section presents the analysis of potential changes on the quality of visual and aesthetic resources that may be caused by the construction of the various alternative segments of the proposed San José transit system. Potential impacts to the visual quality and aesthetic characteristics are usually evaluated with respect to *visibility* impacts and *visual* impacts. Visibility impacts are associated with the form and character of the proposed facilities, i.e., the mere physical presence and the inter-relationship with the physical and natural components of each segment's environment. Visual impacts are associated with the quality of physical inter-relationships and how the visual and aesthetic character of the environment may be altered for better or for worse.

A visual impact is generally considered to be significant if:

- The proposed project is of a scale that contrasts with its surrounding. The magnitude of impacts would be greater in areas with a recognized visual character (e.g., historical monuments, tourist sites, attractive monuments, or major recreational parks) that reinforces their use and is perceived by the community as an asset.

- The proposed project would disrupt important views (e.g., historical buildings, green areas or significant manmade structures).

As described above, the visual character of all the segments in the proposed transit system for San José can be characterized as either (1) a mixture of open space, coffee plantations, small agricultural fields, and medium-density industrial areas; or (2) high-density commercial or residential areas in the cities of San José, Heredia, Alajuela, and Cartago. In downtown San José, the rail ROW segments and the street segments considered for the transit system differ in terms of their potential visual impacts, since buildings have been built facing towards streets, but facing away from the rail ROW. None of the corridors runs through the Amón historical district of the downtown area of San José, where most of the historical monuments are located.

I.2.5.1 Rail ROW Segments

The proposed segments along the rail ROW would introduce a new transportation element into the existing environmental setting and current social patterns around this ROW. The proposed system would constitute, to a certain degree, the re-institution of a former transportation corridor back to San José's urban structure. The linear corridor, along with the uniformity of look, form, and design, would contrast positively with the dominant surrounding urban environment made up of largely unrelated and dissimilar forms. The visual quality of the rail ROW would be greatly enhanced as it is currently abandoned in most of its length, and covered with grass, debris, and garbage in many sections.

The physical elements introduced by each of the four technologies would differ. The LRT would introduce two new rail tracks, large four-car trains passing every five minutes in peak periods with an average speed of 40 km/h, overhead wire catenaries, power substations approximately every four km, gates with warning devices at grade crossings, partially covered passenger platforms at stations, and other supporting infrastructure for safety and comfort (e.g., benches, light poles, ticket vending). Transfer stations would use existing buildings that would probably be renovated. The DMU system would introduce the same physical elements as the LRT with the exception of the overhead wire catenaries and the power stations.

The ETB and dedicated busway options would have an important difference with the LRT and the DMU, as they would require paving the existing rail ROW. The ETB would differ visually from the bus option, as it requires overhead wire catenaries. The passenger transfer structures for the ETB and busway would be similar or even smaller in size and function to those for the LRT and DMU options. Traffic lights would be used for the ETB and busway instead of gates, and the frequency of units going through would increase to one every minute in peak periods. Overall, the bus option is probably the less invasive of the four technologies considered for the rail ROW.

As presented in detail in Section 4.2.2.2, the rail ROW goes through areas of open space and medium-density industrial areas for most of its route, except where it crosses the four largest cities in the San José Metropolitan Area. The Atlantic Line crosses an area with slightly higher urban density than the Pacific Line. The urban character of the areas crossed by the Atlantic Line is more residential in nature than those around the Pacific Line. The field reconnaissance of the areas surrounding the rail ROW segments indicated no potentially sensitive structure of historic or tourist importance. The only two potentially sensitive areas from the perspective of visual quality are the recreational parks La Sabana and Plaza Víquez [see Photo IC-2 at Appendix IC]

In the downtown area, no significant visual impacts to monuments, historic buildings, or tourist attractions are expected along the rail ROW. Two parks are located near the rail ROW. The first is the Museum of Costarican Art, located on the southern side of La Sabana

Metropolitan Park. The rail ROW runs in front of this park. However, visual impacts to La Sabana Metropolitan Park should not be significant because the park is already highly urbanized, and the construction of any of the technological options considered would not impose a different or overwhelming change on the urban surroundings, nor disrupt an important view. The second park is Plaza Víquez, a recreational center with two swimming pools and green areas. Currently, the ROW runs through this park leaving one swimming pool on each side of the track. Landscaping along the ROW would be needed to minimize the resulting impact and enhance the visual quality of the park.

If the noise impact analysis to be performed during the design and operation phases of the selected option determines the need for noise barriers along certain specific segments, these barriers may obstruct views and potentially cause a visual impact. The decision to build such a barrier should be preceded by a community participation plan to incorporate the input of potentially affected communities on issues such as size, appearance, and visual effects.

Visual impacts during construction will be temporary and may be significantly reduced by maintaining construction equipment and activities confined as much as possible to the ROW.

I.2.5.2 Street Segments

The three technologies proposed for the street segments differ in the physical elements that would be introduced to the streets used for the routes. The electric technologies considered in the street segments of the system (Tram and ETB) would require overhead wire catenaries and power substations for their operation. The bus option would not require such infrastructure. Both technologies would introduce newly marked stops for passenger boarding.

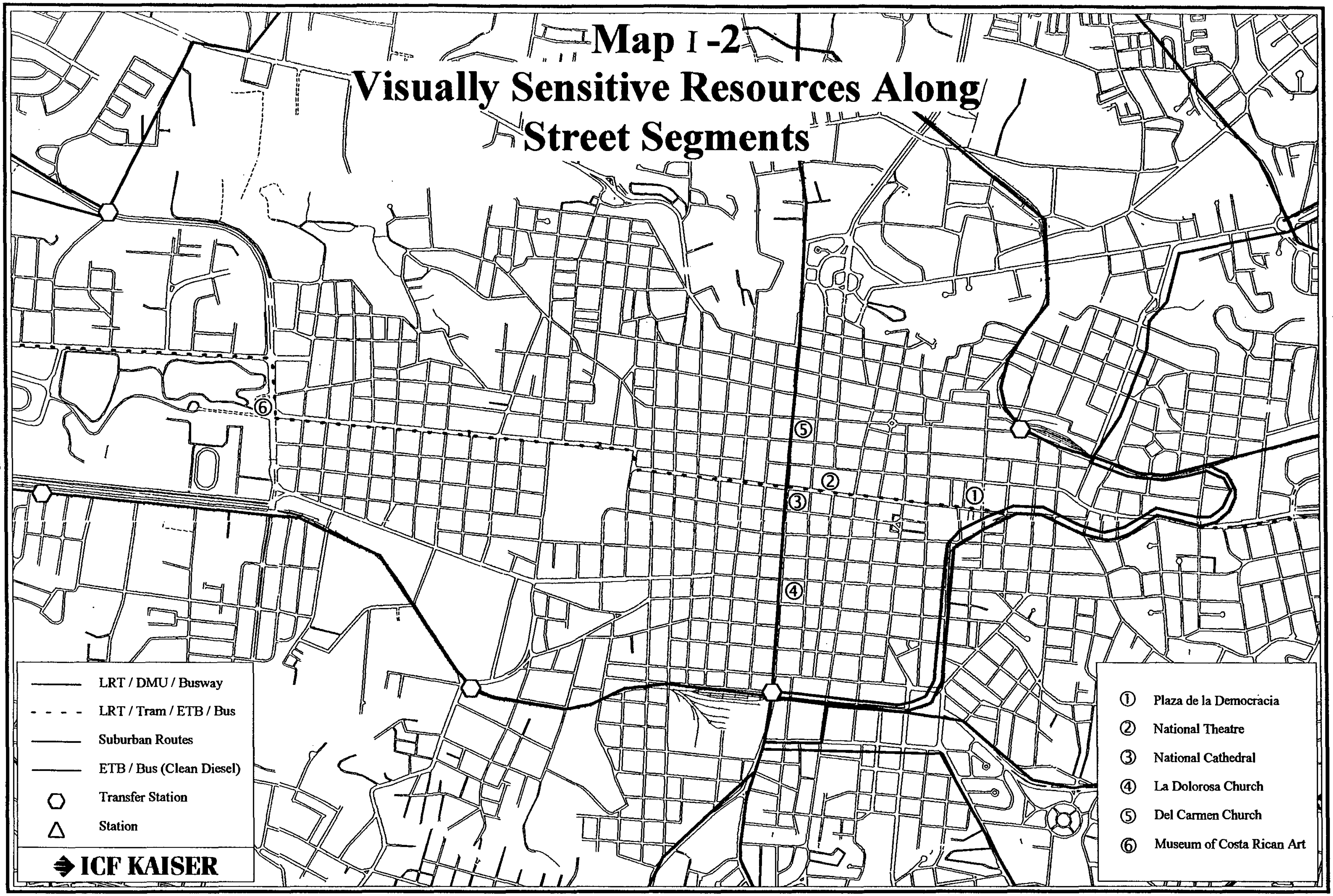
The field reconnaissance of the proposed segments of the San José transit system that use existing streets for their routes indicated a number of particularly sensitive and unique visual resources located in San José downtown area. Most of the areas outside downtown San José did not have sensitive visual resources, as they are small town developments or open areas. Table I.2.5-1 presents a list of some high quality views localized next to any of the proposed street segments. As indicated by this table, the segment from Pavas to San Pedro has the greatest potential for significant visual impacts at these sensitive resources.

The areas surrounding the historic monuments and tourist attractions are already highly developed and have a commercial character. Overhead cables already exist in most of the nearby streets. As a result, the introduction of the overhead catenaries and supporting infrastructure needed for the Tram or ETB options would have little negative visual impacts overall. The movement of trolley buses or Tram vehicles, all with uniformity and identification signs, would strengthen the citizen identification with the transit system and the areas where it runs. Furthermore, the electric trolleys would probably not occur directly in front but on the side of the National Museum, the National Theater, the National Cathedral, and La Sabana Metropolitan Park. For these reasons, the visual impacts to these historical monuments are not expected to be significant.

Table I.2.5-1
Visually Sensitive Resources along Street Segments

Name	Features	Street Segment Affecting					
		1	2	3	4	5	6
Plaza la Democracia	Military base in the 1800's Building has been used as National Museum for over 100 years One of main tourist attractions in San José for the museum and the market place located in front Market displays local art and manufactured goods Plaza used for music concerts	✓					
National Theater	Built in the 1890s and was inaugurated in 1897, recently restored Located next to Plaza de la Cultura and Museo de Oro Considered San José's major architectural attraction and one of its most impressive public buildings Venue for plays, performances by the National Symphony, ballet, opera, poetry readings, and other cultural events	✓					
National Cathedral	Located in front of the Central Park Recently constructed	✓	✓				
La Dolorosa Church			✓				
Del Carmen Church			✓				
Museum of Costarican Art	Houses a collection of local paintings and sculptures from the 19th and 20th centuries	✓					
Segments: (1) Pavas-San Pedro; (2) Tibás-Pacific Station; (3) Paso Ancho-Pacific Station; (4) Desamparados-Pacific Station; (5) Moravia-Atlantic Station; (6) Alajuelita-Hatillo-Pacific Station							

See Photos IC-3, IC-4, IC-5, and IC-6 at the end of Appendix IC.



Map I -2
Visually Sensitive Resources Along
Street Segments
LRT / DMU / Busway
LRT / Tram / ETB / Bus
Suburban Routes
ETB / Bus (Clean Diesel)
Transfer Station
Station
ICF KAISER
① Plaza de la Democracia
② National Theatre
③ National Cathedral
④ La Dolorosa Church
⑤ Del Carmen Church
⑥ Museum of Costa Rican Art

It is important to note that in other cities around the world the construction of an ETB or Tram system in central areas has served, in many cases, as catalyst for transformation and improvement of the visual character of surrounding areas.

I.2.5.3 Transfer Stations

The largest transfer stations proposed for the overall transit system would, for the most part, use existing buildings. The renovation of these buildings would cause a positive visual impact. Other stations would be small in size and with no buildings or ancillary facilities.

The transfer stations would become the focus of new social and economic activities and patterns. A high level of pedestrian activity would be concentrated around these points of transfer between transportation modes. The intensity of activities at these new centers would vary depending on the number of riders originating or destined for the area served by the transfer station. This functional character of the transfer stations would be a highly visible characteristic or attribute of the proposed transit system. With adequate urban planning, visual enhancement of the areas surrounding the proposed transfer stations would be achieved.

I.2.5.4 Mitigation Measures

Even though few significant visual impacts are expected, it is important to have a sensitive and unobtrusive design of stations and miscellaneous structures. Design preferences from the communities should be incorporated, especially in the event of noise barriers are constructed. The segment that crosses Plaza Víquez would need visual mitigation measures.

The possibility to improve the urban design nature of the corridors crossed should be considered by the government as a supplementary action tied to the project. It is a common practice in similar projects around the world to introduce urban improvement details such as "trolley wire", fluted lamp posts, new paving, etc. Furthermore, in order to minimize visual effects, span wires or bracket arm construction can incorporate the use of existing street lights, telephone poles, or utility poles. In some cases, cross spans can even be tied to buildings to eliminate the need for overhead contact support poles. This technique is widely used in Europe.

The construction of any of the segments in the proposed transit system provides the opportunity to enhance the visual quality of the area of influence. With tourism being an important aspect of Costa Rica's economy, this issue is of great importance for the project. As part of the project design, the possibility of integrating the arts and community activities to the system should be considered, especially at transfer stations and other stops. The goal should be to create a link between the San José transit system and the existing dense and culturally rich urban environment not only in downtown San José, but also in Alajuela, Heredia, and Cartago. Furthermore, the construction of the transit system should ideally be accompanied by an urban renewal effort to improve the visual quality of nearby buildings and open areas, in coordination with the municipalities.

I.2.6 Noise and Vibration

This section presents a preliminary evaluation of potential noise and vibration impacts that may be caused by the construction and operation of the various segments and technologies considered for the San José transit system. An increase in noise and vibration is a concern commonly raised by communities crossed by new transit systems. As part of this study, a rapid qualitative assessment of noise conditions in the field at all the segments of the proposed transit system was conducted. This assessment also identified potentially sensitive receptors. In addition, the team compiled technical background information on usual noise and vibration increases for systems with technical specifications similar to those proposed for San José's system. This information may be useful for the more detailed noise impact analysis that should be part of the EIA for the selected segments and the preferred technology.

Section 4.2.6.1 presents definitions of some technical terms used later in the noise analysis, along with general technical background information on noise and vibration. Section 4.2.6.2 presents a qualitative assessment of ambient noise levels and sensitive noise receptors in the San José metropolitan area along each segment of the proposed transit system. Section 4.2.6.3 discusses the most important sources of noise for each of the four technologies considered in this study. Section 4.2.6.4 discusses potential noise impacts and general mitigation measures to be considered in the detailed environmental analyses for the project. Finally, Section 4.2.6.5 discusses potential noise impacts and mitigation measures during construction.

I.2.6.1 Technical Background Information on Noise and Vibration

Definitions

Noise is created when an object vibrates and irradiates part of its energy as an acoustic pressure -- waves through a medium like air, water, or a solid object. The level of disturbance that it may cause depends on its magnitude, frequency, and time of day.

Noise levels are expressed in units called decibels (dB). A decibel is a logarithmic unit of sound pressure. Since the human ear does not respond equally to all frequencies, measured sound levels (in dB at standard frequency bands) are often adjusted or weighted to correspond to the frequency response of human hearing and the human perception of loudness. The weighted sound level is designated as the A-weighted sound level in decibels, or dB(A), and is measured with a calibrated noise sound level meter.

Single number descriptors have been developed to facilitate analysis of the continuously fluctuating community noise environment, and to correlate with human perception. Two descriptors commonly used in transportation and urban planning analyses are the L_{eq} and L_{dn}. The L_{eq} is a level of constant noise that has the same energy content as the fluctuating noise level over a given time period (i.e., it is a weighted average of all frequencies and types of noises over a certain period). The L_{dn} is a 24-hour average calculated from hourly L_{eq} values, with a 10-dB penalty to nighttime levels (10:00 PM to 7:00 AM) to account for heightened noise-sensitivity at night.

Vibration in the context of this transit project is an oscillatory movement caused by the moving vehicles of the system. Compared to noise, there is much less consensus about the scales and indices used in the measurement of ground-borne vibration. For some fields of interest, the range of vibration intensities is extremely wide and a decibel (dB) scale is used. For assessment purposes, other researchers propose the use of variables such as displacement, velocity, or acceleration caused by vibration. Because of the general preference for velocity as a measure of both annoyance and building damage, vibration criteria and measured vibration data are commonly presented in terms of overall unweighted velocity levels.

Typical Ambient Noise and Vibration Levels

The combination of noise from different sources is referred to as community noise, and is most commonly measured in A-weighted decibels (dBA). Community noise levels typically range from about 40 to 60 dBA. Levels as low as 30 dBA are possible during nighttime hours in an area void of traffic and industry, and levels as loud as 90 dBA could result during a truck pass-by or aircraft over-flight. A change in noise levels of less than 3 dBA is practically imperceptible for most people. A change in 10 dBA can be considered as a doubling of the noise level.

Existing ambient noise levels can be taken into account based on generalized community categories. For example, the United States Environmental Protection Agency (U.S. EPA) has developed five generalized definitions used to categorize communities along different areas for the purposes of assigning appropriate noise criteria. Table I.2.6-1 identifies community areas and their typical ambient noise levels. Table I.2.6-2 presents other examples of common noise levels.

Table I.2.6-1
General Categories Of Communities
and Their Typical Ambient Noise and Exposure Levels

Area Category	Area Description	Typical Ambient Noise Level - dBA (Average)	Typical Day/Night Exposure Levels - L_{dn}
I	Low density urban residential, open space park, and suburban residential area. No nearby highways or boulevards.	40 - 50 day 30 - 45 night	Below 55
II	Average urban residential quiet apartments and hotels, open space, suburban residential, or occupied outdoor areas near busy streets.	45 - 55 day 40 - 50 night	50 - 60
III	High density urban residential, average semi-residential/commercial areas, urban parks, museums, and non-commercial public building areas.	50 - 60 day 45 - 55 night	55 - 65
IV	Commercial areas with office buildings, retail stores, etc., primarily daytime occupancy, Central Business Districts.	60 - 70	Over 60
V	Industrial areas or freeway and highway corridors	Over 60	Over 65

Table I.2.6-2
Common High Noise Levels

Activities	Noise Level (dB(A))	Apparent Loudness (compared to base ref.)
Military jet, air raid siren	130	64 times as loud
Amplified rock music	110	16 times as loud
Jet takeoff at 500 meters Train horn at 30 meters	100	8 times as loud
Freight train at 15 meters	95	6 times as loud
Heavy truck at 15 meters Busy city street Loud shout	90	4 times as loud
Busy traffic intersection Highway construction site	80	2 times as loud
Highway truck at 15 meters Roadside traffic Train horn at 500 meters Noisy restaurant	70	Base reference

Common sources of vibration and their maximum velocity levels are shown in Table I.2.6-3.

Table I.2.6-3
Common Vibration Sources and Their Levels

Vibration Source	Maximum Root-Mean-Square Velocity (m/sec)
Foot stamping	0.0018
Truck passing building	0.000025-0.0001
General traffic passing building	0.000005-0.00005
Background inside house, main floor	0.000005-0.000013
Freight train (60 feet)	0.00025
Bus passing (50 feet)	0.001
Automobile (100 feet)	0.000016
LRT (50 feet), concrete tie	0.0001

Noise and Vibration Impact Criteria

Several type of criteria typically are used to assess the impacts of noise and vibration from transportation projects. Each country defines its own limits. In the U.S., the American Public Transit Association (APTA), the Federal Transit Administration (FTA), and the Federal Highway Administration (FHWA) have separate criteria.

The criterion for the onset of impact varies according to the existing noise level and the predicted project noise level, and is determined by the threshold at which the percentage of people highly annoyed by the project noise starts to become measurable. Noise impact criteria are based on a comparison of the existing outdoor noise levels and the future outdoor noise levels from a proposed project. A commonly used relative criterion in acoustic analysis is based upon the ability of an individual to perceive a change in sound level. Typically, a change of less than three decibels is imperceptible, whereas a change of five decibels or more is noticeable. For example, the FTA has developed guidelines for the significance of noise impacts. The following table can be used to judge the impact of any noise level increase.

Table I.2.6-4
FTA Guidelines for the Significance of Noise Impacts

Noise Impact	Increase in Noise Level (L_{eq})
Not Significant	3 dBA or less
Possibly Significant	Not greater than 5 dBA
Generally Significant	6 dBA or more

These guidelines indicate that noise impacts are generally *not significant*: (1) if no noise-sensitive sites are located in the project area; and (2) if increases in the equivalent noise exposure levels (L_{eq}) with implementation of the project are expected to be ≤ 3 dBA. Noise impacts are *possibly significant* if increases in equivalent noise levels (L_{eq}) with implementation of the project are expected to be no greater than 5 dBA. Noise impacts are *generally significant* if the proposed project would cause: (1) an increase in the equivalent noise level (L_{eq}) of 6-10 dBA in built-up areas; and (2) an increase in the equivalent noise level (L_{eq}) of 10 dBA or more in non built-up areas.

The criteria above are usually applied to transportation projects in general. For projects involving exclusively rail operations, the APTA has developed pass-by noise criteria for train operations. The maximum criterion ranges between 75 and 85 dBA depending on community area and building type. APTA has proposed more specific criterion, as presented in Tables 4.2.6-5 and 4.2.6-6. These criteria, when met, are designed to result in an acceptable community noise environment.

Table I.2.6-5
Criteria for Maximum Airborne Noise from Train Operations

		Maximum Passby Noise Level (dBA)		
	Community Area Category	**Single Family Dwellings**	**Multi-Family Dwellings**	**Commercial Buildings**
I	Low Density Residential	70	75	80
II	Average Residential	75	75	80
III	High Density Residential	75	80	85
IV	Commercial	80	80	85
V	Industrial/Highway	80	85	85

Table I.2.6-6
Criteria for Maximum Airborne Noise from Train Operations
Near Specific Types of Buildings

Building or Occupancy Type	Maximum Passby Noise Level
"Quiet" Outdoor Recreation Areas	70 dBA
Concert Halls, Radio, and TV Studios	70 dBA
Churches, Theaters, Schools, Hospitals, Museums, Libraries	75 dBA

There has been little research into human response to vibration, in particular, human annoyance with building vibration. However, experience with U.S. transit projects over the past 20 years represents a good foundation for developing suitable limits for exposure to ground-borne vibration from transit operations. This is why the FTA has developed criteria for acceptable vibration levels from rail transit systems. These vibration criteria are stated in terms of overall vibration velocity levels which have been found to be adequate and appropriate for application to rail transportation systems. Also these criteria can provide a basis for future assessments of potential impacts or complaints relative to perceivable ground-borne vibration.

Table I.2.6-7 presents the appropriate criteria for the maximum ground-borne vibration for various types of residential buildings in terms of vibration velocity. This table has been included because the rail ROW segments cross a large number of residential areas in San José and it can serve as a basis for assessments of impacts for the LRT and DMU options. The criteria apply to the vertical vibration of the ground surface or floor surface within the buildings.

Table I.2.6-7
Criteria for Maximum Ground-Borne Vibration from Train Operations

Community Area Category	Maximum Passby Noise Level Vibration Velocity Level (dB re 10-6 in/sec)		
	Single Family Dwellings	Multi-Family Dwellings	Hotel/Motel Buildings
Low Density Residential	70	70	70
Average Residential	70	70	75
High Density Residential	70	75	75
Commercial	70	75	75
Industrial/Highway	75	75	75

Table I.2.6-8 presents design criteria based on generally acceptable levels of transient ground-borne vibration for specific types of buildings with primarily institutional daytime uses. Ground-borne vibration which complies with these design criteria will not be imperceptible in all cases; however the level will be sufficiently low so that no significant intrusion or annoyance should occur. This table can also be used as a basis for future assessments of vibration impacts.

Table I.2.6-8
Criteria for Maximum Ground-Borne Vibration from Train Operations near Specific Types of Buildings

Type of Building or Room	Maximum Passby Vibration Velocity Level (dB re 10 in/sec)
Concert Halls	65
Auditoriums	70
Churches and Theaters	70
Hospital Sleeping Rooms	75
Schools and Libraries	75
University Buildings	75-80
Offices	75-80
Commercial and Industrial Buildings	75-85
Historic Buildings	90-100

I.2.6.2 Qualitative Assessment of Ambient Noise Levels and Sensitive Receptors in San José

The scope of this EFA did not include ambient noise and vibration level monitoring. The quantitative monitoring is part of later environmental studies, once the preferred segments and technologies are identified. As part of this EFA, a qualitative assessment of noise levels along the various segments of the proposed San José transit system was performed. The principal source of noise within the various corridors, and especially those corresponding to street segments, is motor vehicles. Aircraft traffic and industrial noise are also present in other areas.

Community noise in downtown San José is primarily dominated by heavy road traffic. Concentrations of automobiles and buses on preferred streets in the downtown area create severe traffic congestion, bottlenecks, and high levels of noise. This is partly due to the fact that most streets downtown are extremely narrow (approximately 7 meters from curb to curb). Almost 70 percent of the metropolitan area population uses the public transportation system. The majority of buses in San José are old diesel powered buses; many of which are second-hand school buses, and many of them have poor noise control devices. This situation causes very high noise levels in downtown locations during peak traffic hours.

This section presents the information collected for the various corridors of the proposed transit system. For each segment, the urban density, land use, qualitative noise levels, potentially sensitive noise receptors, and additional comments were recorded. The qualitative assessment was divided in three basic categories, as follows: High for continuously high noise levels (usually caused by heavy traffic); Medium for moderate noise levels with occasional increases to high levels; and Low for quiet areas, typical of open space or residential neighborhoods with no major streets nearby. It is important to emphasize that a quantitative noise monitoring program will be necessary as part of the EIA to determine actual impacts. The qualitative assessment presented in this report may guide the selection of monitoring points.

Ambient Noise Levels at Rail ROW Segments

Table I.2.6-9 presents the results of the qualitative noise assessment along the rail ROW segments. This table also includes a qualitative noise assessment of the most important transfer and regular stations along the rail ROW segments.

Table I.2.6-9
Noise Level Information Along the Rail ROW Segments

Area	Urban Density	Land Use (*)	Qualitative Noise Levels	Sensitive Receptors	Comments
Atlantic Line					
Cartago Station	High	C, R	High	None	The central area is more commercial than the outskirts
Cartago - Curridabat	Low density, changing to High towards Cartago	A, C, R	Low, High near Cartago	Residential areas in Cartago	This corridor has a lot of open areas and croplands
Curridabat-Atlantic Station	High	C, R	High	University of Costa Rica, residential areas	Highly urbanized area
Atlantic Station	High	C	High	National Library, National Park, and the Calderón Guardia Hospital	Interurban and urban bus stops in front of station; station has train yard and shop area

Table I.2.6-9 (cont) Noise Level Information Along the Rail ROW Segments					
Area	**Urban Density**	**Land Use (*)**	**Qualitative Noise Levels**	**Sensitive Receptors**	**Comments**
Atlantic Station - Santo Domingo	Medium	R, I	Medium	Residential areas before and after San Francisco bridge	None
Santo Domingo Station	Low		Low	None observed	None
Santo Domingo - Heredia	Low	A, R	Low	Residential area in Miraflores	Street runs adjacent to rail corridor in Miraflores
Heredia Station	High	C, R	Medium	School (Braulio Morales)	None
From Heredia to San Joaquín	High changing to low density in San Francisco	R, O	Low	Large School (San Francisco de Heredia), and a hospital	Corridor runs adjacent to Avenida 10 in Heredia; track passes behind school in San Francisco
San Joaquín Station	Medium	C, R	Low	Residential areas	Corridor runs adjacent to Avenida Central in San Joaquín
San Joaquín - Alajuela	Low	A, I, R	Low	Residential areas near Alajuela	Corridor runs adjacent to the high traffic Avenida 3 in Cañas, close to Alajuela
Alajuela Station	High	C, R	Medium	None observed	The central area is more commercial than the outskirts
Pacific Line					
Pacific Station	High	C, R	High	Maternity clinic, small park, and several houses	Heavy traffic surrounding station, especially on Ave. 20 and Calle Central
Pacific Station - La Sabana	High	I	Medium	None observed	Few main streets nearby
La Sabana Station	High	C, R, Park	High	La Sabana Metropolitan Park	Rail corridor runs adjacent to the Autopista Próspero Fernandez, one of downtown San José's main highways
La Sabana - Pavas	Low to High	I, R	Low High at 2 overpasses	Residential areas	No main streets nearby; two overpasses in the Autopista Próspero Fernandez and in the loop
Pavas Station	High	R	Low	Residential areas	
Pavas - San Antonio	Low	I	Low, High on aircraft take-off or landing	Church, hotel (Marriot Hotel)	Local low-traffic airport near corridor; industrial noise in rock mining operation at two sites
San Antonio Station	High	R	Low	Residential areas	None

Table I.2.6-9 (cont) Noise Level Information Along the Rail ROW Segments					
Area	**Urban Density**	**Land Use (*)**	**Qualitative Noise Levels**	**Sensitive Receptors**	**Comments**
San Antonio - Ojo de Agua	Mostly open space, and medium density in San Rafael	O, R	Medium	Church, residential areas	Main street with little traffic runs adjacent to corridor
Ojo de Agua Station	Medium to high	R, I	Medium	Residential areas	None
Ojo de Agua - Ciruelas	Low	A	Low	None observed	Car racing track close to rail corridor may be additional source of noise on certain days
Ciruelas Station	Low	R	Low	None observed	Large train yard and shop area
Southeastern Connector					
Atlantic Station - Pacific Station	High	C, R	High	Residential areas, Parque Viquez, several schools and government buildings	Rail corridor runs along two main avenues, Avenida Central and Avenida 2
Alajuela-Ciruelas	Medium	O, R	Low	Residential areas	None
Alajuela-San Antonio	Low	A, O	Low, High near airport	The International Airport, Juan Santamaría	Outside the airport, this area is not highly developed
Land Use Key: C: commercial; R: residential; I: industrial; A: agricultural; O: open space					

Ambient Noise Level at Street Segments

Overall, most of the areas along the proposed street segments, especially in the downtown area, are high-density commercial areas with very high levels of noise due to heavy traffic and congestion. Table I.2.6-10 presents the results of the qualitative noise assessment along the proposed street segments. The last column of this table presents a brief description of the street configuration.

Table I.2.6-10 Noise Level Information Along the Street Segments					
Area	**Density**	**Land Use (*)**	**Qualitative Noise Levels**	**Sensitive Receptors**	**Comments**
From Pavas to San Pedro (diametral)					
Pavas	High	R	Medium	None	Low-income area
La Sabana	High	C	High	La Sabana Metropolitan Park	None
Avenida 2	High	C	High	National Theater, Plaza de la	Avenue shifts from two lanes to a five lane

Table I.2.6-10 Noise Level Information Along the Street Segments					
Area	**Density**	**Land Use (*)**	**Qualitative Noise Levels**	**Sensitive Receptors**	**Comments**
				Democracia, National Museum	highway. High traffic in both segments
Route 2 or Paseo Ruben Darío	High	C	High	None	Four lanes highway with high traffic
San Pedro	High	C	High	San Pedro church, San Pedro Mall	Highly developed area
From Tibas to Pacific Station					
Tibas area	High	C	High	None	Highly developed area
Route 5	High	C, R	High	None	Four lanes with high traffic High traffic except in Cinco Esquinas
Calle Central	High	C	High	Two churches, Central Fire station, Central Park, Cathedral	Two lanes with high traffic
Pacific Station	High	C, R	High	Maternity clinic, small park, and several houses	Heavy traffic surrounding station, especially on Ave. 20 and Calle Central
From Paso Ancho to the Pacific Station					
Paso Ancho	High	R	High	None were observed	None
Pacific Station	High	C, R	High	Maternity clinic, small park, and several houses	Heavy traffic surrounding station, especially on Ave. 20 and Calle Central
From Desamparados to the Pacific Station					
Desamparados	High	C, R	High	Central Park area	High traffic area
Route 209	High	C	High	La Paz recreational park	Four lanes with high traffic
Plaza Viquez	High	Recreational	Medium	Recreational Center	
Avenida 22	High	R	Medium	Ricardo Jimenez school	Four lanes with moderate traffic
From Moravia to the Atlantic Station					
Moravia area	Medium	R, C	Medium	None	None
Avenida Central in Guadalupe	High	C	High	Two schools	Four lane avenue with high traffic
Calle 23 or Ismael Murillo	High	C	High	None	Four lane street with high traffic
Atlantic station area	High	C, R	High	Calderon Guardia Hospital, National Park	High traffic area

Alajuelita - Hatillo - Pacific Station					
Alajuelita	High	C, R	High	Central Park area	Highly developed
Route 214	High	C, R	High	None were observed	Four lanes with high traffic
Pacific Station	High	C, R	High	Maternity clinic, small park, and several houses	Heavy traffic surrounding station, especially on Ave. 20 and Calle Central
Land Use Key: C: commercial; R: residential					

I.2.6.3 Sources of Noise by Technology

The four technologies proposed for the San José transit system (LRT, DMU, ETB, and clean-diesel buses) generate different types and intensities of noise, and the origin of this noise is different for each technology. This section presents a brief overview of the sources and typical levels of noise for each case, including typical sources of noise for support facilities.

Overall, the technology that produces the least noise of the four options considered is the ETB, as it does not create the wheel-rail noise typical of LRTs nor does it have a diesel traction system like DMUs or buses. Clean-diesel buses with well-maintained noise control systems in a dedicated busway may not significantly increase overall noise levels, depending on their frequency and existing background community noise. A DMU system tends to be noisier than LRT as it has all the noise sources of LRT plus the diesel traction system.

Electric Trolley Buses

Trolley bus noise is created by tire and roadway interaction, electric traction motors, and braking. Trolley buses radiate very low noise levels while in motion and no noise while stopped. In general, ETBs are much quieter than diesel buses.

Noise criteria for trolley buses have not been well documented or developed as they are for LRT systems. Some studies have described that lower noise levels are radiated by trolley buses compared to automobiles and buses. Several studies have been performed on the comparative noise levels from diesel buses, diesel powered motor coaches, and trolley buses. Most studies indicate that noise created by the trolley buses tested was not discernible over the prevailing ambient noise levels. Measurements by the San Francisco Department of Public Health indicated peak noise levels of 69 to 84 dB for trolleys. Elsewhere, it was reported that tests made in Seattle found average noise levels of 65 dB for trolleys. In these and other studies, the noise generated by trolley buses was found to be significantly less than general traffic noise.

Clean-Diesel Buses

One of the most important factors in keeping noise generation from diesel buses to a low level is maintenance of their exhaust and noise control systems. Table I.2.6-13 shows the general dominant sources of diesel bus noise.

Table I.2.6-13
Sources of Diesel Bus Noise

Dominant Sources	Comments
Cooling Fans	While idling
Engine casing	While idling
Diesel exhaust	At low speeds and while accelerating
Tire/roadway interaction	At moderate speeds and high speeds

The dominant source of noise from diesel buses is the tire and roadway interaction, which is strongly dependent on speed. The sources of diesel bus noise in downtown San José are usually created when buses idle inside or close to transfer stations, by cold starts, and by the stop and go acceleration due to bottlenecks. Maximum passby bus noise at 50 feet is approximately 83dB for 30-40 feet bus coach designs. In highly congested areas like downtown San José, changes in motor vehicle traffic need to be substantial to produce a noticeable change in sound levels.

Light Rail Electric Trains

Light rail transit systems in general generate noise levels that are well below freight trains, due to their difference in weight and traction systems. Wayside noise radiated into the community from LRT operations is, along with the noise created inside the rail vehicles, the most important aspect of train noise. Wayside noise is generally a function of a number of different factors including the interaction of the wheels and rails, the vehicle or locomotive propulsion system, auxiliary equipment, noise radiated from vibrating structures, train speed, and train length. Other aspects of wayside noise include warning device or horn noise, track maintenance noise, and yard and shop noise.

The noise from an electric locomotive pass-by is generally characterized by a high noise level during the locomotive pass-by with lower noise levels of different character during pass-byes of the cars (carriages). The principal source of wayside noise from an electric locomotive is the propulsion system (i.e., electric motors, cooling fans and sometimes gearing), which is dependent on the passing speed. The major noise from the trailing cars is produced by the interaction of the wheels and the rails.

It should be noted that LRT vehicle noise is strictly a function of speed. At very low speeds (<9 mi/hr) auxiliary equipment (compressors, motor generators, brakes, ventilation systems and any other car-mounted equipment) may predominate. At speeds up to approximately 31 mi/hr, wheel-rail noise predominates, while at speeds greater than 31 mi/hr, the propulsion equipment noise (from traction motors, cooling fans for the traction motors, and reduction gears) predominates. Wheel and rail interaction will be the expected dominant source of LRT noise in most areas across San José, because its average speed will be 25-30 mi/hr. The predictions of noise impacts from the LRT alternative must also take into consideration its various operational characteristics. Table I.2.6-11 describes various sources of noise expected from a LRT. In general, noise increases with speed and train length. Lower speeds mean less noise for LRTs on exclusive ROWs.

Table I.2.6-11
Sources of Noise for Light Rail Transit

Dominant Components	Comments
Wheel/Rail interaction and guideway amplification	Depends on condition of wheels and rails
Propulsion system	When accelerating and at higher speeds
Brakes	When stopping
Auxiliary equipment	When stopped
Wheel squeal	On tight curves
Horns and crossing bells	At grade crossings

To provide a basis for evaluating the potential noise impact of the LRT, levels of expected wayside noise from LRT operations should be determined. Table I.2.6-12 provides a summary of maximum wayside noise levels for LRT vehicle passbys at selected distances and speeds by track type (embedded and ballast & tie). The information in Table I.2.6-12 is based on measured data from the Portland (Oregon) Tri-Met LRT, a LRT system similar in many respects to the one proposed for San José.

Table I.2.6-12
Maximum Sound Levels (L_{max} dB) for LRT Vehicle Passbys At Selected Distances and Speeds by Track Type

Speed kph (mph)	Type of Track	Distance to Receiver							
		4.6 m (15 ft.)	6.1 m (20 ft.)	7.6 m (25 ft.)	9.1 m (30 ft.)	12.2 m (40 ft.)	15.2 m (50 ft.)	22.9 m (75 ft.)	30.5 m (100 ft.)
15 (9)	Embedded	79	78	78	77	76	75	74	73
	Ballast & Tie	77	75	73	72	70	68	65	65
20 (12)	Embedded	83	82	84	81	80	79	78	77
	Ballast & Tie	81	79	77	76	74	72	69	66
25 (16)	Embedded	86	85	84	84	83	82	80	79
	Ballast & Tie	84	82	80	79	76	74	72	69
30 (19)	Embedded	88	87	87	86	89	84	83	82
	Ballast & Tie	87	84	82	81	79	77	74	72
35 (22)	Embedded	--	--	--	--	--	--	--	--
	Ballast & Tie	88	86	84	83	81	79	76	74
40 (25)	Embedded	--	--	--	--	--	--	--	--
	Ballast & Tie	90	88	86	85	83	81	78	75

SOURCE: Technical Report: Environmental Consequences, HBLRT FEIS, ICF Kaiser in association with Lewis Goodfriend and Associates, March 1996, Revised April 1996.

Another potentially significant source of noise for rail system are turnouts and crossovers. In areas where special trackwork is located, such as at crossovers and turnouts, the wheel impact at the switch points or other discontinuities can significantly increase the radiated noise levels. Wheel squeal occurs as the rail cars traverse a turn because the outer wheel slips relative to the track at low speeds. The slip occurs because the inside and outside wheels are fixed solid to a single axle. The noise thus produced by friction is high frequency in nature, and often is a source of annoyance.

In San José, curves along the rail ROW are commonplace, as sharp as 100m in radius, and have the potential to be significant sources of noise along the corridor area. For example, there are 98 curves in the 41.4 km distance between Alajuela and Cartago. The line between Ciruelas and Alajuela has five consecutive horseshoe curves located just south of Alajuela. From the Pacific Station to the Atlantic Station there is a sharp horseshoe curve in the 10 meters right of way. If the detailed noise impact analysis to be performed later indicates significant noise impacts near these areas, mitigation measures such as noise barriers should be considered, especially for noise-sensitive receptors.

Diesel Mobile Units

Diesel Mobile Units (DMU) noise is generally a function of a number of different factors including the diesel propulsion system, diesel exhaust, wheel and rail interaction, auxiliary equipment, noise radiated from vibrating structures, and train length. DMU noise is normally dominated by the exhaust noise from the generators. This source of noise is independent of the pass-by noise of the unit, but dependent on engine load and throttle setting. Opposite to LRT vehicle noise, speed dependence is less for DMU vehicles, particularly where the locomotive exhaust noise dominates. As for LRT vehicles, wheel squeal noise for DMU vehicles can be potentially significant in turnouts and crossovers.

Other Potential Sources of Noise

Transfer Stations Transfer stations have the potential to be a significant source of noise, as different modes of transportation and large number of commuters converge into a single transfer point. Noise levels from different technologies are combined (e.g., inter-urban buses, cars, LRT, freight trains, etc.) in the same area. The potential noise impacts of transfer stations are site-specific and are characterized by peak activity periods. In the proposed San José transit system, the transfer stations with the largest expected number of commuters and vehicle activity are under operation and are located in high-density commercial areas with high levels of noise.

Yard and Shop Yard and shop noise can be a major contributor of the overall project in community areas adjacent to the yards. The classification and maintenance activities are varied and the noise levels and their duration are dependent on the particular activities, yard layout, and operational patterns. Yards typically receive incoming trains and redistribute the freight cars into new outgoing trains bound for new destinations. Major sources of yard and shop noise include: wheel squeal on curves, intermittent noise as wheels pass over joints and through switches, other general train rolling noise, noise from auxiliary equipment operations, coupling and uncoupling of cars, operation impact tools and machinery, shouting workmen, car washing equipment, telephone and warning buzzers and horns. The impact noise is typically 20-30 dBA or more above the ambient noise level, in the range of 95-105 dBA at 30m. Proposed yards and shops for the LRT and DMU systems would be located at the Pacific and Atlantic Stations and at both ends of the rail corridor. Proposed yard and shop areas for the ETB and Busway systems would be located at the Pacific Station and at other locations outside the downtown area that have not been determined.

Track Maintenance Activities Track maintenance, even though essential for reducing rail-wheel interaction noise, can be an additional source of noise. Most frequently used corridors should have regular scheduled track maintenance including ballast cleaning, tamping, and rail grinding. Noise levels from maintenance activities obviously depend on the exact activity occurring; however, the noise levels are typically of diesel, hydraulic, and pneumatic equipment used at heavy construction projects.

Warning Noise Warning gates and devices will be placed at each rail-street crossing. There are approximately 150 crossings across the rail ROW segments. The Atlantic line alone has 85 crossings and the Pacific line has approximately 46 crossings. Noise sources associated with grade crossings are the grade crossing bells that start sounding just before the gates are lowered and idling traffic that must wait at the crossing.

Freight Operation Noise Along some sections of the Pacific Line, the existing railroad tracks may be shared in the future by both transit operations and railroad freight train operations. The Pacific line might have double-tracking in order to have freight train operations running during the day. The Atlantic line may have in the future railroad freight operations running during the night-time period when the LRT is not working. Freight operation noise should not have a substantial increase from LRT-related noise in areas with perceived high noise levels. However, special attention should be placed to areas with perceived low noise levels and sensitive receptors because freight operations have higher wayside noise levels at increasing speeds. Further studies should assess the specific impacts of freight operations once routes and schedules of these operations have been decided.

Electric Power Substations As the LRT and ETB systems will be powered from overhead electrical lines, at-grade substations will be located at intervals along the line. The noise from the substations varies considerably depending on power requirements and installation details; however, most are not enclosed and in this condition can generate noise levels of 40-45 dBA at 30m from the edge of the substation installation. This fact should be taken into consideration when defining the location of these substations, in order to avoid sensitive receptors.

I.2.6.4 Key Noise-Sensitive Areas, Potential Impacts, and Mitigation Measures

This section presents an assessment of potential noise increases along those segments of the proposed San José transit system. This assessment is preliminary and should be considered only as a guidance for further studies that would include quantitative noise monitoring and noise modeling with special considerations of sensitive receptors located along the segments selected. Section 4.4.3 presents recommendations for a following phase of noise impact analysis.

As discussed in previous sections, 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 on 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 located near the proposed segments and with current low noise levels.

As San José is located in a high-seismicity area, any potential increase in vibration due to any of the technologies considered would not affect nearby structures, as these are designed to resist much larger ground-borne movements. Nuisance to nearby residents should be considered, especially for sensitive receptors, along with the noise impact analysis. Mitigation measures similar to those recommended for areas with significant noise impact would also help reduce increases in vibration levels caused by the new transit system.

Rail ROW Segments

The railroad ROW is typically 15 meters wide. In other locations, such as the Southeastern Connector's section through Avenida 2 and Paseo Rubén Darío, the official ROW is less than the typical 15 meters. Of the various land uses that surround the rail corridor, residential areas are the most noise-sensitive. This is partly due to the fact that these residential areas are very close to the ties (actually some houses have actually invaded the ROW as is discussed in Section 4.2.7). At 7.5 m from the centerline, high density residential areas (with perceived low noise levels) could experience *possibly* significant noise impacts (greater than 3dBA, but smaller than 6dBA) from LRT or DMU vehicles traveling at average speed. At the same distance, low density residential areas (with perceived low noise levels) could experience *generally* significant noise impacts (greater than 6 dBA) from LRT or DMU vehicles traveling at average speed.

The following rail ROW segments and proposed stations could experience *possibly* significant noise impacts due to the operation of an LRT, DMU or bus systems (an ETB system would cause a very small increase in noise levels): from La Sabana to Pavas, the Pavas Station, close to the Ojo de Agua station, from Ciruelas to Molinos, from the Atlantic Station to Santo Domingo just before and after the San Francisco bridge, and in the Heredia station and its surroundings. These segments are surrounded by high-medium density residential areas with perceived low-medium noise levels. The following rail ROW segments and proposed stations could experience *generally* significant noise impacts: from Santo Domingo to Heredia in Miraflores, the San Joaquín Station, and from San Joaquín to Alajuela. These segments are surrounded by low-density residential areas with perceived low noise levels. Part of the rail ROW runs adjacent to streets and avenues in many of the above-mentioned areas. These areas are not completely void of traffic noise. The potential significance of these impacts cannot be determined until detailed monitoring measurements and modeling is performed, once the preferred technology and segments are selected.

High density residential areas with perceived high levels of noise located near rail ROW segments should not experience any significant impacts during operation of any of the four technologies considered. In these areas, the rail ROW generally runs adjacent to heavily congested streets and avenues. For example, the Pacific Station experiences heavy traffic noise from Avenida 20 and Calle Central. La Sabana Station experiences heavy traffic noise from the Autopista Próspero Fernandez. The rail ROW segment from the Pacific Station to the Atlantic Station also runs along two of San José's main avenues, Avenida Central and Avenida 2. Depending on the number of users of the new transit system, noise levels might be reduced due to the reduction in buses and traffic congestion in the downtown area.

Certain specific types of buildings can be considered noise-sensitive; these include: schools, hospitals, churches, libraries, and other special use buildings. As stated before, maximum wayside noise from the LRT or DMU systems on these specific types of buildings is recommended to be 75 dBA. Areas that have high perceived noise levels should not experience noise impacts in buildings near the corridor. For example, the maternity clinic and the small park close to the Pacific station already experience heavy traffic noise. The LRT noise will not exceed the current ambient noise levels in this area; however, yard and shop noise should be considered. From the Pacific Station to the Atlantic Station the corridor passes near several schools and government buildings. The right of way in this area is 10 meters, smaller than the typical 15 meters of the corridor. Therefore, special considerations may be taken when passing near schools during operating hours even though this is a heavy traffic and congested area. The Atlantic station, a high-noise area, lies near the National Library and the Calderon Guardia Hospital. Similar to the Pacific Station, LRT noise will probably not exceed current ambient noise levels in this area; however, yard and shop noise should be considered and analyzed further for this site.

Areas with low to medium noise levels might experience noise impacts in buildings near the rail ROW. For example, the church and Marriot Hotel near the Rincón Grande - San Antonio segment, and the church near the San Antonio - Ojo de Agua segment might experience possibly significant noise impacts. The corridor runs extremely close to educational buildings in low noise areas. For example, the Braulio Morales school near the Heredia Station and the San Francisco de Heredia school near the Heredia - San Joaquín segment. There are some University of Costa Rica buildings near the San José - Curridabat segment. Even though this area has a high urban density, the transit system may have some impacts on these buildings because it runs through an exclusive right of way behind the educational buildings. Therefore, it would be the only source of noise coming directly from that area. Special considerations should be taken for these areas if the detailed noise impact analysis indicates a significant negative effect.

Street Segments

There are many different noise sensitive receptors located along the street segments of the proposed transit system. For example, the National Museum and the National Theater are located in Route 1 or Paseo Colón. At the same time, there are hospitals, schools, churches, government buildings, and residential and recreational areas throughout the street segments. However, all these areas are located in high density zones with perceived high to medium noise levels. High noise levels on these areas are attributable to high traffic and congestion. Most of the street segments pass through the streets and avenues with the largest traffic volumes in downtown San José. Therefore, the ETB system or a new bus system with well-maintained noise-controlled units would potentially reduce noise level and bring a positive effect.

Potential Mitigation Measures

After a noise monitoring and modeling analysis of the selected segments and technological options is completed, a detailed plan to mitigate noise impacts can be designed. This section presents some general mitigation measures that are commonly implemented in similar projects around the world. Some of these mitigation measures, such as noise barriers or noise walls require the participation of the surrounding communities to incorporate their input into the design and physical features, and to avoid other impacts such as degradation of visual quality.

Noise Barriers Noise barriers are commonly used in the reduction of noise levels of transit and traffic systems. If designed appropriately and adjusted to real noise levels, barriers can be effective in the reduction of noise impacts. However, noise barriers are not effective in locations where access to vehicular traffic has to be provided.

Different materials, including concrete, wood, metal, brick, or a combination of these materials, can be used in the construction of noise barriers. In order to achieve a 10 dBA noise level reduction, it is recommended that selected noise barrier materials are rigid and dense (approximately 20 kg/m^2, as a minimum). The selection of materials will greatly depend on the local conditions of costs and aplicability. For example, the use of soil as a noise barrier can be effective in the reduction of noise levels and the improvement of the system's visual qualities; but, in many cases there is not enough space to place the barrier between the operational segments and the sensitive receptors. To achieve significant noise impact reductions, the designer of the noise barriers shoud consider the following aspects during the design process: height of the noise barriers, foundations, location, maintenance, and additional costs of drainage.

Rail Maintenance (LRT and DMU) Rail-wheel interaction noise is the noise radiated directly from the vibrating wheels and rails. This interaction creates three types of noise: 1) rolling noise due to continuous rolling contact; 2) impact noise when a wheel encounters a discontinuity in the running surface, such as a rail joint, turnout, or crossover; and 3) squeal generated by friction on tight curves. Rail-wheel interaction is dependent on speed, wheel condition, rail condition, and whether the track is jointed or welded.

Noise levels can increase as much as 15dBA when rails and wheels are in poor condition. Maintaining rail in good condition is an important step in controlling train noise. Visible rail corrugations should be removed regularly by grinding. One of the most common problems on wheels is the formation of flats caused by wheels sliding under hard braking. To solve this problem, regular wheel truing can help control noise levels. Proper maintenance can play an important role in minimizing noise due to aging of the track system and vehicles.

Speed Reduction (LRT and DMU) In some cases, where noise barriers are not appropriate, another potential mitigation measures is to reduce the velocity of trains in certain specific segments with noise-sensitive receptors at certain hours of operation (e.g., night-time). Train speed can be reduced in corridor areas where there are residential zones with perceived low noise levels and in corridor areas where schools and hospitals are very close to the right of way. Identification of areas appropriate and suitable for the reduction of train speed should be based on the results of a detailed noise impact assessment. Operational difficulties may preclude the implementation of this mitigation measure.

I.2.6.5 Construction Noise

Construction activities associated with any of the segments of the proposed transit system will result in a temporary increase of noise. The most important construction activities for each technology are presented in Table I.2.6-14.

Table I.2.6-14
Major Noise-Generating Construction Activities by Technology

Construction Activity	LRT	DMU	Tram	ETB	Busway
Ballast replacement	✓	✓			
Track construction	✓	✓	✓		
Paving			✓	✓	✓
Posts for overhead wires	✓		✓	✓	

The dominant source of noise from most construction equipment is the engine, usually diesel, without sufficient muffling. In a few cases, such as impact pile driving or pavement braking, noise generated by the process dominates. For considerations of noise assessment, construction equipment can be considered to operate in two modes, stationary and mobile. Construction activities are characterized by variations in the power expended by equipment, with resulting variation in noise levels with time. Table I.2.6-15 presents the typical noise levels for the type of equipment that is expected to be used during construction. It should be noted that these noise levels are based on equipment that has been manufactured in the United States. Therefore, noise levels of construction equipment manufactured in other countries, in this case Costa Rica, are probably different.

Table I.2.6-15
Construction Equipment Noise Emission Levels

Construction Equipment	Typical noise levels (dBA) at 50ft. of source
Air Compressor	81
Backhoe	85
Compactor	80
Concrete Mixer	85
Concrete Pump	82
Concrete Vibrator	76
Crane, Mobile	83
Dozer	80
Generator	78
Grader	85
Impact Wrench	85
Jack Hammer	88

Loader	79
Paver	89
Pile Driver (Impact)	101
Pire Driver (Sonic)	96
Pneumatic Tool	85
Pump	98
Rock Drill	98
Roller	74
Saw	90
Scraper	88
Shovel	82
Truck	91
Source: Draft *Guidance Manual for Transit Noise and Vibration Impact Assessment*, Federal Transit Administration, U.S. Department of Transportation	

For a general noise impact assessment, one should estimate the combined noise level in one hour from the two noisiest pieces of equipment, assuming they both operate at the same time. Then identify the locations where the level exceeds the criteria presented in Table I.2.6-16.

Table I.2.6-16
Noise Impact Criteria for Construction Equipment

	One-hour Leq (dBA)	
Land Use	**Day**	**Night**
Residential	90	80
Commercial	100	100
Industrial	100	100

Although noise impacts during construction will be temporary, site-specific, and closely related to the various types and phases of construction, it is important to take certain mitigation measures to reduce nuisance to neighboring communities. Contractors may be required to schedule construction during daytime hours to minimize impacts. Also, the flow of trucks transporting materials to and from the construction site will have to be redirected far from residential streets or, where it is not possible, through streets that have few residences. Stationary equipment, such as compressors, will have to be placed as far away from residences as possible. Trees and other existing noise barriers should be left in place in order to reduce noise levels. Additionally, the adequate and continuos maintenance of the construction equipment can help reduce noise emissions. It is therefore recommended that periodical inspections and maintenance measures be conducted on all construction equipment.

Community relations are also an important component of mitigation measures. Early information disseminated to the public about the kinds of equipment, expected noise levels and duration will help to forearm potentially affected neighbors about the temporary inconvenience. In these cases, a general description of the variation of noise levels during a typical construction day may be helpful.

I.2.7 Encroachment and Induced Development

This section analyzes potential impacts to land use that may be caused by the construction and operation of the proposed transit system. The two most important potential impacts to land use are the changes caused on properties located next to the rail ROW, many of which have encroached into the ROW and will be potentially impacted during construction activities, in order to clear the necessary width for the operation of any of the four technologies considered.

The second potentially significant land-use impact is associated with long-term development induced by the different routes and transfer stations of the proposed transit system. Transportation and the growth pattern of cities have always been closely linked. Prior to the automobile, urban development was influenced by the location of the railroads with intensive uses clustering near stations and major transfer points. Automobiles, with their greater mobility and flexibility, generally contributed to the dispersion of land uses. The operation of a new system along the ROW introduces a new important element in the development structure of the San José Metropolitan Area.

Section 4.2.7.1 presents an overview of current encroachment conditions along the rail ROW, along with recommended mitigation measures. Section 4.2.7.2 focuses on long-term development issues around the proposed transfer stations, along the rail ROW, and along the proposed street segments.

I.2.7.1 Encroachment Along Rail ROW

As described in Section 4.2.2.2, the rail service at the Atlantic line was interrupted in 1991. The Pacific line operated until 1995. As rail operations were discontinued, maintenance of the ROW was more sporadic and, as a result, some houses and properties located next to the ROW encroached into it (see a typical example in Photo IC-7 in Appendix IC). This situation is more common in those areas where the rail ROW crosses urban centers. Furthermore, in some cases, the rail ROW has been paved over to provide access for vehicle traffic.

Parallel to the preparation of this EFA, the railroad company INCOFER did an evaluation of the encroachment situation along the Atlantic Line between Alajuela and San José. Table I.2.7-1 presents the results of this inventory. The reader is referred to Map 2-1 for locations of communities presented in the table. It is important to note that the INCOFER team counted the number of encroachment incidents, regardless of their size. In some cases, the encroachment corresponds to part of a house, and in some others, it is simply a yard fence. There appears to be no residence wholly within the ROW. However, a more detailed inventory is needed to confirm this statement.

Table I.2.7-1
Number of Encroachment Incidents, Atlantic Line

Segment	Number
Atlantic Station-Santo Domingo	103
Santo Domingo-Heredia	72
Heredia-San Joaquín	166
San Joaquín-Alajuela	140
Atlantic Station - Pacific Station	143

Currently, INCOFER is continuing its evaluation of the Atlantic Station-Cartago segment in the Atlantic Line, and will also perform a similar study for the Pacific Line. A qualitative assessment of these segments indicates that a similar encroachment situation to that illustrated by Table I.2.7-1 occurs at Atlantic Station-Curridabat, Pacific Station-La Sabana, and Molino-Alajuela. Other segments appear to have less encroachment incidents, as urban density is lower than the segments above.

The implementation of any of the four technologies considered for the rail ROW segments would require the clearing of the ROW. The removal of many of the encroachment incidents would not cause a significant impact to residents, as they are small structures, such as fences. In other cases, squatters and portions of residences may have encroached into the ROW, and the impacts could be significant and unavoidable.

Although residents that have encroached into the rail ROW do not have land titles, it is necessary to design and implement a ROW clearing plan that takes into consideration the needs of these residents. A community participation plan and a public information campaign are recommended to minimize the significance of impacts. Early explanation of the work program and close coordination with residents will avoid any potential conflicts.

The encroachment problem is basically non-existent for the street segments, as existing corridors will be used in these cases. It is possible that the final design of the selected technology may require the displacement of certain structures due to safety or technical specifications. The specific residences and/or structures that may need relocation would be defined at a later time.

I.2.7.2 Long-Term Changes in Land Use

Rail ROW Segments

The rail ROW segments are expected to reinforce and focus already well-established growth patterns in the Greater Metropolitan Area. The proposed project would enhance regional accessibility for commuters. Furthermore, it would be generally supportive of future development which may be focused around proposed station areas. Access for the proposed transit systems is viewed as advantageous. Therefore, this project is expected to be supportive of anticipated density increases in the Greater Metropolitan Area.

Based upon the experience of other regions, transit can have a positive effect on land use and development, because new transit systems enhance the accessibility of areas, increase the attractiveness of land for development, and support trends already underway. However, new land development is dependent on a combination of interrelated factors, including: the overall regional and market demand for development; the quantity of developable land; the nature of adjacent land uses; and the availability of financing. The implementation of any of the four technologies considered for the rail ROW, in and of itself, is not expected to dramatically reshape land use patterns and economic activity in the San José Metropolitan Area. Additionally, the impact of new development should not alter significantly overall land use patterns in the corridor. However, it could have more significant impacts around the proposed stations, especially those with larger volumes of commuters.

Transit improvements provide an important, although not the sole, impetus for new development. These decisions depend primarily on the market and demand for such projects, and on other factors. These favorable conditions for development, with the exception of transit accessibility, have already manifested themselves to an extent in the four major cities. The implementation of the proposed transit system along the rail ROW segments has the potential both to enhance access to San José for workers, while concentrating a large number of transit users within specific areas, thereby increasing the desirability of those locations which possess the various attributes that constitute attractive development sites.

Growth trends within the corridor are already well-established. Some show a pattern of high-density commercial services (such as, the Pacific Station, La Sabana, 10th Avenue, 2nd Avenue, Avenida Central, the Atlantic Station, San Pedro), others show a pattern of industrial development (areas in the outskirts of San José), others have a high-density residential development (such as, Pavas, Molino, Alajuela West, Plaza Gonzalez Viquez, Heredia, San Joaquín, Alajuela East, Curridabat, Cartago), others are small developing towns (for example, San Antonio, Ojo de Agua, San Francisco, Santo Domingo, Tres Ríos, El Alto), and some areas have open space that is not currently being developed (for instance, Ciruelas, Highway 5, Río Segundo). Some changes may be expected in land use along the rail ROW segments where the transit system is implemented. However, this is a long-term process that is not easy to predict given the large number of factors involved.

Street Segments

Overall, the ETB/TRAM service is not expected to have significant induced development along its corridor, nor at the stops. This service would stop every few blocks. Thus, the frequency of stops on the proposed routes is not expected to generate enough activity at transit stops to change the character of surrounding development. However, the transportation service within residential areas, regardless of the technology used, would have the positive impact of increasing mobility.

Some minor alterations in the residential pattern in the urbanizing area of San José may occur due to more extensive ETB, TRAM or Bus service. The improved linkages between the residential areas and major employment centers may encourage more residential development on the southern side of the city. Similarly, better access to major employment centers from areas outside central San José would increase the choice of residential locations for people who depend upon transit. As a result, some change in place of residence to areas outside central San José may occur.

Transfer Stations

These stations would primarily serve as transfer areas for riders traveling to and from San José, as well as riders who would transfer between different modes of transportation (e.g., LRT to buses, ETB to LRT, or buses to and from the suburbs). In general terms, the transfer stations would favor the development of local communities. The emphasis on a multiple-center route structure in the proposed plan would have a positive influence in reinforcing the development of identifiable local communities. This form of development respects the autonomy of local communities to develop as independent units.

The potential development activities around transfer stations are summarized below:

- Stations, such as San Pedro/University, Desamparados, Colón, Guadalupe, the Atlantic and the Pacific stations, would probably strengthen commercial concentrations that already exist. The proposed express route system would tend to strengthen the concentration of commercial development at existing locations by providing a fast and convenient service to these established areas. Major commercial centers include the downtown area, the San Pedro Mall, and the central areas of Guadalupe and Desamparados. Clustering intensive activities at these key locations would have a positive influence in establishing focal points that would generate additional, mutually supporting activities. An increase in development is expected around these proposed stations.

- The transfer stations at Alajuela, Cartago, San Juan, San Sebastián, Escazú, Hatillo, Zapote, San Rafael, San Isidro, and San Francisco present a residential character in the surrounding areas. That character may be subject to changes on a long-term scale. Such transfer stations could face potential development for service, small commerce, and related development in the immediate area.

- The transfer stations at the airport currently presents low density areas and croplands. Due to the increasing traffic demand from the international airport to downtown San José, the area surrounding this stations is subject to change. The proposed transfer stations might induce new commercial development in its surrounding area.

I.2.8 Energy Requirements

Costa Rica currently has a electrification coverage of 92.53%. Last year, the maximum energy demand at the national level was 871 MW. The sources of energy in Costa Rica vary and are allocated in the following way: 74.57 percent comes from hydroelectric plants, 15.37 percent from thermal plants, and 10.06 percent from geothermal production. The national capacity installed for energy production is 782,163 kW hydroelectric, 249,540 kW thermal energy, 55,000 kW geothermal sources, 4,000 kW private thermal plants, and 4,497 kW private hydroelectric; for a total of 1,095,200 kW of which 525,000 kW are generated by CNFL.

CNFL, the largest national distributor of electric energy, manages the market in the Central Valley where the city of San José and the largest concentration of population and industrial and commercial areas is located. CNFL operates 2,091 km of primary lines, 2,048 km of secondary lines, and has an installed capacity of distribution transformers of 785,816 kVA, which are fed from 19 strategically located substations.

CNFL's maximum energy capacity for 1995 was 525 MW and the maximum capacity for 1996 was 630 MW. Additionally, CNFL is about to complete the construction of a hydroelectric plant (Daniel Gutiérrez) that will add an additional 21 MW to the Central Valley area. The maximum energy demanded from CNFL in 1996 was 417 MW.

Calculations of Energy Requirements for the Proposed Systems

The operation of the LRT or the ETB system will require the supply of electric energy. For the purposes of this FEA, annual energy demands and annual maximum energy capacity were determined for each of the technologies operating along the rail ROW segments and the street segments. Based on these calculations, a preliminary evaluation of the potential energy requirements is possible. To evaluate the significance of energy requirements, CNFL's maximum energy capacity was compared to the annual maximum energy capacity required for the operation of each technology.

All estimates of energy requirements for LRT and ETB vehicle operation are based on preliminary operation data. Annual energy demand is estimated as the product of the number of kW hours per system's revenue kilometers, multiplied by the number of annual Car-Km. The number of kW-hours per system's revenue kilometer is a known factor for a given transit system. For example, the proposed LRT system requires 5.2 kW-hour per system's revenue kilometer. The proposed ETB system requires 4.7 kW-hour per system's revenue kilometer.

The annual maximum energy capacity needed for each system is determined by determining first the total number of kW-hours based on operational data for the peak hour:

Total kW hours = [kW hours per system's revenue kilometers] * [Route distance (km) * 2] * [# of Cars/Vehicle]

The total number of kW-hour is then multiplied by a form factor (1.6) and divided by 1000 to get maximum energy capacity needed for the systems in MW.

Energy Requirements for the Rail ROW segments

This section analyses specific energy requirements along the rail ROW for the two electric technologies proposed. Table I.2.8-1 presents the annual energy demands and the annual maximum energy capacity needed for the LRT system along the rail ROW.

Table I.2.8-1
Energy Requirements for LRT System along Rail ROW Segment

Rail ROW segment	Annual Energy Demand (MW)	Annual Maximum Energy Capacity (MW)
Heredia to San Pedro	5.0	7.3
Alajuela to San Pedro	18.4	26.0
Alajuela to Cartago	35.7	52.3
San Antonio de Belén to Pacific Station	8.9	12.8
Pavas to Pacific Station	2.2	3.2
Ciruelas to Pacific Station	15.3	21.9
Alajuela to Pacific Station		
- Via Ciruelas	26.2	37.7
- Via San Antonio de Belén	12.9	19.0
Atlantic Station to Pacific Station		
- double track	0.9	1.23
- single track	0.6	0.6

The operation of the entire LRT system (Alajuela to Cartago, Alajuela to Pacific Station (via Ciruelas) and Atlantic to Pacific (double track)) is projected to approximately require an annual maximum capacity of 91 MW. This represents less than 15 percent of the generating capacity available from CNFL last year and is not considered a significant impact. No new generating capacity will be required for implementation of the LRT system.

Table I.2.8-2 presents the annual energy demands and the maximum energy capacity needed for the ETB system along the rail ROW.

Table I.2.8-2
Energy Requirements for ETB System along Rail ROW Segment

Rail ROW segment	Annual Energy Demand (MW)	Annual Maximum Energy Capacity (MW)
Heredia to San Pedro	5.1	7.6
Alajuela to San Pedro	19.4	28.7
Alajuela to Cartago	38.3	57.3

The annual maximum energy capacity for the operation of the entire ETB system along the rail ROW (Alajuela-Cartago) is approximately 57.3 MW. This represents approximately 9 percent of the generating capacity available from CNFL last year and is not considered a significant impact.

Energy Requirements along the Street Segments

This section analyses specific energy requirements along the street segments for the two technologies studied. Table I.2.8-3 presents the annual energy demands and annual maximum energy capacity needed for the ETB system along the street segments.

Table I.2.8-3
Energy Requirements for ETB System along Street Segments

Street segment	Annual Energy Demand (MW)	Annual Maximum Energy Capacity (MW)
Pavas to San Pedro	10.0	14.7
Tibas to Pacific Station	1.8	2.7
Paso Ancho to Pacific Station	1.4	2.2
Desamparados to Pacific Station	2.7	4.1
Moravia to Atlantic Station	1.8	2.7
Alajuelita to Hatillo to Pacific Station	2.3	3.4

The operation of the ETB system along the street segment is projected to require approximate a maximum energy capacity of 29.8MW. This represents less than five percent of the generating capacity currently available from CNFL for 1996 and is not considered a significant impact. Just like in the operation of the LRT or ETB system along the rail ROW segments, no new generating capacity will be required for implementation of the ETB system.

Table I.2.8-4 presents the annual energy demands and annual maximum energy capacity needed for the LRT system along the Pavas to San Pedro segment.

Table I.2.8-4
Energy Requirements for LRT System along the Pavas to San Pedro Segment

Street segment	Annual Energy Demand (MW)	Annual Maximum Energy Capacity (MW)
Pavas to San Pedro	5.9	8.7

The operation of the LRT system across the Pavas to San Pedro street segment is projected to require a maximum energy capacity of 8.7 MW. This represents a very small percent of the generating capacity available from CNFL and is not considered a significant impact.

Potential Energy Impacts and Recommended Mitigation Measures

An energy impact is generally significant if the proposed project would result in a major increase in energy consumed for transportation. Maximum energy capacity needs for the different technologies are small compared to the existing generating capacity of CNFL. Therefore, no significant energy impacts are expected from the LRT or ETB system based on preliminary operation data. Therefore, no mitigation measures are needed. Given the relative size of the proposed transit system, the impact in terms of air emissions from energy facilities will also be minor because most of the energy supplied in San José comes from clean sources, such as hydroelectric and geothermal energy.

I.3 Summary of Environmental Consequences

This section presents a summary of the most important conclusions regarding environmental consequences, as identified in this EFA. The evaluation of these consequences is preliminary and consistent with the goals and objectives of a feasibility analysis. A more detailed environmental impact analysis will be required once the preferred segments and technologies of the proposed transit system for San José are selected. This section presents the summary of environmental consequences following the same sequence of impacts in Section 4.2.

Air Quality

The environmental benefits of clean transportation 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 most transit buses, 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.

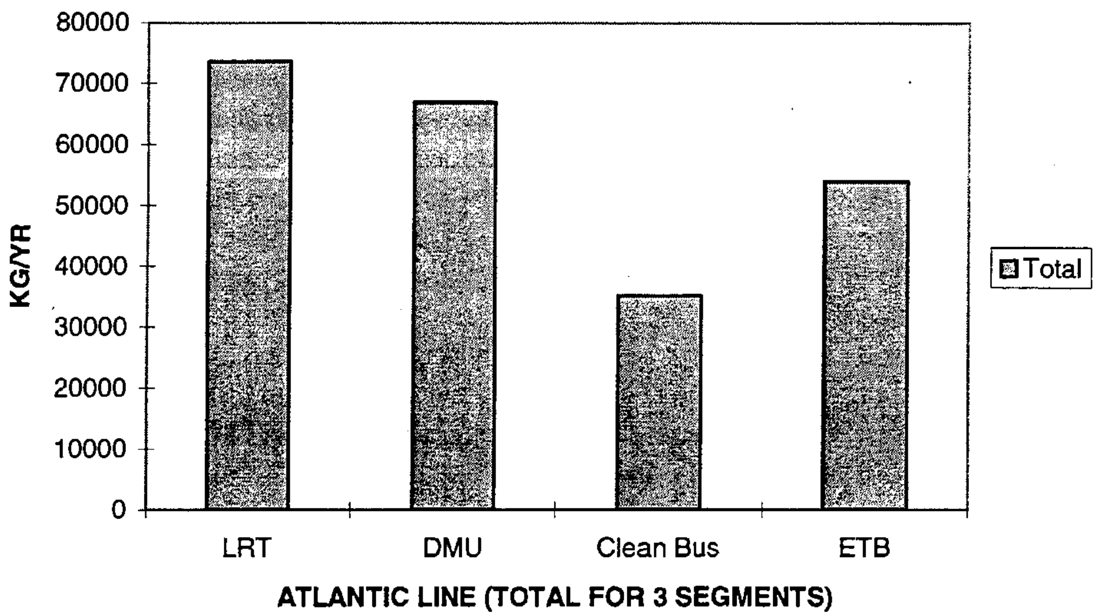
To place these results in context, we also studied the existing ambient pollutant monitoring data that have been collected for the metropolitan area. We compared these data with World Health Organization (WHO), U.S., and available Costa Rican standards for ambient air quality. With these comparisons, 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 U.S. 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. 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 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. Not surpassingly, the greatest benefits accrue from the electrical technologies of LRT. 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. 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. 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. 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.

Figure 4.3-1
Savings Impacts of Technologies on PM



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.

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 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. 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 vibration 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.

The implementation of any of the technological options analyzed for the 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. 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.

I.4 Recommendations and Next Steps

I.4.1 Environmental Requirements

The purpose of this section is to provide information on the general environmental requirements necessary to comply with Costarican environmental laws. Section 4.4.1.1 describes the requirements on how to present an Environmental Impact Statement (EIS, hereinafter EIA for "Estudio de Impacto Ambiental"). Section 4.4.1.2 describes the role of SETENA, the agency involved in overviewing the EIA process. Section 4.4.1.3 briefly explains the review process for EIAs. Section 4.4.1.4 explains how public participation occurs in Costa Rica, followed by Section 4.4.1.5 explaining the monitoring and enforcement.

I.4.1.1 Requirements on EIAs in Costa Rica

Section	Components of the Section
I. General Information	General Information - Basic Definitions - Definition of the Areas of Influence
II. General Information of the Project Owner that Will Perform the Activity and the Team that Will Elaborate the EIA	
III. Location and Timing of the Project	
IV. Environmental Diagnosis	A. Description of the Environment - Physical Medium (geology, geomorphology, soils, wheather, hydrological resources, including surface and groundwater, air quality, noise and vibration levels, and natural risks) - Biological Medium (environments, flora, and fauna) - Anthropological Medium (socio-economic, land use, communities, natural and cultural heritage) B. Spatial Representation of Environmental Issues
V. Detailed Description of the Project	Project Characteristics Activities To Be Executed (pre-operational, operational, and post-operational) Teams Project Schedule
VI. Evaluation of Environmental Risk	Spills and Releases of Hazardous Materials and Wastes
VIII. Mitigation for the Forecasted Impacts	Minimization Rehabilitation y/o Recuperation Compensation
IX. Contingency Plan	Logistical and Operational Plan
X. Environmental Management Systems, Monitoring Plans, Surveillance and Auditoring	Mitigation Plan
XI. Cost/Benefit Analysis and Environmental Cost of the Project	Positive and Negative Environmental Externalities
XII. Juridical Declaration and Environmental Team of the Project	Notarized Declaration and Official Commitment to Protect the Environment
XIII. Statement of the Environmental Impacts (DIA)	Public Participation Document

I.4.1.2 Agencies Involved

SETENA is the "Secretaría Técnica Nacional Ambiental," or the National Environmental Technical Secretary. SETENA is managed under the Ministry of the Environment and Energy of Costa Rica. SETENA exists as such office only for the past year approximately. However, a similar office existed for approximately eight years under different names, such as the Commission of Environmental Impact. The new SETENA office was created as a result of an environmental law (pers. comm. M. Chinchilla, 1997).

Any work at the national level, or any major work requires an EIA. According to Mr. Chinchilla from the SETENA office, if one or several of the components presented in this feasibility study would be developed in the San José Greater Metropolitan Area, it would probably require the preparation of an EIA.

I.4.1.3 Review Process

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. If an EIA is not required, the interested party would apply for a permit, or license, or concession to the Administrative Authorities and would start the project. On the other hand, if an EIA is required, a guide document on how to present an EIA should to be followed. The evaluating authority would have ten working days to decide if an EIA is necessary and notify the interested party. 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 firm and its subcontractors that would present the EIA document must be registered in SETENA. Registration only requires to fill out a form and to pay a small fee.

I.4.1.4 Public Participation

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 (pers. comm M. Chinchilla 1997).

I.4.1.5 Monitoring and Enforcement

An environmental regent must be nominated. The approved regent would implement the proposed mitigation measures and the interested party would actually apply them (pers. comm. M. Chinchilla 1997).

I.4.2 Feasibility of Further Air Quality Analyses

I.4.2.1 Air Quality Modeling

Air quality modeling is a useful supplement to air quality monitoring. Modeling studies provide indirect evidence of air quality, since values are calculated and one must rely on the quality of input data and the validity of modeling assumptions and model formulation. Despite their uncertainties, modeling approaches have several advantages over personal monitoring approaches:

- Temporal flexibility. Modeling can be performed for any past, present, or future year, whereas measurements reflect only current conditions.

- Source attribution. Individual sources and/or source categories can be tracked throughout the modeling process to yield information on the importance of each source or source category to overall exposures of the population to ambient contaminants.

- Consideration of hypothetical situations. Modeling can address situations such as impacts of planned facilities, controls on existing facilities, accidental releases, etc.

All of these advantages of modeling approaches assume that model results portray actual air quality conditions with a reasonable degree of accuracy. Thus, model evaluation is a key component to any modeling study.

This section presents an evaluation of the feasibility of conducting air quality modeling in Costa Rica for assessment of ozone, carbon monoxide, and particulate matter.

Modeling Systems

A prominent example of a gridded modeling system is the latest version of U.S.EPA's Urban Airshed Model (UAM). The U.S.EPA recommends that federal, state, and local agencies use this model to develop ozone air quality plans for urban areas. As a result this model has been applied in numerous cities throughout the United States. Recent widespread recognition of the model's capabilities has also prompted its use as part of a cost benefit analysis tool in many cities of Western Europe and in countries with developing economies.

The UAM is a three-dimensional photochemical grid model designed to calculate the concentrations of both inert and chemically reactive pollutants by simulating the physical and chemical processes in the atmosphere that affect pollutant concentrations. The basis for the UAM is the atmospheric diffusion or species continuity equation. This equation represents a mass balance in which all of the relevant emissions, transport, diffusion, chemical reactions, and removal processes are expressed in mathematical terms. The model is usually applied to a 48- to 96-hour period for photochemical events and shorter periods for inert pollutants during which adverse meteorological conditions result in elevated pollutant concentrations of the chemical species of interest.

The major factors that affect photochemical air quality include:

- The spatial and temporal distribution of emissions of NO_x and VOC (both anthropogenic and biogenic),
- The composition of the emitted VOC and NO_x,
- The spatial and temporal variations in the wind fields,
- The dynamics of the boundary layer, including stability and the level of mixing,
- The chemical reactions involving VOC, NO_x, and other important species,
- The diurnal variations of solar insolation and temperature,
- The loss of ozone and ozone precursors by dry deposition, and
- The ambient background of VOC, NO_x, and other species in such as precursors to the formation of secondary aerosols and toxics, immediately upwind and above the region of study.

The UAM simulates these processes when it is used to calculate ozone, NO_2, and other photochemical pollutant concentrations. It can also be used to simulate carbon monoxide (CO) concentrations or primary particulate matter concentrations in an urban area, simulations that involves no chemical reactions. For San José, the model could be applied to simulate all of the unreactive pollutants of concern (e.g., fine primary particulates, CO and diesel particulates) in a single model simulation. Newer versions of the model that are designed for simulating the formation of primary and secondary particulates are currently being tested by EPA.

The UAM is described in more detail in Appendix 4.B.

Emissions Data Requirements

The UAM requires spatially and temporally resolved estimates of anthropogenic, geogenic, and biogenic emissions in the modeling domain in order to predict air quality. Generally, total emissions for the domain will be estimated for an average day reflective of episodic conditions (e.g., average winter day or summer day, weekend or weekday). They are then allocated to individual modeling grid cells, which may be on the order of 1 km by 1 km in size, using some type of spatial allocation surrogate. The level of detail for such surrogates varies based upon the type of data available. As a default, population data (such as are collected for the regional TRANPLAN-type transportation models that currently exist for San José) may be used to spatially allocate emissions. The emissions are also allocated by hour of day using assumptions for the typical hourly activity of different industries. Very detailed assumptions for a broad range of emissions sources have been developed by air quality planning agencies in the U.S. and other countries and these could be extrapolated to Costa Rica if needed.

Although a comprehensive inventory of emissions and their sources does not currently exist for the SJMA, a greenhouse gas inventory that includes the standard pollutants required for UAM modeling has been developed for calendar year 1990. This inventory could serve as the foundation for an inventory representative of current conditions. Additional research would be required to identify missing sources in the inventory, although some indication of these omissions could be obtained by comparing the inventory with emission inventories developed for other urban air basins and correcting for differences in population and local industry characteristics.

It should be noted that, although the emission inventory requirements of the UAM can be intensive, qualitative approximations or indications of the relative importance of different emission sources and different pollutants can be obtained even with a preliminary, incomplete inventory. With these types of data, the model functions as a research, rather than planning, tool. More refined emission estimates are required in order to confidently quantify the benefits of emission control strategies with the UAM.

Other Data Requirements

The UAM simulates the emission, advection, and dispersion of precursors and the formation and deposition of ozone within every grid cell of the modeling domain (i.e., for the entire modeling domain). The successful and technically defensible simulation of ozone, NO_2 and other gaseous photochemical species formation and transport can be more easily accomplished with an enhanced meteorological data base. However, applications of the UAM in five U.S. cities[2] demonstrated that using routine[3] meteorological and air quality data for UAM input is feasible in less complex airsheds. More recent studies have shown that for more isolated locations (e.g., San José) in which transport and boundary conditions are relatively clean that the UAM is able to reliably simulate the formation, mixing and transport of ozone and ozone precursors within the modeling domain.[4]

Meteorological data. The UAM requires hourly estimates for the height of the mixed layer. Because ozone concentrations calculated by UAM may be sensitive to mixing heights,

[2] Systems Applications International, "A Low-Cost Application of the Urban Airshed Model to the City of St. Louis", SYSAPP-89/038, (1989); "Low-Cost Application of the Model to Atlanta and Evaluation of the Effects of Biogenic Emissions on Emission Control Strategies", SYSAPP-90/026 (1990); " Demonstration of Low-Cost Application of the UAM Model to the City of Atlanta and Dallas-Fort Worth Metroplex Regions", SYSAPP-89/122; "Evaluation of Practice-for-Low-Cost-Airshed-Application for Nonattainment Regions Applications of UAM to the St. Louis and Philadelphia Regions, SYSAPP-90/019 (1990).

[3] Routine - meaning air quality and meteorological data collected daily on a regular basis, not data collected as part of a special field study program

[4] Systems Applications International, "Photochemical Modeling of the Maricopa County Ozone Nonattainment Area", SYSAPP-94/079 (1994).

day-specific upper-air temperature and wind data are required at various times throughout the day to adequately estimate the evolution of the nighttime and daytime mixed layers. This data would be obtained from the routine upper-air measurements observed in San José and archived by the U.S. National Climatic Data Center (NCDC) under a cooperative upper-air data unit operation agreement. Other meteorological data required by the UAM include ambient temperature, water concentration (derived from relative humidity measurements), atmospheric pressure, solar radiation, and cloud cover. In addition, the UAM requires a fully three-dimensional wind field for each hour. Upper-level wind data are used to estimate the flow field throughout and above the urban boundary layer, and surface measurements throughout the domain provide data for the surface wind fields. The routine surface meteorological measurements made throughout the San José Metropolitan area would provide the needed measures of wind speed and direction, temperature, relative humidity, atmospheric pressure and cloud cover. Solar radiation is estimated by a UAM-preprocessor program based on latitude, time of year and time of day.

Observed air quality data. The use of UAM to adequately replicate the full three-dimensional structure of the atmosphere during an ozone episode requires a day-specific data base for input preparation. For UAM photochemical applications, the observed air quality data are used to estimate the initial condition field for ozone, NO_x, and volatile organic compounds (VOC). These data are also used to evaluate model predictions. For San José we would use observed air quality data (O_3, VOC, NO_x) to initiate the model. Where these data are lacking, we would use either default conditions based on historical ambient measurements under similar meteorological conditions or estimates based on measurements from other cities of similar size, topography and emission inventory for which we have data. For photochemical applications, the UAM is usually used to simulate a two- or three-day episode and the model simulation is started sometime during the early morning hours of the first day. This procedure is followed so that the peak model calculations are not affected by the assumed (and possibly errant) initial condition field. In addition to simulating ozone concentrations throughout the modeling domain, levels of NO and NO_2 calculated by the UAM can be evaluated with NO_x data from continuous samplers. Concentrations of reactive hydrocarbons are not required to run the model; however, in recent years measurements of reactive hydrocarbons have been used to check the modeled concentrations and the calculated hydrocarbon-to-NO_x ratios at various locations within the modeling domain.

For application of the UAM in an unreactive mode for CO or particulate matter, similar meteorological data is needed. However, only the air quality data for the specific species being simulated is needed for the initial conditions and model evaluation.

Surface roughness and deposition. In addition to meteorological and air quality estimates the model also needs estimates of the surface roughness and deposition factor for each grid cell. For San José, estimates of surface roughness and deposition would be determined from readily available maps of surface land-use data.

I.4.2.2 Valuation Of Health Benefits

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. These include:

- A cost/benefit analysis of environmental infrastructure projects for Coatzacoalcos, Mexico conducted for the World Bank by ICF Kaiser;

- Studies of external costs of electric utility resource selection in Nevada, conducted for Nevada Power Company and Sierra Power Company by ICF Kaiser and National Economic Research Associates;

- The development of the *Air Quality Valuation Model* for the California Energy Commission by Regional Economic Research, Inc.;

- *Coal Fuel Cycle: Estimation Methods, Impacts, and Values* conducted for the U.S. Department of Energy by Oak Ridge National Laboratory and Resources for the Future; and

- The *New York State Environmental Externalities Cost Study* conducted for the Empire State Electric Energy Research Corporation by RCG/Hagler, Bailly, Inc.

All of these studies use a damage function approach to estimate benefits and/or damages associated with changes in pollutant emissions. Typically, these estimates are made step-wise as follows:

1. Changes in air concentrations resulting from changes in pollutant emissions are estimated with an air quality dispersion model;
2. Changes in population exposure resulting from changes in air concentrations are estimated with a population exposure model;
3. Changes in incidence of excess mortality and/or morbidity resulting from changes in population exposure are estimated with a health risk model (i.e., an exposure-health risk relationship);
4. The value of changes in incidence of excess mortality and/or morbidity is estimated from willingness-to-pay (WPT) and cost-of-illness (COI) studies, described below.

Procedures for air quality dispersion modeling are discussed above. In this section information about population exposure assessment, health risk assessment, and valuing health risk damages and benefits is presented.

Population Exposure Assessment

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. Gridded air dispersion models discussed above can provide spatially and temporally resolved pollutant concentration estimates as input to population exposure models.

Characterization Of Population Exposure To Air Pollutants For application of an exposure-health risk relationship, exposure must be specified in same terms used to develop the relationship. With respect to the exposure indicator, the relationships based on epidemiological data discussed below use outdoor concentrations in the vicinity of an individual's residence as the indicator of exposure concentrations. This requires a relatively simple exposure model that combines spatial distributions of outdoor concentrations and residential populations, to estimate the number of individuals "exposed" to various pollutant concentration levels.

Relationships based on clinical studies of either humans or animals, on the other hand, use actual concentrations in proximity to the individual as the indicator of exposure. Application of these relationships requires estimation of exposure concentrations actually experienced by individuals as they move among locations and among indoor and outdoor environments. More complex population exposure models, such as NEM/SAI (Austin et al., 1988; Rosenbaum et al., 1988) and EPA's pNEM/O3 (Johnson et al., 1994), make these estimates on the basis of population time-activity data and microenvironment concentration data. An activity profile defines a schedule of movements among specified locations (e.g., indoors at home, outdoors at a neighborhood park) and activities (e.g., sleeping, walking the dog) for an individual over a period of time. The specified locations where the activities take place are referred to as microenvironments. A microenvironment is a location within which the pollutant concentration is assumed to be uniform at any point in time, although it may vary over time and may vary with the associated activity.

Utilization of some of the more advanced features of complex exposure models requires data on population activity patterns, population mobility, and the building inventory with respect to typical air infiltration rates for evaluation of indoor concentrations of outdoor-generated pollutants. Because most people spend more than 80 percent of their time indoors, and because indoor concentrations of outdoor-generated ozone and particulate matter are often significantly lower than ambient levels, accounting for time spent indoors generally produces a substantial reduction in estimates of population exposure. Accounting for population mobility can either increase or decrease estimates of population exposure depending upon the relationship between the distributions of population and ambient concentrations. Consequently, a complex model is expected to provide much more realistic estimates of population exposure than a simple exposure model.

With respect to the duration of relevant exposure, most of the exposure-health risk relationships described below pertain to either daily or annual average exposure concentrations. In both cases a full year of air quality data is required. If air quality changes are modeled only for episodic conditions (e.g., ozone) relative changes estimated for modeled conditions can be combined with monitored data to estimate annual changes.

Assessment of Population Exposure to Pollutant Concentrations in Costa Rica

The results of gridded air quality modeling of ozone and/or particulate matter in San José, Costa Rica can be used as inputs to a population exposure model. As noted above, 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.

If the health risk relationship is based on clinical data, additional information is required:

- typical diurnal patterns of population subgroups as they move among indoor, outdoor, and in-vehicle microenvironments

- typical diurnal patterns of population subgroups as they move among geographic areas

- either typical ratios between outdoor and indoor pollutant concentrations for various types

- of buildings, or typical air exchange rates for various types of buildings from which such ratios can be derived

These types of data are available for the U.S. population and typical U.S. buildings in various areas. U.S. EPA has recently completed the National Human Activity Pattern Survey (NHAPS), a two-year probability based telephone interview survey of 9,386 individuals to ascertain time, location, and other characteristics of activities which are most relevant to estimating pollutant exposure (Nelson and Rodon-Naveira, 1996).

There are some published studies which address typical population activity patterns internationally, e.g., fraction of time spent indoors. Most research generally shows similarities between urban populations, so that U.S. data for warmer climates could be used for Costa Rica, if site-specific data is unavailable. Estimates of diurnal movement of populations among geographic areas may be derived from travel pattern data, that is likely to be available from the development of mobile source emission inventories for air quality modeling. Typical air exchange rates may be derived from information on the distribution of air-conditioning technology, if available.

Also as noted above, if air quality changes are modeled only for episodic conditions, they will need to be combined with monitoring data to project air quality changes, and thus exposure concentration changes, throughout the year.

Exposure-Health Risk Relationships

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 studies include Schwartz and Dockery (1992a,b), Schwartz (1991, 1993), Dockery et al. (1992), and Pope et al. (1992). 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 U.S. 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 U.S. 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 U.S. 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.

Valuation of Health Benefits

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. There have also been some contingent valuation studies where subjects have been asked their WPT to reduce risks of fatal accidents. In addition, a few studies have estimated costs associated with observed behaviors that reduce risk, such as use of automobile seat belts and smoke detectors. Surveys of such studies for the U.S. have found estimates for the value of a "statistical life" (i.e., the WTP to reduce population risk by a small amount that is expected to eliminate one excess death in the population on average) that range from $1 million to more than $10 million. Refinements to application of these values include accounting for life expectancy of the population at risk.

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. However, WPT estimates are not available for every health impact of interest.

WPT and COI values are likely to vary from geographically, so that extrapolation from the U.S. 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.

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APPENDIX I-A

Average Air Quality Impacts of Urban Buses

Local meteorological data for the SJMA were collected and used to evaluate the contribution to ambient pollutant levels along roadway intersections that might be attributed to urban buses, under generic modeling conditions. The meteorological patterns used in the modeling are summarized in Figures A1A-1 and A1A-2. Two levels of bus emissions were evaluated, representing current and possible future emission factors. Contributions to ambient pollution during bus cruise and idling were also evaluated. The results are summarized in Tables A1A-1 to A1A-3.

The values in these tables, expressed in micrograms PM10 per cubic meter of air, represent the ambient concentrations people located within the transit corridors might be exposed to during peak travel periods when there is a relatively steady flux of buses moving through the corridors. Both average concentrations and maximum, or worst location, concentrations are shown. The per vehicle concentrations reflect the potential reduction in ambient levels of PM that would result from removal of an hour of, for example, bus idling in a transit corridor.

Figure A1A-1

Average Hourly Wind Speed - San Jose

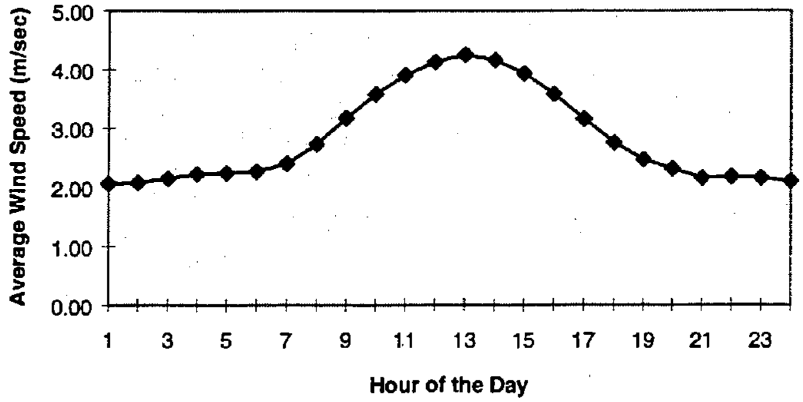


Figure A1A-2

Number of Calm Hours: San Jose

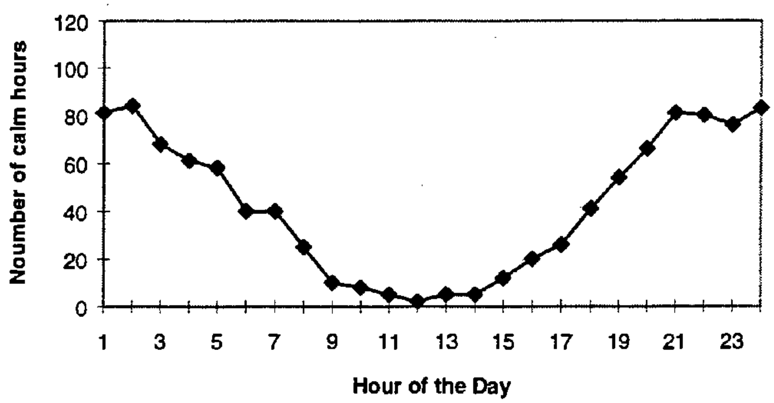


Table AIA-1
Summary of CAL3QHCR modeling results: One idling vehicle scenario - Per vehicle hourly PM average concentrations

		Current emission factor				Future emission factor				
Hour	**NB**	**SB**	**WB**	**EB**	**AVG**	**NB**	**SB**	**WB**	**EB**	**AVG**
1	0.6933	0.8226	0.6493	0.6660	0.7078	0.0644	0.0766	0.0606	0.0617	0.0658
2	0.6680	0.7936	0.6368	0.6350	0.6834	0.0620	0.0740	0.0594	0.0590	0.0636
3	0.6757	0.8045	0.6445	0.6431	0.6920	0.0628	0.0751	0.0601	0.0597	0.0644
4	0.6647	0.7891	0.6382	0.6334	0.6814	0.0618	0.0736	0.0593	0.0587	0.0634
5	0.6694	0.7944	0.6449	0.6385	0.6868	0.0620	0.0740	0.0600	0.0590	0.0638
6	0.6652	0.7867	0.6561	0.6333	0.6853	0.0618	0.0734	0.0608	0.0587	0.0637
7	0.6575	0.7828	0.6309	0.6241	0.6738	0.0610	0.0729	0.0589	0.0580	0.0627
8	0.5963	0.7080	0.5597	0.5779	0.6105	0.0551	0.0656	0.0523	0.0536	0.0567
9	0.5039	0.5989	0.4660	0.5182	0.5218	0.0462	0.0552	0.0424	0.0479	0.0479
10	0.4148	0.4941	0.3858	0.4460	0.4352	0.0378	0.0450	0.0342	0.0408	0.0395
11	0.3706	0.4325	0.3394	0.3992	0.3854	0.0337	0.0390	0.0297	0.0365	0.0347
12	0.3409	0.3989	0.3152	0.3746	0.3574	0.0310	0.0357	0.0274	0.0342	0.0321
13	0.3229	0.3829	0.3022	0.3575	0.3414	0.0291	0.0339	0.0264	0.0325	0.0305
14	0.3510	0.4056	0.3258	0.3883	0.3677	0.0317	0.0361	0.0289	0.0355	0.0331
15	0.3711	0.4195	0.3419	0.4092	0.3854	0.0336	0.0376	0.0302	0.0374	0.0347
16	0.4238	0.4687	0.3836	0.4573	0.4334	0.0384	0.0420	0.0344	0.0417	0.0391
17	0.4907	0.5345	0.4286	0.5145	0.4921	0.0448	0.0487	0.0389	0.0472	0.0449
18	0.5606	0.6175	0.4871	0.5772	0.5606	0.0514	0.0567	0.0448	0.0533	0.0516
19	0.6216	0.7019	0.5408	0.6217	0.6215	0.0573	0.0647	0.0505	0.0575	0.0575
20	0.6547	0.7470	0.5797	0.6515	0.6582	0.0607	0.0693	0.0546	0.0605	0.0613
21	0.6780	0.7946	0.5989	0.6572	0.6822	0.0631	0.0740	0.0564	0.0611	0.0637
22	0.6788	0.7971	0.6104	0.6528	0.6848	0.0634	0.0740	0.0575	0.0608	0.0639
23	0.6937	0.8195	0.6337	0.6673	0.7036	0.0646	0.0766	0.0595	0.0622	0.0657
24	0.6907	0.8130	0.6378	0.6595	0.7003	0.0643	0.0758	0.0597	0.0614	0.0653

Table AIA-2
Summary of CAL3QHCR modeling results: One idling vehicle scenario - Per vehicle hourly PM maximum concentrations

		Current emission factor					Future emission factor			
Hour	NB	SB	WB	EB	MAX	NB	SB	WB	EB	MAX
1	14.53	14.53	7.76	7.18	14.53	0.99	1.35	0.67	0.72	1.35
2	14.05	14.05	8.06	6.75	14.05	0.97	1.31	0.63	0.75	1.31
3	14.35	14.35	8.21	6.87	14.35	1.00	1.34	0.64	0.77	1.34
4	13.98	13.98	8.22	6.63	13.98	0.97	1.30	0.61	0.77	1.30
5	14.03	14.03	8.36	6.64	14.03	0.97	1.31	0.62	0.78	1.31
6	13.77	13.77	8.97	6.38	13.77	0.96	1.28	0.59	0.84	1.28
7	13.92	13.92	8.14	6.63	13.92	0.97	1.30	0.62	0.76	1.30
8	12.49	12.49	5.94	7.04	12.49	0.78	1.16	0.66	0.55	1.16
9	10.49	10.49	3.32	7.60	10.49	0.51	0.98	0.71	0.30	0.98
10	8.47	8.47	3.53	7.57	8.47	0.48	0.79	0.71	0.33	0.79
11	7.07	7.07	3.39	6.77	7.07	0.43	0.66	0.63	0.31	0.66
12	6.47	6.47	3.34	6.42	6.47	0.41	0.61	0.60	0.31	0.61
13	6.37	6.37	3.23	6.29	6.37	0.40	0.59	0.58	0.30	0.59
14	6.49	6.49	3.34	6.17	6.49	0.38	0.60	0.57	0.31	0.60
15	6.42	6.42	3.44	6.12	6.42	0.37	0.60	0.57	0.32	0.60
16	6.83	6.83	3.31	6.16	6.83	0.37	0.64	0.57	0.31	0.64
17	7.55	7.55	2.91	6.47	7.55	0.41	0.70	0.60	0.27	0.70
18	9.22	9.22	3.03	6.54	9.22	0.47	0.86	0.61	0.28	0.86
19	11.20	11.20	4.25	6.92	11.20	0.66	1.05	0.64	0.39	1.05
20	12.32	12.32	5.07	7.12	12.32	0.76	1.15	0.66	0.47	1.15
21	13.79	13.79	5.89	7.39	13.79	0.90	1.28	0.69	0.55	1.28
22	13.93	13.93	6.37	7.30	13.93	0.92	1.30	0.68	0.59	1.30
23	14.37	14.37	7.09	7.28	14.37	0.97	1.34	0.68	0.66	1.34
24	14.12	14.12	7.50	6.91	14.12	0.97	1.32	0.64	0.70	1.32

Table AIA-3
Summary of CAL3QHCR modeling results: pass-through scenario - Per vehicle hourly PM average concentrations

	Current emission factor				Future emission factor		
	Hourly	Intersection	Per Veh	Max	Hourly	Per Veh	Max
Hour	Conc	Traffic Vol	Conc	Conc	Conc	Conc	Conc
1	6.7114	216	0.0310	.118	0.2255	0.0010	0.0074
2	6.4853	216	0.0300	.1168	0.2157	0.0010	0.0073
3	6.5621	216	0.0303	.1194	0.2179	0.0010	0.0074
4	6.4764	216	0.0299	.1179	0.2157	0.0010	0.0072
5	6.5334	216	0.0302	.119	0.2166	0.0010	0.0074
6	6.5475	216	0.0303	.1211	0.2166	0.0010	0.0074
7	38.3111	1298	0.0295	.1075	1.4042	0.0011	0.0050
8	75.2676	2700	0.0279	.0842	2.9161	0.0011	0.0038
9	30.2495	1298	0.0233	.0835	1.1059	0.0009	0.0041
10	20.5662	1038	0.0198	.0813	0.7506	0.0007	0.0043
11	14.6749	831	0.0177	.0788	0.5326	0.0006	0.0045
12	13.6601	831	0.0164	.0747	0.4947	0.0006	0.0043
13	13.0461	831	0.0157	.0715	0.4736	0.0006	0.0041
14	14.0383	831	0.0169	.0736	0.5086	0.0006	0.0042
15	18.4051	1038	0.0177	.0718	0.6720	0.0006	0.0039
16	25.7480	1298	0.0198	.0732	0.9423	0.0007	0.0038
17	61.6087	2700	0.0228	.0740	2.3636	0.0009	0.0034
18	43.5662	1731	0.0252	.0867	1.6102	0.0009	0.0041
19	35.5758	1298	0.0274	.0940	1.3028	0.0010	0.0043
20	25.0588	865	0.0290	.0956	0.9172	0.0011	0.0043
21	6.4335	216	0.0297	.1041	0.2178	0.0010	0.0065
22	6.4707	216	0.0299	.1071	0.2203	0.0010	0.0068
23	6.6503	216	0.0307	.1128	0.2256	0.0010	0.0071
24	6.6284	216	0.0306	.1139	0.2235	0.0010	0.0072

APPENDIX I-B
DESCRIPTION OF THE URBAN AIRSHED MODEL

The latest version of U.S.EPA's Urban Airshed Model (UAM) contains Version IV of the Carbon-Bond Chemical Mechanism (CB-IV). The U.S.EPA, recommends that federal, state, and local agencies use this model to develop ozone air quality plans for urban areas. As a result this model has been applied in numerous cities throughout the United States. Recent widespread recognition of the models capabilities has also prompted it's use as part of a cost benefit analysis tool in many cities of Western Europe and in countries with developing economies.

Conceptual Overview of The Model

The UAM is a three-dimensional photochemical grid model designed to calculate the concentrations of both inert and chemically reactive pollutants by simulating the physical and chemical processes in the atmosphere that affect pollutant concentrations. The basis for the UAM is the atmospheric diffusion or species continuity equation. This equation represents a mass balance in which all of the relevant emissions, transport, diffusion, chemical reactions, and removal processes are expressed in mathematical terms. The model is usually applied to a 48- to 96-hour period for photochemical events and shorter periods for inert pollutants during which adverse meteorological conditions result in elevated pollutant concentrations of the chemical species of interest.

The major factors that affect photochemical air quality include:

- The spatial and temporal distribution of emissions of NO_x and VOC (both anthropogenic and biogenic),
- The composition of the emitted VOC and NO_x,
- The spatial and temporal variations in the wind fields,
- The dynamics of the boundary layer, including stability and the level of mixing,
- The chemical reactions involving VOC, NO_x, and other important species,
- The diurnal variations of solar insolation and temperature,
- The loss of ozone and ozone precursors by dry deposition, and
- The ambient background of VOC, NO_x, and other species in, immediately upwind, and above the region of study.

The UAM simulates these processes when it is used to calculate summertime ozone, NO_2 and other photochemical pollutant concentrations. It can also be used to simulate wintertime carbon monoxide (CO) concentrations in an urban area, a simulation that involves no chemical reactions. In the model, the species continuity equation is solved in four steps: (1) advection/diffusion is solved in the x-direction, (2) advection/diffusion is solved in the y-direction, (3) emissions are injected and vertical advection/diffusion is solved, and (4) chemical transformations are performed for reactive pollutants. The UAM performs this four-step procedure during each time step. The maximum time step is a function of the grid size and the maximum wind velocity. Typical time steps for urban-scale photochemical simulations are on the order of 3 to 6 minutes.

Because the UAM accounts for spatial and temporal variations as well as differences in the reactivity (speciation) of emissions, it is ideally suited for evaluating the effects of emission control scenarios on urban air quality. This is accomplished by first replicating a historical ozone or NO_2 episode to establish a base case simulation. Model inputs are prepared from observed meteorological, emission, and air quality data for a particular day or days. The model is then applied with these inputs and the results are evaluated to determine its performance. Once the model results have been evaluated and determined to perform within prescribed levels, the same meteorological inputs and a projected emission inventory can be used to simulate possible future emission scenarios. That is, the model will calculate hourly ozone, NO_2 patterns likely to occur under the same meteorological conditions as those in the base case.

History Of The Uam Model Development

The UAM has been under continual development for over 25 years, involving more than 100 person-years of technical effort. It has been supported by many organizations, with the U.S.EPA providing most of the financial support. Several other public and private organizations have contributed to the substantial effort of demonstrating the utility of the UAM to investigate complex ozone air quality management issues.

The history and development of mathematical photochemical models, particularly the UAM, has been paced by advances along three fronts.

- The scientific front, which is governed by the scientific community's acceptance of a suitable formulation, of supporting algorithms that represent pertinent physical and chemical processes, and of measurement methods and data bases that support parameter estimation and model performance evaluations.

- The regulatory front, which is governed by the relevance and practicality of the UAM to evolving regulatory programs and by acceptance of decision makers.

- The computing technology front, which is governed by the availability (to air quality modelers) of computing systems capable of large-scale numerical modeling, by the transportability of the UAM to those systems, and by the UAM being relatively "friendly" to users.

Since 1969, when the UAM was first conceived, substantial changes across all three fronts have occurred and the model has continued to undergo substantial improvements. Most notable advancements and recognized improvements in the past five years for air quality modeling specific to the needs for the greater Metropolitan of San José are:

- The model has been extended to apply for relatively unreactive pollutants (e.g., CO and primary particulates) during episodic conditions conducive to high concentrations,

- The widespread acceptance by regulators and decision makers regarding the use of the tool to make informed decisions about the cost benefit of emission reduction programs,

- The availability of the model for application on a personnel computer platform.

The model is widely recognized by the international air quality community as the premier modeling tool for photochemical modeling. The model has been applied in a number of research studies throughout Western Europe and Japan to simulate ozone and NO_2. It is now being applied as an application tool for decision makers to make informed decisions for assessing the effectiveness of control strategy programs. The model has also been successfully applied in countries with developing economies including: Mexico City, Taipei and Keelung, Taiwan. As a result of this earlier work, we are confident about the feasibility of applying the UAM to the greater San José Metropolitan Area.

APPENDIX I-C
PHOTOGRAPHS OF SENSITIVE AREAS

Photo I-1, Cables in Downtown San José

Photo I-2, La Sabana Metropolitan Park

Photo I-3, Plaza la Democracia

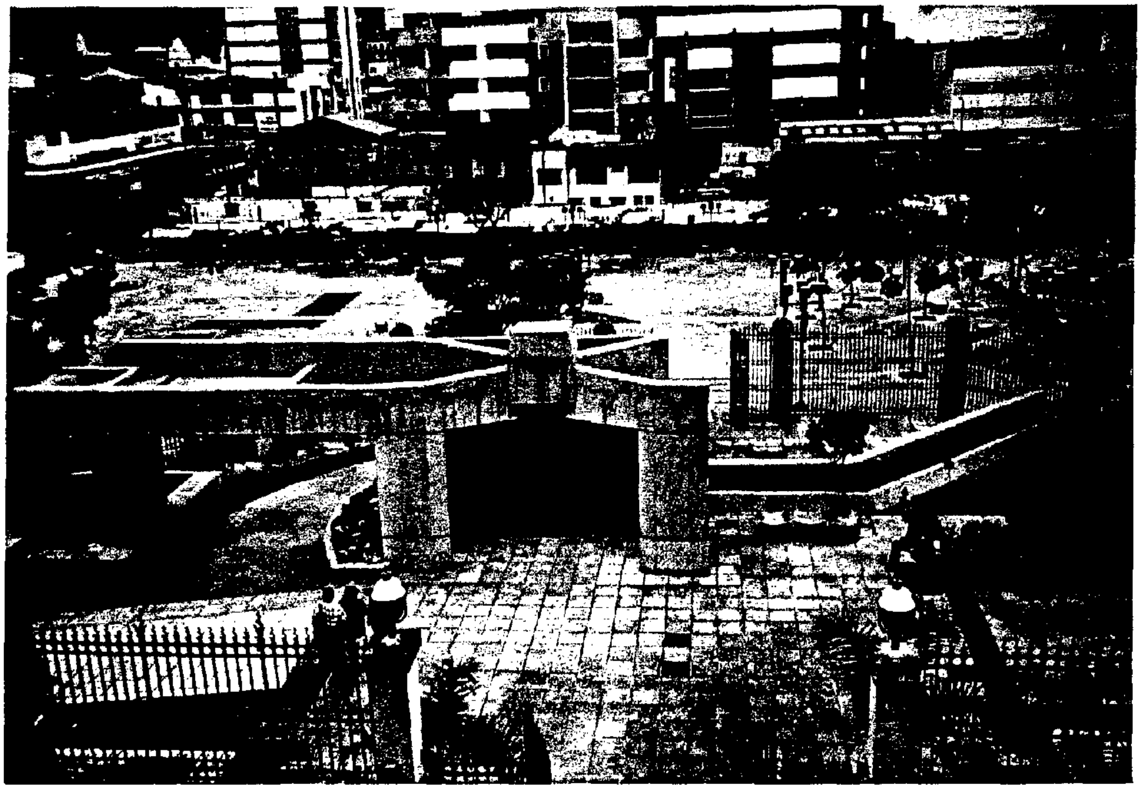
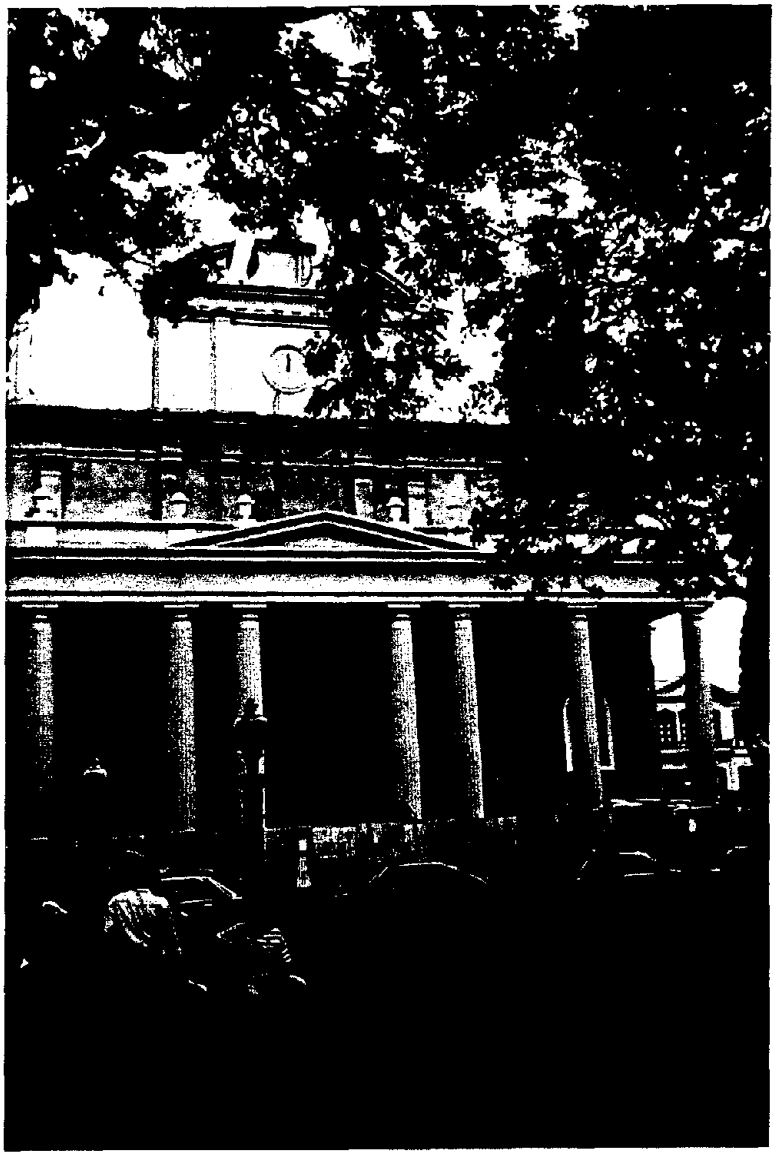


Photo I-4, National Museum of Costa Rica

Photo I-5, Nacional Theater

Photo I-7, Encroachment on the Atlantic Line

Photo I-6, National Cathedral



APPENDIX II

CORRIDOR AND TECHNOLOGY DATA PROVIDED TO WORK GROUPS AT SEMINAR/WORKSHOP AND WORKSHEETS FOR EACH GROUP

Route

HEREDIA TO SAN PEDRO

Route length Km	11			
Peak hour boardings / Km	394.5			
Compound annual growth rate (1996-2015)	4.7%			
1996 fares (Colones)	65	70	95	
Corridor population	20,049			
Relative Income index	1.9			

	LRT/TRAM	DMU	ETB	BUS
Total Capital Cost ($ million)	$232.3	$232.4	$80.7	$36.5
Annualized capital cost (millions)	$29.4	$29.6	$11.1	$5.5
Annual O&M Cost (millions)	$0.9	$0.9	$1.0	$0.5
Total Annual Cost (millions)	$30.4	$30.4	$12.1	$6.0
Total Annual Cost/Passenger-km	$627	$628	$250	$124
Break-Even Fare (colones @ 220/$)	629	627	232	107
Environment:				
Air	100	99	100	70
Noise				
Relocation/displacement				
Visual				
Traffic Interference				
Utilities Interference				
Land Use				

Route

ALAJUELA TO SAN PEDRO

Route length Km	23			
Peak hour boardings / Km	349.4			
Compound annual growth rate (1996-2015)	4.7%			
1996 fares (Colones)	90	110	120	150
Corridor population	37,127			
Relative Income index	1.9			

	LRT/TRAM	DMU	ETB	BUS
Total Capital Cost ($ million+B63)	$422.0	$407.7	$151.0	$66.1
Annualized capital cost (millions)	$53.4	$52	$20.7	$9.9
Annual O&M Cost (millions)	$3.4	$3	$3.8	$2.0
Total Annual Cost (millions)	$56.8	$55	$24.5	$11.9
Total Annual Cost/Passenger-km	$303	$293	$131	$63
Break-Even Fare (colones @ 220/$)	635	612	635	116
Environment:				
Air	100	99	74	78
Noise				
Relocation/displacement				
Visual				
Traffic Interference				
Utilities Interference				
Land Use				

Route

ALAJUELA TO CARTAGO

Route length Km	41.4	
Peak hour boardings / Km	534.1	
Compound annual growth rate (1996-2015)	3.5%	
1996 fares (Colones)	170	230
Corridor population	266,773	
Relative Income index	1.7	

	LRT/TRAM	DMU	ETB	BUS
Total Capital Cost ($ million)	$587.5	$520.4	$204.3	$81.6
Annualized capital cost (millions)	$53.4	$66.1	$27.6	$12.0
Annual O&M Cost (millions)	$3.4	$6.1	$7.5	$4.0
Total Annual Cost (millions)	$56.8	$72.1	$35.1	$16.0
Total Annual Cost/Passenger-km	$303	$79	$38	$17
Break-Even Fare (colones @ 220/$)	635	295	136	58
Environment:				
Air	43	32	27	19
Noise				
Relocation/displacement				
Visual				
Traffic Interference				
Utilities Interference				
Land Use				

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Route

SAN ANTONIO DE BELEN TO PACIFIC STATION

Route length Km	16.0
Peak hour boardings / Km	776.6
Compound annual growth rate (1996-2015)	4.8%
1996 fares (Colones)	80
Corridor population	50,361
Relative Income index	1.9

	LRT/TRAM	DMU	ETB	BUS
Total Capital Cost ($ million)	$294.1	$285.2		
Annualized capital cost (millions)	$37.2	$36.3		
Annual O&M Cost (millions)	$1.6	$1.5		
Total Annual Cost (millions)	$38.9	$37.8		
Total Annual Cost/Passenger-km	$193	$187		
Break-Even Fare (colones @ 220/$)	281	272		
Environment:				
Air	76	74		
Noise				
Relocation/displacement				
Visual				
Traffic Interference				
Utilities Interference				
Land Use				

Route

PAVAS TO PACIFIC STATION

PAVAS TO PACIFIC STATION		137.547696
Route length Km	7.0	20.416
Peak hour boardings / Km	1674.8	
Compound annual growth rate (1996-2015)	4.8%	
1996 fares (Colones)	60	80
Corridor population	47,517	
Relative Income index	2.4	

	LRT/TRAM	DMU	ETB	BUS
Total Capital Cost ($ million)	$156.3	$158.2		
Annualized capital cost (millions)	$19.8	$20.1		
Annual O&M Cost (millions)	$3.4	$0.4		
Total Annual Cost (millions)	$23.2	$20.5		
Total Annual Cost/Passenger-km	$243	$246		
Break-Even Fare (colones @ 220/$)	155	156		
Environment:				
Air	81	60		
Noise				
Relocation/displacement				
Visual				
Traffic Interference				
Utilities Interference				
Land Use				

Route

CIRUELAS TO PACIFIC STATION

Route length Km	23.5	
Peak hour boardings / Km	591.3	
Compound annual growth rate (1996-2015)	4.8%	
1996 fares (Colones)	110	130
Corridor population	56,324	
Relative Income index	2.2	

	LRT/TRAM	DMU	ETB	BUS
Total Capital Cost ($ million)	$378.6	$352.7		
Annualized capital cost (millions)	$47.8	$44.8		
Annual O&M Cost (millions)	$2.8	$2.6		
Total Annual Cost (millions)	$50.7	$47.4		
Total Annual Cost/Passenger-km	$153	$143		
Break-Even Fare (colones @ 220/$)	328	305		
Environment:				
Air	68	50		
Noise				
Relocation/displacement				
Visual				
Traffic Interference				
Utilities Interference				
Land Use				

Route

ALAJUELA TO PACIFIC STATION VIA CIRUELAS

Route length Km	23.5	
Peak hour boardings / Km	611.4	
Compound annual growth rate (1996-2015)	4.8%	
1996 fares (Colones)	130	160
Corridor population	78,056	
Relative Income index	2.2	

	LRT/TRAM	DMU	ETB	BUS
Total Capital Cost ($ million)	$495.4	$456.5		
Annualized capital cost (millions)	$62.6	$58.0		
Annual O&M Cost (millions)	$4.9	$4.4		
Total Annual Cost (millions)	$67.4	$62.4		
Total Annual Cost/Passenger-km	$109	$101		
Break-Even Fare (colones @ 220/$)	315	290		
Environment:				
Air	49	36		
Noise				
Relocation/displacement				
Visual				
Traffic Interference				
Utilities Interference				
Land Use				

Route

ALAJUELA TO PACIFIC STA VIA SAN ANTONIO DE BELEN

Route length Km	22.0	
Peak hour boardings / Km	808.5	
Compound annual growth rate (1996-2015)	4.8%	
1996 fares (Colones)	130	160
Corridor population	72,092	
Relative Income index	2.2	

	LRT/TRAM	DMU	ETB	BUS
Total Capital Cost ($ million)	$357.6	$332.2		
Annualized capital cost (millions)	$45.2	$42.2		
Annual O&M Cost (millions)	$2.4	$2.2		
Total Annual Cost (millions)	$47.6	$44.4		
Total Annual Cost/Passenger-km	$120	$112		
Break-Even Fare (colones @ 220/$)	240	223		
Environment:				
Air	53	39		
Noise				
Relocation/displacement				
Visual				
Traffic Interference				
Utilities Interference				
Land Use				

Route

ATLANTIC TO PACIFIC STATIONS (SINGLE TRACK)

Route length Km	3.1
Peak hour boardings / Km	564.2
Compound annual growth rate (1996-2015)	4.1%
1996 fares (Colones)	30
Corridor population	42,822
Relative Income index	1.9

	LRT/TRAM	DMU	ETB	BUS
Total Capital Cost ($ million)	$61.0	$66.4		
Annualized capital cost (millions)	$7.8	$8.5		
Annual O&M Cost (millions)	$0.1	$0.1		
Total Annual Cost (millions)	$7.9	$8.6		
Total Annual Cost/Passenger-km	$1,448	$1,575		
Break-Even Fare (colones @ 220/$)	406	441		
Environment:				
Air	100	100		
Noise				
Relocation/displacement				
Visual				
Traffic Interference				
Utilities Interference				
Land Use				

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Route

ATLANTIC TO PACIFIC STATIONS (DOUBLE TRACK)

Route length Km	3.1
Peak hour boardings / Km	0.0
Compound annual growth rate (1996-2015)	0.0%
1996 fares (Colones)	30
Corridor population	42,822
Relative Income index	1.9

	LRT/TRAM	DMU	ETB	BUS
Total Capital Cost ($ million)	$115.8	$127.9		
Annualized capital cost (millions)	$14.7	$16.3		
Annual O&M Cost (millions)	$0.2	$0.1		
Total Annual Cost (millions)	$14.9	$16.5		
Total Annual Cost/Passenger-km	$2,731	$3,017		
Break-Even Fare (colones @ 220/$)	414	457		
Environment:				
Air	100	100		
Noise				
Relocation/displacement				
Visual				
Traffic Interference				
Utilities Interference				
Land Use				

Route

PAVAS TO SAN PEDRO (DIAMETRAL)

Route length Km	10.0
Peak hour boardings / Km	2049.5
Compound annual growth rate (1996-2015)	3.2%
1996 fares (Colones)	90
Corridor population	182,432
Relative Income index	2.2

	LRT/TRAM	DMU	ETB	BUS
Total Capital Cost ($ million)	$248.3		$128.6	$59.2
Annualized capital cost (millions)	$31.5		$18.3	$9.3
Annual O&M Cost (millions)	$1.1		$1.9	$1.0
Total Annual Cost (millions)	$32.6		$20.2	$10.3
Total Annual Cost/Passenger-km	$159		$99	$50
Break-Even Fare (colones @ 220/$)	145		81	38
Environment:				
Air	47		47	14
Noise				
Relocation/displacement				
Visual				
Traffic Interference				
Utilities Interference				
Land Use				

ETB

Route

PASO ANCHO TO PACIFIC STATION

Route length Km	3.5
Peak hour boardings / Km	658.6
Compound annual growth rate (1996-2015)	4.8%
1996 fares (Colones)	
Corridor population	88,880
Relative Income index	1.9

	LRT/TRAM	DMU	ETB	BUS
Total Capital Cost ($ million)			$52.5	
Annualized capital cost (millions)			$7.5	
Annual O&M Cost (millions)			$0.3	
Total Annual Cost (millions)			$7.8	
Total Annual Cost/Passenger-km			$951	
Break-Even Fare (colones @ 220/$)			270	
Environment:				
Air			100	
Noise				
Relocation/displacement				
Visual				
Traffic Interference				
Utilities Interference				
Land Use				

ETB

Route

TIBAS TO PACIFIC STATION

Route length Km	4.0
Peak hour boardings / Km	1161.4
Compound annual growth rate (1996-2015)	3.1%
1996 fares (Colones)	
Corridor population	134,915
Relative Income index	2.1

	LRT/TRAM	DMU	ETB	BUS
Total Capital Cost ($ million)			$57.1	
Annualized capital cost (millions)			$8.2	
Annual O&M Cost (millions)			$0.4	
Total Annual Cost (millions)			$8.5	
Total Annual Cost/Passenger-km			$460	
Break-Even Fare (colones @ 220/$)			149	
Environment:				
Air			100	
Noise				
Relocation/displacement				
Visual				
Traffic Interference				
Utilities Interference				
Land Use				

ETB

Route

DESAMPARADOS TO PACIFIC STATION

Route length Km 5.0
Peak hour boardings / Km 658.6
Compound annual growth rate (1996-2015) 3.1%
1996 fares (Colones)
Corridor population 217,722
Relative Income index 1.9

	LRT/TRAM	DMU	ETB	BUS
Total Capital Cost ($ million)			$70.1	
Annualized capital cost (millions)			$10.0	
Annual O&M Cost (millions)			$0.5	
Total Annual Cost (millions)			$10.5	
Total Annual Cost/Passenger-km			$112	
Break-Even Fare (colones @ 220/$)			46	
Environment:				
Air			100	
Noise				
Relocation/displacement				
Visual				
Traffic Interference				
Utilities Interference				
Land Use				

ETB

Route

MORAVIA TO ATLANTIC STATION

Route length Km	4.0
Peak hour boardings / Km	3962.4
Compound annual growth rate (1996-2015)	3.2%
1996 fares (Colones)	
Corridor population	189,837
Relative Income index	2.2

	LRT/TRAM	DMU	ETB	BUS
Total Capital Cost ($ million)			$57.7	
Annualized capital cost (millions)			$8.2	
Annual O&M Cost (millions)			$0.4	
Total Annual Cost (millions)			$8.6	
Total Annual Cost/Passenger-km			$136	
Break-Even Fare (colones @ 220/$)			115	
Environment:				
Air			100	
Noise				
Relocation/displacement				
Visual				
Traffic Interference				
Utilities Interference				
Land Use				

ETB

Route

ALAJUELITA-HATILLO-PACIFIC STATION

Route length Km	4.5
Peak hour boardings / Km	1493.4
Compound annual growth rate (1996-2015)	4.5%
1996 fares (Colones)	
Corridor population	125,354
Relative Income index	1.6

	LRT/TRAM	DMU	ETB	BUS
Total Capital Cost ($ million)			$64.4	
Annualized capital cost (millions)			$9.2	
Annual O&M Cost (millions)			$0.4	
Total Annual Cost (millions)			$9.6	
Total Annual Cost/Passenger-km			$315	
Break-Even Fare (colones @ 220/$)			115	
Environment:				
Air			100	
Noise				
Relocation/displacement				
Visual				
Traffic Interference				
Utilities Interference				
Land Use				

REVENUE

	Segment	New LRT				
		Annual Cost	O&M Costs	Required Revenue	Annual Ridership	Break Even Fee
1.	HEREDIA TO SAN PEDRO	$29,715,157	$1,391,393	$31,106,551	11,014,704	$2.82
2.	ALAJUELA TO SAN PEDRO	$53,709,871	$5,112,819	$58,822,690	20,397,600	$2.88
3.	ALAJUELA TO CARTAGO	$73,971,532	$9,924,320	$83,895,852	55,456,800	$1.51
4.	SAN ANTONIO DE BELEN TO PACIFIC STATION	$37,375,332	$2,464,077	$39,839,409	31,571,448	$1.26
5.	PAVAS TO PACIFIC STATION	$20,049,958	$599,992	$20,649,950	29,788,800	$0.69
6.	CIRUELAS TO PACIFIC STATION	$47,864,370	$4,265,703	$52,130,072	35,309,636	$1.48
7.	ALAJUELA TO PACIFIC STATION VIA CIRUELAS	$62,585,262	$7,276,726	$69,861,988	48,932,178	$1.43
8.	ALAJUELA TO PACIFIC STA VIA SAN ANTONIO DE BELEN	$45,531,735	$3,579,741	$49,111,476	45,193,989	$1.09
9a.	ATLANTIC TO PACIFIC STATIONS (DOUBLE TRACK)	$15,004,846	$238,707	$15,243,553	8,168,909	$1.87
9b.	ATLANTIC TO PACIFIC STATIONS (SINGLE TRACK)	$7,925,542	$157,698	$8,083,240	4,403,251	$1.84
11.	PAVAS TO SAN PEDRO (DIAMETRAL)	$32,799,282	$1,627,155	$34,426,437	51,189,600	$0.67

	Segment	New DMU				
		Annual Cost	O&M Costs	Required Revenue	Annual Ridership	Break Even Fee
1.	HEREDIA TO SAN PEDRO	$29,730,408	$1,391,393	$31,121,802	11,014,704	$2.83
2.	ALAJUELA TO SAN PEDRO	$51,827,331	$5,112,819	$56,940,150	20,397,600	$2.79
3.	ALAJUELA TO CARTAGO	$65,142,180	$9,924,320	$75,066,500	55,456,800	$1.35
4.	SAN ANTONIO DE BELEN TO PACIFIC STATION	$36,202,915	$2,464,077	$38,666,992	31,571,448	$1.22
5.	PAVAS TO PACIFIC STATION	$20,293,020	$599,992	$20,893,012	29,788,800	$0.70
6.	CIRUELAS TO PACIFIC STATION	$44,471,031	$4,265,703	$48,736,734	35,309,636	$1.38
7.	ALAJUELA TO PACIFIC STATION VIA CIRUELAS	$57,476,191	$7,276,726	$64,752,917	48,932,178	$1.32
8.	ALAJUELA TO PACIFIC STA VIA SAN ANTONIO DE BELEN	$42,190,822	$3,579,741	$45,770,563	45,193,989	$1.01
9a.	ATLANTIC TO PACIFIC STATIONS (DOUBLE TRACK)	$16,594,758	$238,707	$16,833,465	8,168,909	$2.06
9b.	ATLANTIC TO PACIFIC STATIONS (SINGLE TRACK)	$8,632,328	$157,698	$8,790,026	4,403,251	$2.00

	Segment	Busway				
		Annual Cost	O&M Costs	Required Revenue	Annual Ridership	Break Even Fee
1.	HEREDIA TO SAN PEDRO	$3,734,578	$1,391,393	$5,125,972	11,014,704	$0.47
2.	ALAJUELA TO SAN PEDRO	$6,765,706	$5,112,819	$11,878,525	20,397,600	$0.58
3.	ALAJUELA TO CARTAGO	$7,806,584	$9,924,320	$17,730,904	55,456,800	$0.32
11.	PAVAS TO SAN PEDRO (DIAMETRAL)	$6,920,122	$1,627,155	$8,547,277	51,189,600	$0.17

	Segment	ETB on the Busway				
		Annual Cost	O&M Costs	Required Revenue	Annual Ridership	Break Even Fee
1.	HEREDIA TO SAN PEDRO	$11,136,345	$1,391,393	$12,527,738	11,014,704	$1.14
2.	ALAJUELA TO SAN PEDRO	$20,817,081	$5,112,819	$25,929,900	20,397,600	$1.27
3.	ALAJUELA TO CARTAGO	$28,329,036	$9,924,320	$38,253,356	55,456,800	$0.69

	Segment	ETB				
		Annual Cost	O&M Costs	Required Revenue	Annual Ridership	Break Even Fee
1.	TIBAS TO PACIFIC STATION	$7,702,115	$1,391,393	$9,093,508	11,578,800	$0.79
2.	PASO ANCHO TO PACIFIC STA	$7,076,063	$5,112,819	$12,188,882	5,851,200	$2.08
3.	DESAMPARADOS TO PACIFIC STA	$9,508,400	$9,924,320	$19,432,721	46,970,400	$0.41
4.	MORAVIA TO ATLANTIC STATION	$7,825,648	$2,464,077	$10,289,724	39,610,800	$0.26
5.	ALAJUELITA TO HATILLO TO PACIFIC STATION	$8,741,659	$599,992	$9,341,650	17,013,600	$0.55
11.	PAVAS TO SAN PEDRO (DIAMETRAL)	$17,335,383	$1,627,155	$18,962,538	51,189,600	$0.37

COSTA RICA STUDY - BUSWAY (CLEAN DIESEL) CAPITAL COST ESTIMATES

SEGMENT: HEREDIA TO CURRIDABAT | **ROUTE KM = 14.0**

ITEM	COST CATEGORY	QNTY	UNIT	UNIT COST	TOTAL COST	CR ADJ	ADJUSTED COST	REMARKS	LIFESPAN (YEARS)	ANNUALIZATION FACTOR	ANNUALIZED COST
1	USED TRACK, 100#-112# CWR	14.6	KM	$400,000	$5,840,000		$5,840,000	CONCRETE TIES	15	0.1710	$998,740
2	USED TURNOUT, #6-10 - SIDINGS	8	KM	$30,000	$240,000		$240,000	4 SDGS @ I50M EA	15	0.1710	$41,044
3	ASPHALT BUSWAY - 2 LANE	14	KM	$500,000	$7,000,000	x	$4,200,000	W/SIDE BARRIERS	10	0.1993	$836,859
4	TRAFFIC INTERSECTN SIGNALS	45	EACH	$90,000	$4,050,000		$4,050,000		30	0.1523	$616,816
5	REHAB BRIDGE, + WOOD DECK	9	EACH	$60,000	$540,000	x	$324,000	AVG LGTH= 30 M	30	0.1523	$49,345
6	NEW CULVERT	1	EACH	$10,000	$10,000	x	$6,000	SAN AGUSTIN	30	0.1523	$914
7	NEW CROSS DRAINAGE	42	EACH	$2,500	$105,000	x	$63,000	3 PER KM	30	0.1523	$9,595
8	NEW STATION - TERMINAL	2	EACH	$50,000	$100,000	x	$60,000		30	0.1523	$9,138
9	NEW STATION - INTERMEDIATE	5	EACH	$15,000	$75,000	x	$45,000		30	0.1523	$6,854
10	REHAB EXISTING STATION	1	EACH	$100,000	$100,000	x	$60,000	ATLANTIC STATION	30	0.1523	$9,138
11	COMMUNICATIONS SYSTEMS	66	BUS	$20,000	$1,320,000		$1,320,000	ON BUS & WAYSIDE	15	0.1710	$225,743
12	FARE COLLECTION EQUIPMENT	66	BUS	$10,000	$660,000		$660,000	FAREBOX ON BUS	15	0.1710	$112,871
13	NEW BUS GARAGE/PARKING	66	BUS	$50,000	$3,300,000	x	$1,980,000		30	0.1523	$301,554
14	NEW CLEAN DIESEL BUS	66	EACH	$210,000	$13,860,000		$13,860,000	CAPACITY = 180	12	0.1845	$2,556,904
15	RIGHT-OF-WAY - URBAN		ACRE		$0						
16	RIGHT-OF-WAY - RURAL		ACRE		$0						
17	OTHER COST ITEM				$0						
18	OTHER COST ITEM				$0						

			ADJUSTED TOTAL		ADJUSTED AVERAGE	
SUBTOTAL AND AVERAGE COST PER KM		$37,200,000	$32,708,000	$2,657,143	$2,336,286	$5,775,513
DESIGN, CONSTRUCTION MGT, ETC.	20%	$7,440,000	$6,541,600			$1,155,103
CONTINGENCY (on total cost, only 10% on Buses)	25%	$9,081,000	$8,177,000			$1,443,878
TOTAL AND AVERAGE COST PER KM		$53,721,000	**$47,426,600**	$3,837,214	$3,387,614	$8,374,494

COSTA RICA STUDY - BUSWAY (CLEAN DIESEL) CAPITAL COST ESTIMATES

SEGMENT: PAVAS TO PACIFIC STATION **ROUTE KM = 7.0**

ITEM	COST CATEGORY	QNTY	UNIT	UNIT COST	TOTAL COST	CR ADJ	ADJUSTED COST	REMARKS	LIFESPAN (YEARS)	ANNUALIZATION FACTOR	ANNUALIZED COST
1	USED TRACK, 100#-112# CWR	7.3	KM	$400,000	$2,920,000		$2,920,000	CONCRETE TIES	15	0.1710	$499,370
2	USED TURNOUT, #10 - SIDINGS	4	KM	$30,000	$120,000		$120,000	2 SDGS @ 150M EA	15	0.1710	$20,522
3	ASPHALT BUSWAY - 2 LANE	7	KM	$500,000	$3,500,000	x	$2,100,000	W/SIDE BARRIERS	10	0.1993	$418,429
4	TRAFFIC INTERSECTN SIGNALS	23	EACH	$90,000	$2,070,000		$2,070,000		30	0.1523	$315,261
5	REHAB BRIDGE, + WOOD DECK	4	EACH	$60,000	$240,000	x	$144,000	AVG LGTH= 30 M	30	0.1523	$21,931
6	NEW CULVERT		EACH	$10,000	$0	x			30		
7	NEW CROSS DRAINAGE	21	EACH	$2,500	$52,500	x	$31,500	3 PER KM	30	0.1523	$4,797
8	NEW STATION - TERMINAL	1	EACH	$50,000	$50,000	x	$30,000		30	0.1523	$4,569
9	NEW STATION - INTERMEDIATE	2	EACH	$15,000	$30,000	x	$18,000		30	0.1523	$2,741
10	REHAB EXISTING STATION	1	EACH	$100,000	$100,000	x	$60,000	PACIFIC STATION	30	0.1523	$9,138
11	COMMUNICATIONS SYSTEMS	40	BUS	$20,000	$800,000		$800,000	ON BUS & WAYSIDE	15	0.1710	$136,814
12	FARE COLLECTION EQUIPMENT	40	BUS	$10,000	$400,000		$400,000	FAREBOX ON BUS	15	0.1710	$68,407
13	NEW BUS GARAGE/PARKING	40	BUS	$50,000	$2,000,000	x	$1,200,000		30	0.1523	$182,760
14	NEW CLEAN DIESEL BUS	40	EACH	$210,000	$8,400,000		$8,400,000	CAPACITY = 180	12	0.1845	$1,549,639
15	RIGHT-OF-WAY - URBAN		ACRE		$0						
16	RIGHT-OF-WAY - RURAL		ACRE		$0						
17	OTHER COST ITEM				$0						
18	OTHER COST ITEM				$0						

		TOTAL COST	ADJUSTED TOTAL		ADJUSTED AVERAGE	ANNUALIZED COST
SUBTOTAL AND AVERAGE COST PER KM		$20,682,500	$18,293,500	$2,954,643	$2,613,357	**$3,234,379**
DESIGN, CONSTRUCTION MGT, ETC.	20%	$4,136,500	$3,658,700			$646,876
CONTINGENCY (on total cost, only 10% on Buses)	25%	$4,944,750	$4,573,375			$808,595
TOTAL AND AVERAGE COST PER KM		$29,763,750	**$26,525,575**	$4,251,964	$3,789,368	**$4,689,849**

Monthly Volume in Thousands of Riders
Based on Bus Ridership Data

Percent Growth

Component	1994	1995	1996	1997	1998	1999	2000	2005	2010	2015	94-96	96 - 2000	2000-05	2005-10	2010-15
HEREDIA TO SAN PEDRO	1,387.7	918.8	904.8	917.9	935.7	979.0	1,032.9	1,380.9	1,757.0	2,166.3	-19.26%	3.37%	5.98%	4.94%	4.28%
ALAJUELA TO SAN PEDRO	2,569.9	1,701.5	1,675.5	1,699.8	1,732.8	1,813.0	1,912.8	2,557.2	3,253.7	4,011.7	-19.26%	3.37%	5.98%	4.91%	4.28%
ALAJUELA TO CARTAGO	5,992.1	4,605.7	4,610.7	4,621.4	4,652.7	4,801.9	4,996.1	6,260.8	7,554.3	8,828.7	-12.28%	2.03%	4.62%	3.83%	3.17%
SAN ANTONIO DE BELEN TO PACIFIC STATION	2,402.9	2,601.1	2,590.7	2,631.0	2,682.4	2,806.7	2,961.3	3,970.9	5,078.3	6,332.0	3.83%	3.40%	6.04%	5.04%	4.51%
PAVAS TO PACIFIC STATION	2,267.2	2,454.2	2,444.4	2,482.4	2,530.9	2,648.2	2,794.1	3,746.7	4,791.6	5,974.5	3.83%	3.40%	6.04%	5.04%	4.51%
CIRUELAS TO PACIFIC STATION	2,687.4	2,909.0	2,897.4	2,942.5	3,000.0	3,139.0	3,311.9	4,441.1	5,679.6	7,081.8	3.83%	3.40%	6.04%	5.04%	4.51%
ALAJUELA TO PACIFIC STATION VIA CIRUELAS	3,724.2	4,031.4	4,015.3	4,077.7	4,157.3	4,350.0	4,589.7	6,154.5	7,870.9	9,813.9	3.83%	3.40%	6.04%	5.04%	4.51%
ALAJUELA TO PACIFIC STA VIA SAN ANTONIO DE	3,439.7	3,723.4	3,708.5	3,766.2	3,839.7	4,017.7	4,239.1	5,684.3	7,269.6	9,064.2	3.83%	3.40%	6.04%	5.04%	4.51%
ATLANTIC TO PACIFIC STATIONS (DOUBLE TRAC	835.8	741.9	678.8	680.7	685.3	708.0	737.5	935.8	1,141.8	1,343.7	-9.88%	2.10%	4.88%	4.06%	3.31%
ATLANTIC TO PACIFIC STATIONS (SINGLE TRACK	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	1,225.4	1,008.0	968.6	964.9	965.1	990.6	1,025.4	1,265.6	1,508.1	1,730.9	-11.09%	1.43%	4.30%	3.57%	2.79%
PASO ANCHO TO PACIFIC STA	535.6	481.8	480.6	487.6	497.1	520.1	548.8	736.1	941.4	1,166.8	-5.27%	3.37%	6.05%	5.04%	4.39%
DESAMPARADOS TO PACIFIC STA	5,609.9	3,896.6	3,927.2	3,914.2	3,916.3	4,021.1	4,163.1	5,133.2	6,106.1	6,982.3	-16.33%	1.47%	4.28%	3.53%	2.72%
MORAVIA TO ATLANTIC STATION	4,543.6	3,713.7	3,304.7	3,300.9	3,309.5	3,404.9	3,531.8	4,395.4	5,270.0	6,059.7	-14.72%	1.68%	4.47%	3.70%	2.83%

Grupo

TABLA DE EVALUACION DE OPCIONES DEL SISTEMA DE TRANSPORTE MASIVO DE SAN JOSE

	Factores Econom.		Fact. Ambiental		Facilidad de Imple-mentacion agil		Reduccion en Im-portaciones Petroleo		Consideraciones Legales		Atractivo al Usuario		
	Peso______%		Peso______%		Peso______%		Peso______%		Peso______%		Peso______%		
Segmento/Tecnologia	Puntos	%xPuntos	Puntos	%xPuntos	Puntos	%xPuntos	Puntos	%xPuntos	Puntos	%xPuntos	Puntos	%xPuntos	TOTAL
1. Heredia-San Pedro													
LRT		0		0		0		0		0		0	0
DMU		0		0		0		0		0		0	0
ETB on Busway		0		0		0		0		0		0	0
Busway		0		0		0		0		0		0	0
2. Alajuela-San Pedro													
LRT		0		0		0		0		0		0	0
DMU		0		0		0		0		0		0	0
ETB on Busway		0		0		0		0		0		0	0
Busway		0		0		0		0		0		0	0
3. Alajuela-Cartago													
LRT		0		0		0		0		0		0	0
DMU		0		0		0		0		0		0	0
ETB on Busway		0		0		0		0		0		0	0
Busway		0		0		0		0		0		0	0
4. San Antonio de Belen-Estacion Pacifico													
LRT		0		0		0		0		0		0	0
DMU		0		0		0		0		0		0	0

Score: a number between 1 and 9 with 1 being low ranking and 9 being high ranking.
Weight: percentage factor for each category which totals 100%.

TABLA DE EVALUACION DE OPCIONES DEL SISTEMA DE TRANSPORTE MASIVO DE SAN JOSE

Segmento/Tecnologia	Factores Econom. Peso____%		Fact. Ambiental Peso____%		Facilidad de implementacion agil Peso____%		Reduccion en importaciones Petroleo Peso____%		Consideraciones Legales Peso____%		Atractivo al Usuario Peso____%		TOTAL
	Puntos	%xPuntos	Puntos	%xPuntos	Puntos	%xPuntos	Puntos	%xPuntos	Puntos	%xPuntos	Puntos	%xPuntos	
5. Pavas-Estacion Pacifico													
LRT		0		0		0		0		0		0	0
DMU		0		0		0		0		0		0	0
6. Ciruelas-Estacion Pacifico													
LRT		0		0		0		0		0		0	0
DMU		0		0		0		0		0		0	0
7. Alajuela - Pacifico por Ciruelas													
LRT		0		0		0		0		0		0	0
DMU		0		0		0		0		0		0	0
8. Alajuela - Pacifico por San Antonio de Belen													
LRT		0		0		0		0		0		0	0
DMU		0		0		0		0		0		0	0
9. Estacion Atlantico-Estacion Pacifico													
LRT		0		0		0		0		0		0	0
DMU		0		0		0		0		0		0	0

Score: a number between 1 and 9 with 1 being low ranking and 9 being high ranking.
Weight: percentage factor for each category which totals 100%.

TABLA DE EVALUACION DE OPCIONES DEL SISTEMA DE TRANSPORTE MASIVO DE SAN JOSE

	Factores Econom.		Fact. Ambiental		Facilidad de Imple-mentacion agil		Reduccion en Im-portaciones Petroleo		Consideraciones Legales		Atractivo al Usuario		
	Peso_____%		Peso_____%		Peso_____%		Peso_____%		Peso_____%		Peso_____%		
Segmento/Tecnologia	Puntos	%xPuntos	Puntos	%xPuntos	Puntos	%xPuntos	Puntos	%xPuntos	Puntos	%xPuntos	Puntos	%xPuntos	TOTAL
10. Pavas - San Pedro Diametral													
LRT/TRAM		0		0		0		0		0		0	0
ETB		0		0		0		0		0		0	0
BUS		0		0		0		0		0		0	0
11. Tibas-Pacifico													
ETB		0		0		0		0		0		0	0
12. Paso Ancho-Pacifico													
ETB		0		0		0		0		0		0	0
13. Desamparados-Pacifico													
ETB		0		0		0		0		0		0	0
14. Moravia-Atlantico													
ETB		0		0		0		0		0		0	0
15. Alajuelita-Hatillo-Pacifico													
ETB		0		0		0		0		0		0	0

Score: a number between 1 and 9 with 1 being low ranking and 9 being high ranking.
Weight: percentage factor for each category which totals 100%.

APPENDIX III

LIST OF PREVIOUS STUDIES AND OTHER IDEAS REVIEWED BY ICF KAISER

ICF Kaiser reviewed over 20 previous ideas and studies

#	Name of the Document	Author	Date	General Description of the Document
1	Feasibility Study of the Collective Transport Integrated System in the Metropolitan Area (Final Draft)	TRANSMESA (Alfredo Wesson)	January, 1996	This document analyzes the current bus system thoroughly and it proposes a new integrated system including diagonal, inter-sectorial, feeder, and radial routes, transfer stations, and an operation and control system.
2	Technical Evaluation of the Traffic Rearrangement Plan in Downtown San Jose	CNFL (National Company of Power and Light) and LCR LOGISTICA S.A.	September, 1996	Three alternatives were analyzed using SIATGAM (to estimate the projections of commuter demand and the distribution of traffic flow) and NETSIM (to analyze traffic operation). The plan recommends traffic rearrangements and pedestrian activity in 6 steps.
3	Master Plan of Urban Transport in the Greater Metropolitan Area 1992-2012	MOPT (Ministry of Public Works and transportation) (Leonardo Castro)	January, 1992	This document thoroughly analyzes the patterns of urban development, the regulations for transport, demand patterns, costs, and other for 1992 and projects it to 2012.
4	Feasibility Study of Massive Passenger Transport Through the Cartago-San Jose-Alajuela Line (Volumes I and II and Summary)	INCOFER (Costarican Institute of Railroads) and ELC ELECTROCONSULT (Italy)	May, 1986	This report analyzes the technical-economic feasibility of upgrading the railroad in the urban corridor of SJ to transport passengers along the Cartago-Alajuela line. Vol. I contains the report and maps. Vol. II contains the appendices.
5	Urban Management Plan: San Jose 2015: For a Pleasant, Livable, and Competitive City	San Jose Municipality	January, 1994	This document describes and analyzes the urban area, such as the transport problems, the proposal for each canton, a renovation of the downtown area, the recreational areas, the economy and tourism, and environmental conditions to improve it.
6	Background Project for an Electric Tram Line, Pavas-Curridabat (Technical Report)	MOPT, BCEOM-SOFRETU	July, 1984	This document analyzes the urban structure of SJ and its transport system. It includes traffic projections and proposes to restructure the bus network and to use an electric tram system.

ICF Kaiser reviewed over 20 previous ideas and studies

7	Urban Electric Transport	MAE (Ministry of the Environment and Energy), CNFL, and MOPT	October, 1996	It provides a brief description of the urban transport in the metro area, the administrative and leagal aspects for an LRT or an electric system, a cost analysis for TDA, a description of an electric transport system.
8	Revision of the CEFSA Economic Forecast 1996 and Economic Profile for 1997	CEFSA (Economic and Financial Advisors)	August, 1996	Economic analysis of Costa Rica for 1996 and 1997 using previous data on economic factors (inflation, devaluation, interest rates, gross internal product, salaries and prices, external debt).
9	Interurban Electric Transport, Workshop	CNFL	February, 1996	This document analyzes the existing characteristics of the SJ metro area, the existing railroad, and the demand for public transportation. It presents justifications for the need of an electric transport system.
10	Table containing data on public transportation routes in the metro area	Provided by Olga Villalobos, MOPT	Provided on Dec 16, 1996	This table contains the name and number for each bus route, the company that owns it, the person in charge, their telephone number, the condition (permit or concession), and the expiration date.
11	The State of the Nation in Sustainable Human Development	European Union, Defensoria de los Habitantes, CONARE, Estado de la Nacion, PNUD	1995	A detailed and objetive analysis of the Costarican population, using the most recent data from 1995.
12	Presentation by the President of Costa Rica, Ing. Jose Maria Figueres, to the Working Group Session on Urban Transport	Ing. Jose Maria Figueres	26-Sep-96	The president exposes his view on the Electric Vehicle (EV) and presents justifications for its use compared to the use of conventional vehicles. He presents a 5-year plan to implement it.

ICF Kaiser reviewed over 20 previous ideas and studies

13	Preliminary Study for the Railroad Upgrade Project in Costa Rica	Railroad Technical Service of Japan (JARTS)	March, 1992	It describes the 1992 situation of the whole railroad (Pacific and Atlantic lines) its operation and maintenance, a better administration for INCOFER, a description of the facilities and wagons, and future considerations.
14	Technical and Economic Feasibility of a Rehabilitation of the Costa Rican Railway and an Assessment of an Interurban Passenger Service Between Alajuela, San Jose, and Cartago	Canadian Pacific Consulting Services	February, 1989	This study examines the available alternatives for revitalization of the whole existing rail network operated by INCOFER. It describes the transport costs, demand data, operating and maintenance costs, and an economic analysis.
15	Table containing information on the bus routes for the SJ metro area.	Olman Bonilla, MOPT	15-Jan-97	It provides information on the bus routes, the owner, the bus fare, the monthly demand for each one, and the number of units.
16	Costa Rica, Calculation of the Population for Each Province, Canton, and District Till January 1996	Direction of Statistics for the Ministry of Economy, Industry, and Commerce	September, 1996	Population of Costa Rica: number of men and women for each Province, Canton, and District.
17	Tables With Information on the Population for the Metropolitan Area	Provided by the Department of Statistics	Undated	Information of the population for the SJ metropolitan area.
18	National Inventory of the Sources of Gases With a Green House Effect in Costa Rica	National Metereologic Institute	September, 1995	This document discusses the gas emissions of several sources, such as mobile sources, industrial sources, agricultural sources, and explains the land use in CR. The last chapter describes the total gas emissions.
19	Administrative Territorial Division of the Republic of Costa Rica	National Commission of Administrative Territorial Division	1993	It provides the area, population, altitude, location, rivers, etc for each province, canton, and district.

ICF Kaiser reviewed over 20 previous ideas and studies

20	Tables With the Population Projections for Each District	Latin-American Center of Demographics	February, 1990	The tables show the population projections for the years 1990, 1992, 1997, 2002, and 2012 for each district.
21	Traffic Rearrangement Plan	MOPT, CNFL, SJ Municipality, SWISS CONTACT, LCR LOGISTICA	December, 1996	This document explains the current traffic problems of SJ. It proposes to modify several traffic routes and provides maps showing the new rearrangement.
22	Notes on a Project to Build an Elevated Metro System	Ing. Ricardo Umana	1991	This document explains his view for a new transport system that includes a pedestrian walk-way, two rail loops, and other routes for private and public transport.
23	Pedestrian Activity, an Option for Urban Rescue	Eduardo Brenes Mata	1995	This book explains all the advantages that a city or town obtains when they increase the opportunities for pedestrian activity.
24	Metropolitan Regional Plan	Office of Planning for the Metropolitan Area	1983	It provides a description of the urban planning for the metropolitan area in 1983, including the industry, the environment, recreation, energy, and transport services.
25	Data on gas emissions measurements	Dr. Maria del Rosario Alfaro	1995	Three documents that include data on gas emissions measurements for the SJ metropolitan area.

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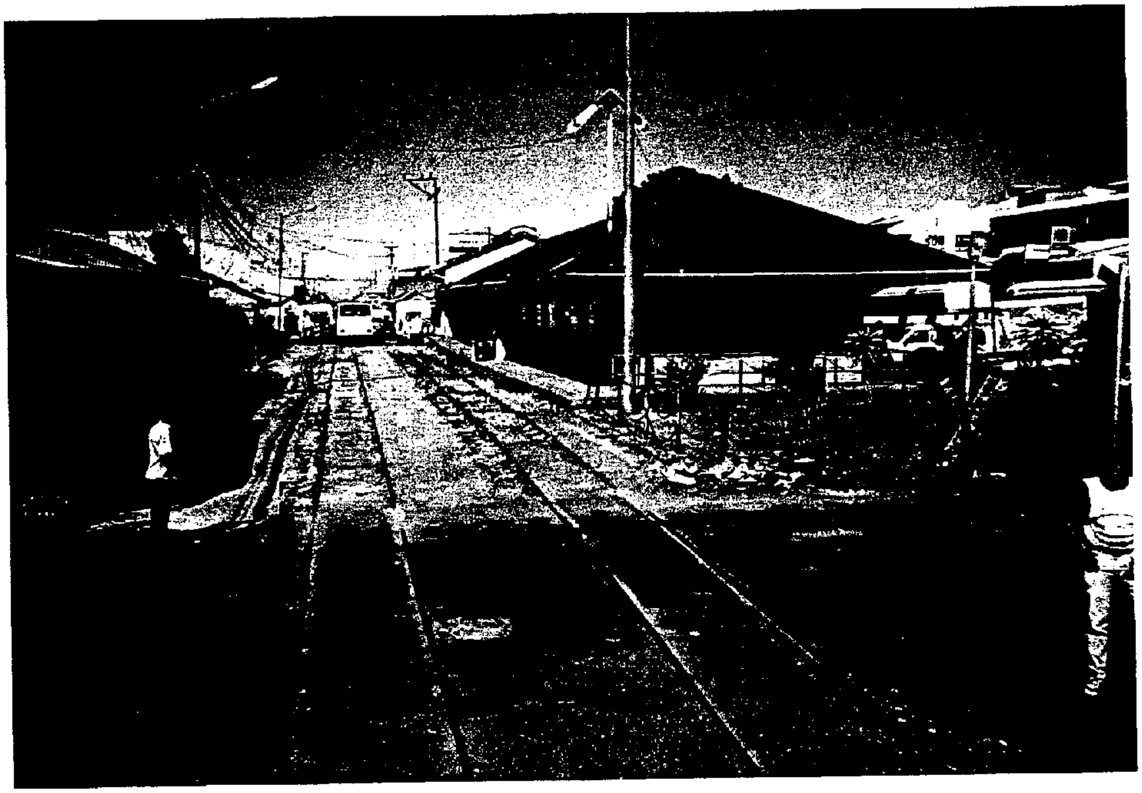
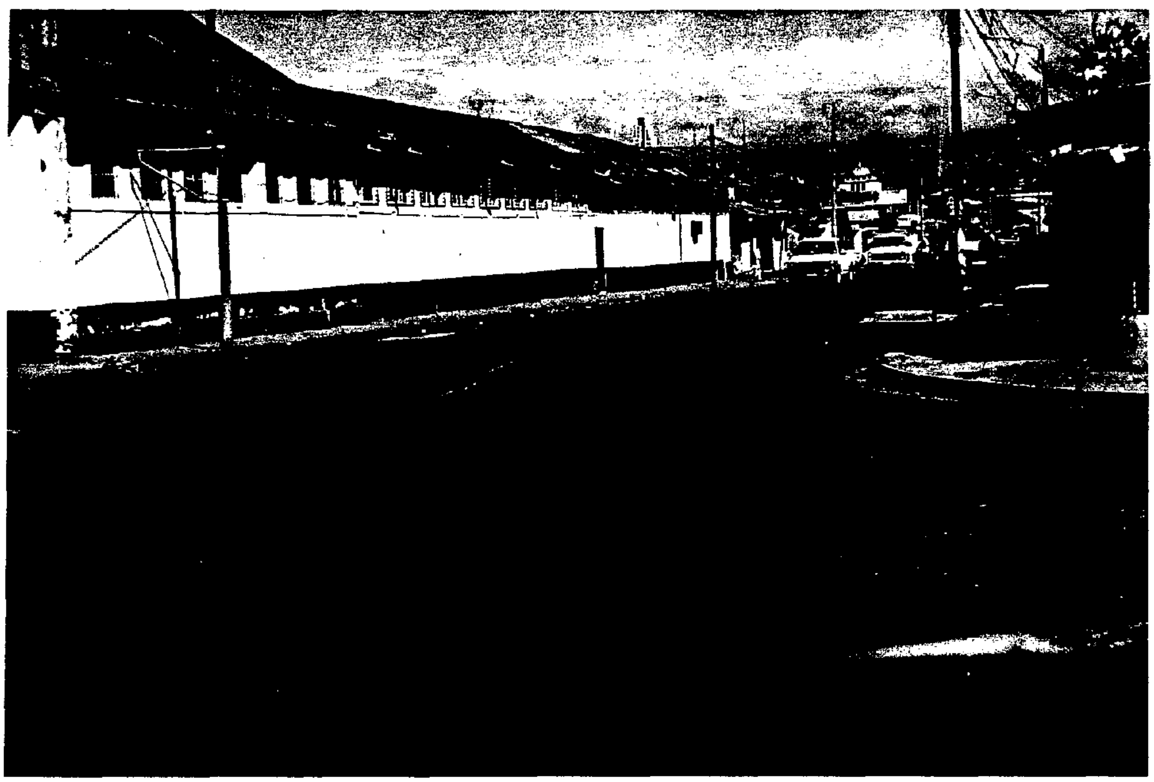
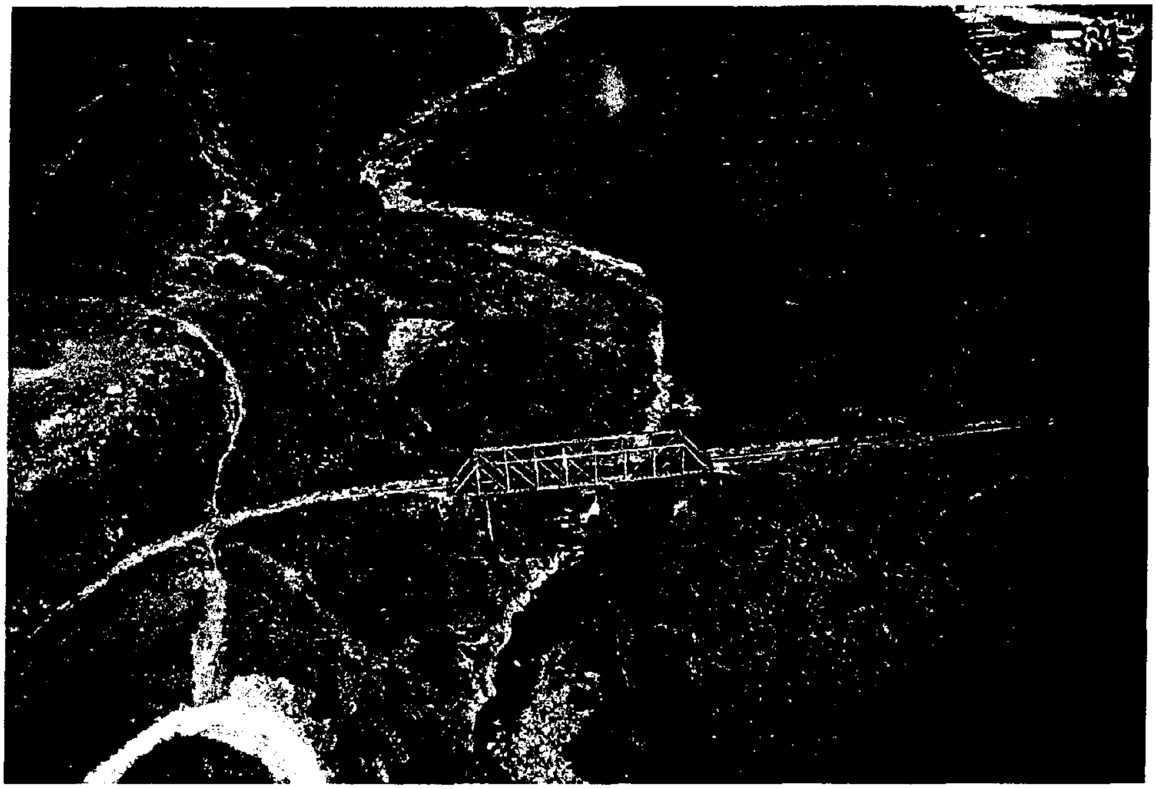
APPEN IX IV

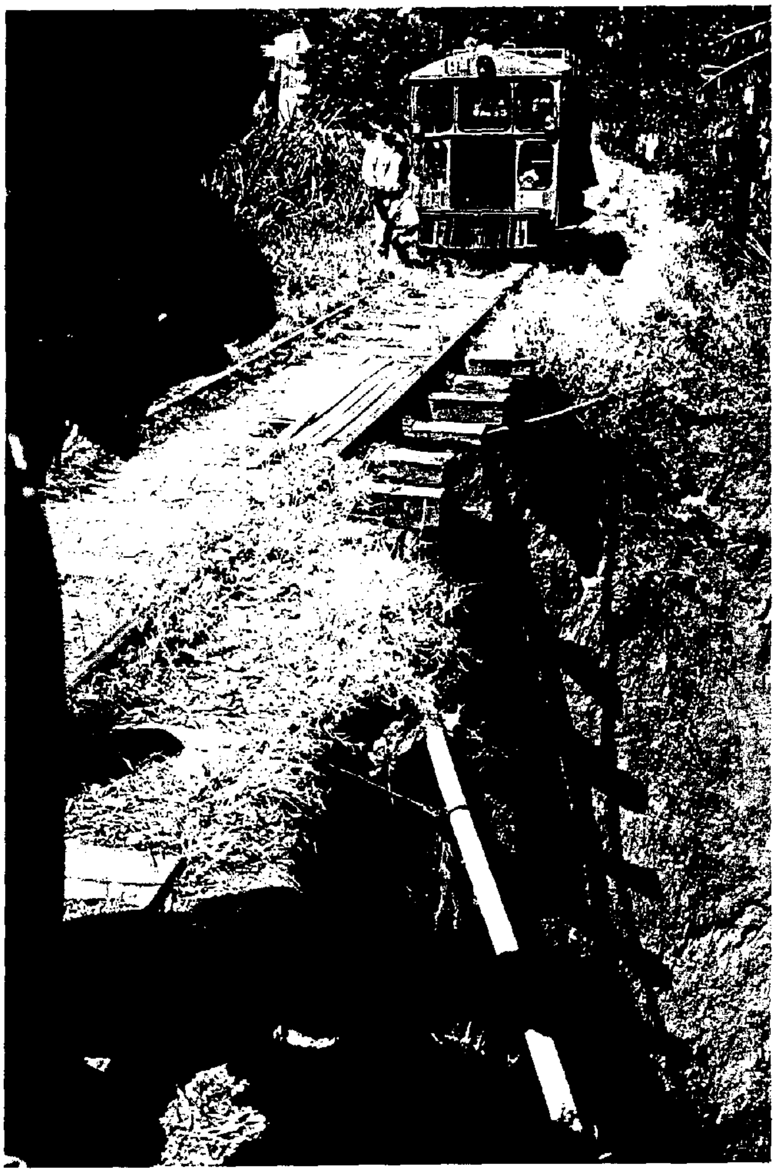
PHOTOGRAPHS OF THE RIGHT-OF-WAY

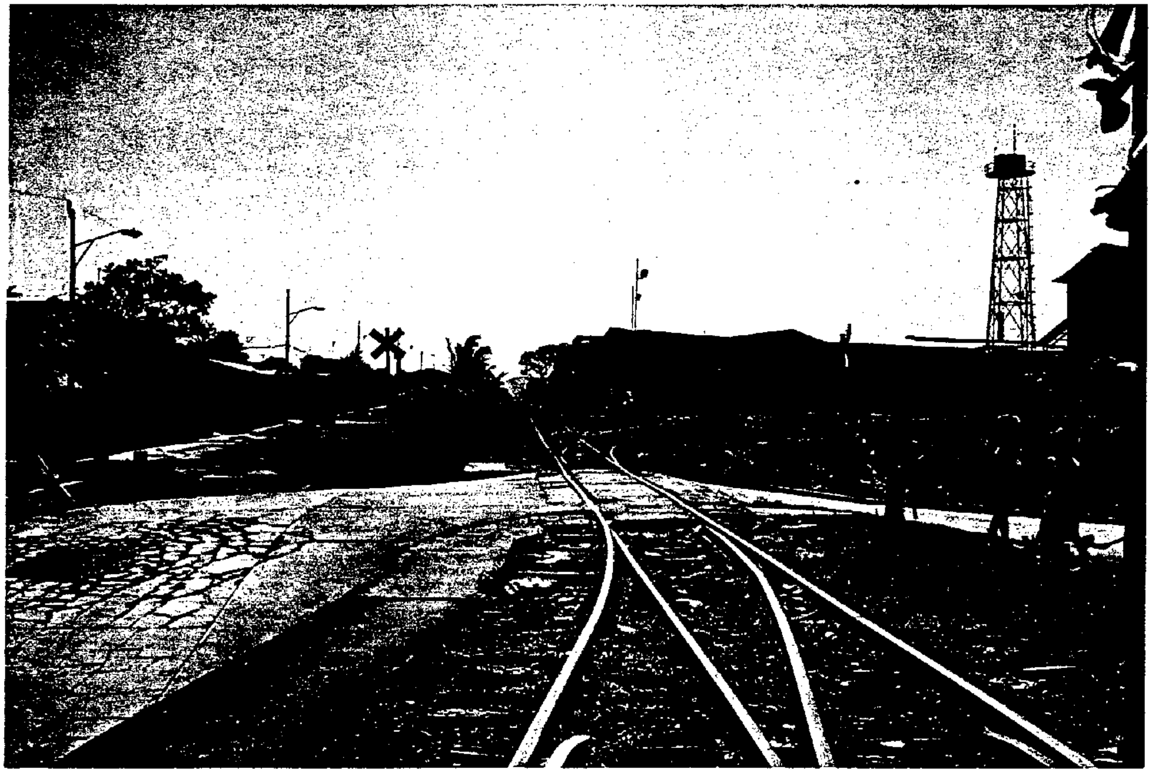
Photographs of INCOFER's Right-of-way from Heredia to Curridabat

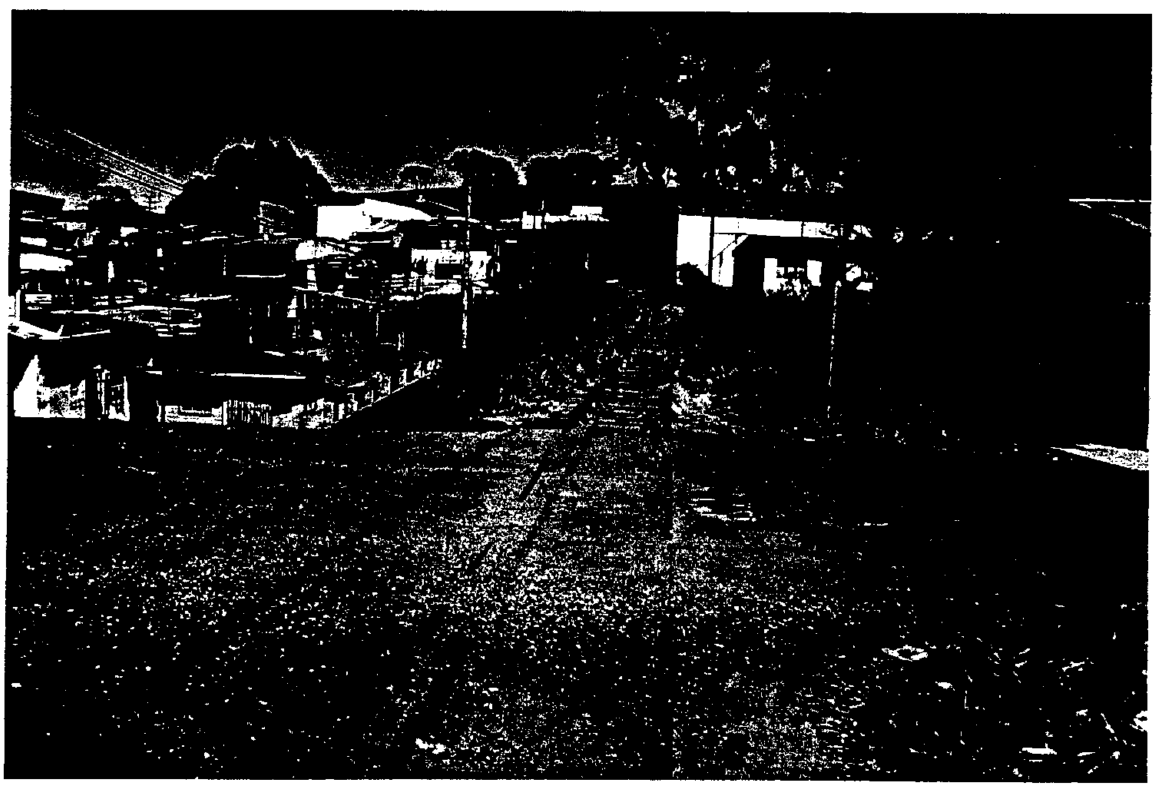


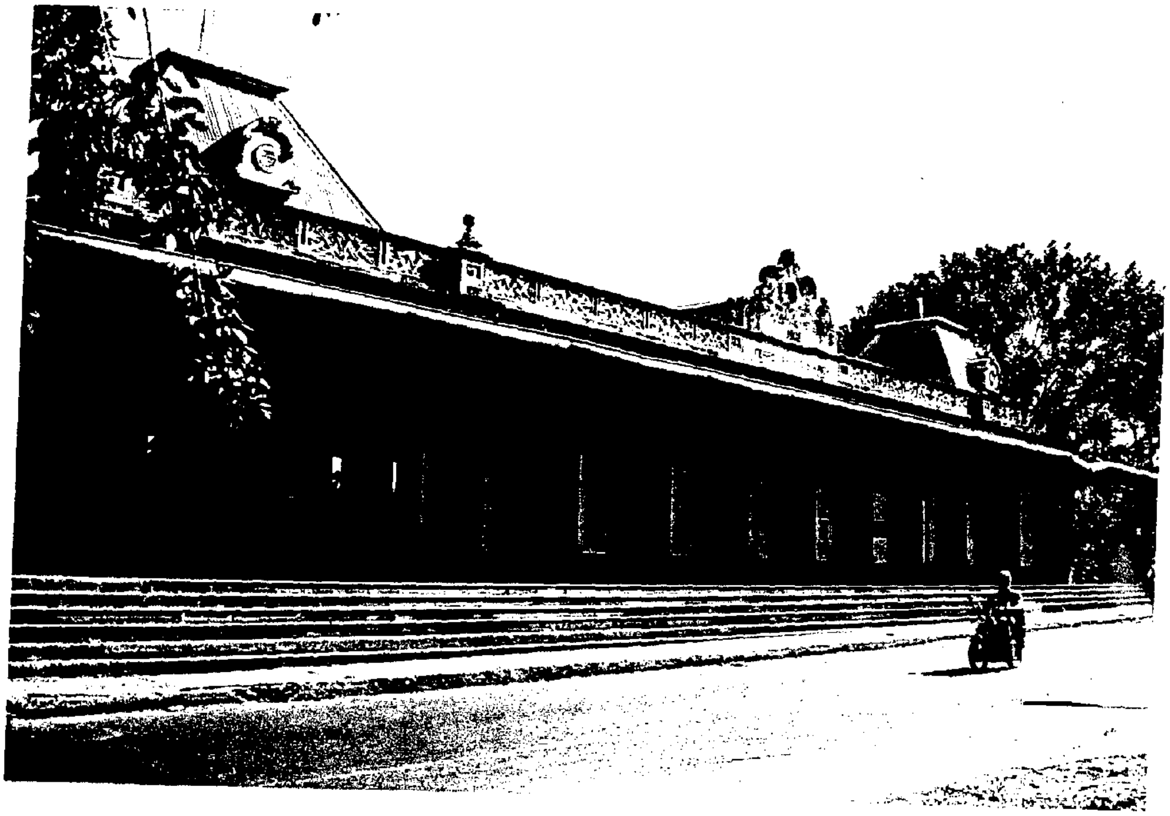










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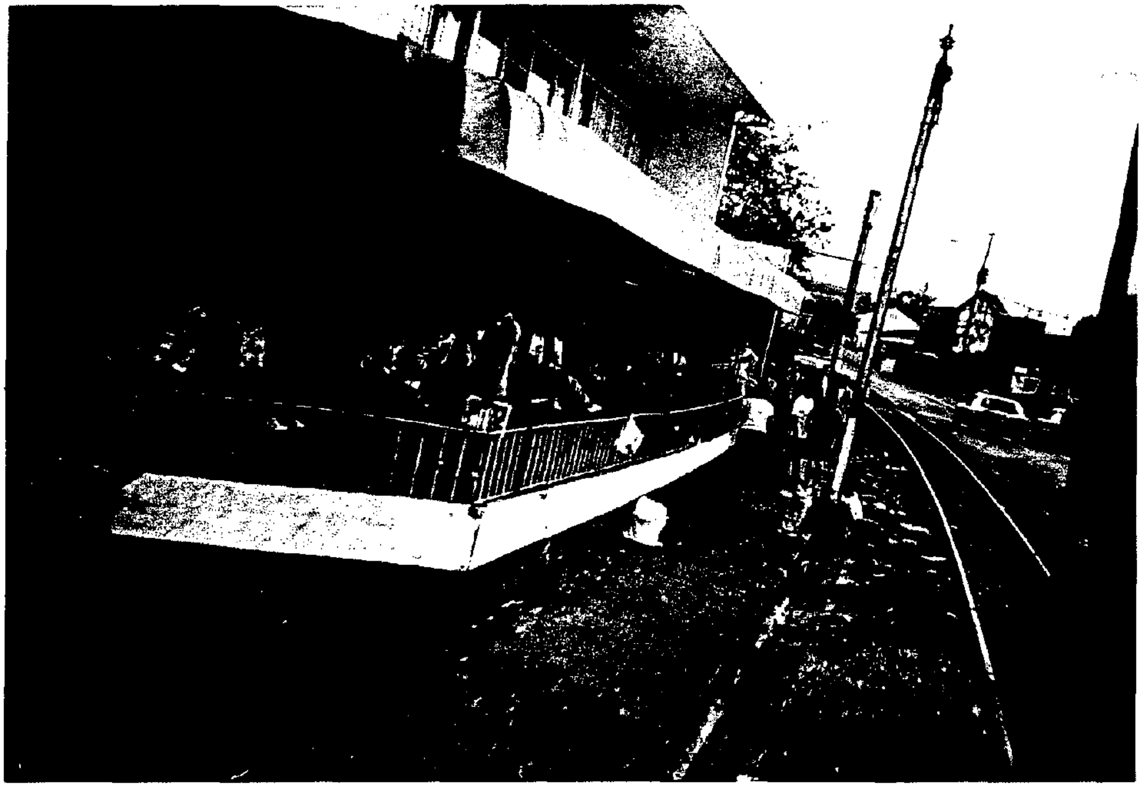
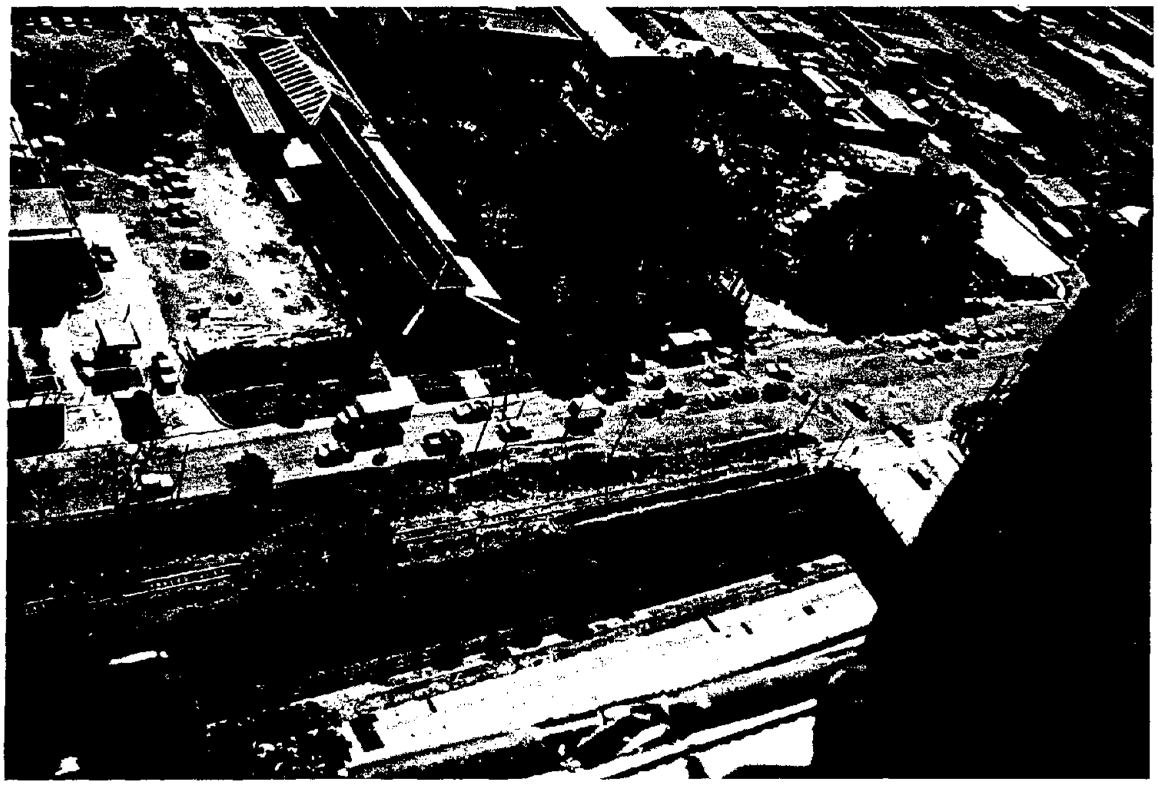
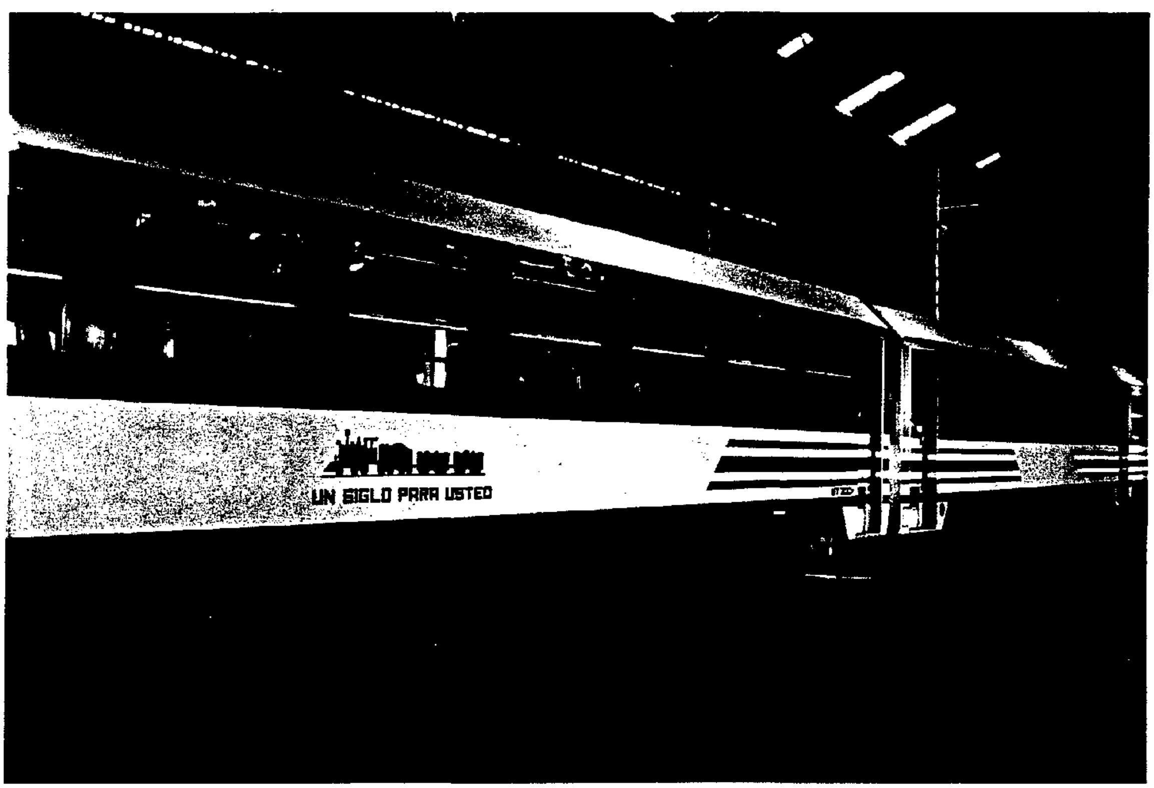


Photographs of INCOFER's Right-of-way from Pavas to the Pacific Station

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APPENDIX V

CAPITAL COSTS BY CORRIDOR AND TECHNOLOGY

COSTA RICA STUDY - BUSWAY (CLEAN DIESEL) CAPITAL COST ESTIMATES

SEGMENT: HEREDIA TO SAN PEDRO **ROUTE KM = 11.0**
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	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	x	$2,100,000		30	0.1523	$319,830
	CONCRETE HIGHWAY CROSSINGS	35	EACH	$2,400	$84,000	x	$50,400		10	0.1993	$10,042
5	REHAB BRIDGE, + WOOD DECK	9	EACH	$48,000	$432,000	x	$259,200	AVG LGTH= 30 M	10	0.1993	$51,646
6	NEW CULVERT	1	EACH	$8,000	$8,000	x	$4,800	SAN AGUSTIN	30	0.1523	$731
7	NEW CROSS DRAINAGE	33	EACH	$2,000	$66,000	x	$39,600	3 PER KM	30	0.1523	$6,031
8	NEW STATION - TERMINAL	2	EACH	$40,000	$80,000	x	$48,000		30	0.1523	$7,310
9	NEW STATION - INTERMEDIATE	5	EACH	$12,000	$60,000	x	$36,000		30	0.1523	$5,483
10	REHAB EXISTING STATION	1	EACH	$80,000	$80,000	x	$48,000	ATLANTIC STATION	30	0.1523	$7,310
11	COMMUNICATIONS SYSTEMS	0	BUS	$20,000	$0			COVERED BY BUS OPERATOF	15		
12	FARE COLLECTION EQUIPMENT	0	BUS	$10,000	$0			COVERED BY BUS OPERATOF	15		
13	NEW BUS GARAGE/PARKING	0	BUS	$50,000	$0			COVERED BY BUS OPERATOF	30		
14	NEW CLEAN DIESEL BUS	0	EACH	$210,000	$0			COVERED BY BUS OPERATOF	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				$11,939,400		$9,563,400				$1,807,970

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

COSTA RICA STUDY - BUSWAY (CLEAN DIESEL) CAPITAL COST ESTIMATES

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**	X	**$1,380,000**		30	0.1523	$210,174
	CONCRETE HIGHWAY CROSSINGS	**23**	**EACH**	**$2,400**	**$55,200**	X	**$33,120**		10	0.1993	$6,599
5	**REHAB BRIDGE, + WOOD DECK**	**4**	**EACH**	**$60,000**	**$240,000**	X	**$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**	X	**$31,500**	3 PER KM	30	0.1523	$4,797
8	**NEW STATION - TERMINAL**	**1**	**EACH**	**$50,000**	**$50,000**	X	**$30,000**		30	0.1523	$4,569
9	**NEW STATION - INTERMEDIATE**	**2**	**EACH**	**$15,000**	**$30,000**	X	**$18,000**		30	0.1523	$2,741
10	**REHAB EXISTING STATION**	**1**	**EACH**	**$100,000**	**$100,000**	X	**$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	X			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

COSTA RICA STUDY - BUSWAY (CLEAN DIESEL) CAPITAL COST ESTIMATES

SEGMENT: HEREDIA TO SAN PEDRO **ROUTE KM = 11.0**
BUSES ONLY

ITEM	COST CATEGORY	QNTY	UNIT	UNIT COST	TOTAL COST	CR ADJ	ADJUSTED COST	REMARKS	LIFESPAN (YEARS)	ANNUALIZATION FACTOR	ANNUALIZED COST
1	USED TRACK, 100#-112# CWR	0	KM	$400,000	$0			CONCRETE TIES	15		
2	USED TURNOUT, #6-10 - SIDINGS	0	KM	$30,000	$0			4 SDGS @ 150M EA	15		
3	ASPHALT BUSWAY - 2 LANE	0	KM	$500,000	$0			W/SIDE BARRIERS	10		
4	TRAFFIC INTERSECTN SIGNALS	0	EACH	$90,000	$0				30		
5	REHAB BRIDGE, + WOOD DECK	0	EACH	$60,000	$0			AVG LGTH= 30 M	30		
6	NEW CULVERT	0	EACH	$10,000	$0			SAN AGUSTIN	30		
7	NEW CROSS DRAINAGE	0	EACH	$2,500	$0			3 PER KM	30		
8	NEW STATION - TERMINAL	0	EACH	$50,000	$0				30		
9	NEW STATION - INTERMEDIATE	0	EACH	$15,000	$0				30		
10	REHAB EXISTING STATION	0	EACH	$100,000	$0			ATLANTIC STATION	30		
11	COMMUNICATIONS SYSTEMS	23	BUS	$20,000	$460,000		$460,000	ON BUS & WAYSIDE	15	0.1710	$78,668
12	FARE COLLECTION EQUIPMENT	23	BUS	$10,000	$230,000		$230,000	FAREBOX ON BUS	15	0.1710	$39,334
13	NEW BUS GARAGE/PARKING	0	BUS	$50,000	$0				30		
14	NEW CLEAN DIESEL BUS	23	EACH	$210,000	$4,830,000		$4,830,000	CAPACITY = 180	12	0.1845	$891,042
15	RIGHT-OF-WAY - URBAN		ACRE		$0						
16	RIGHT-OF-WAY - RURAL		ACRE		$0						

			ADJUSTED TOTAL		ADJUSTED AVERAGE	
SUBTOTAL AND AVERAGE COST PER KM		$5,520,000	$5,520,000	$501,818	$501,818	$1,009,044
DESIGN, CONSTRUCTION MGT, ETC.	20%	$1,104,000	$1,104,000			$201,809
CONTINGENCY (on total cost, only 10% on Buses)	25%	$931,500	$931,500			$169,057
TOTAL AND AVERAGE COST PER KM		$7,555,500	$7,555,500	$686,864	$686,864	$1,379,910

COSTA RICA STUDY - BUSWAY (CLEAN DIESEL) CAPITAL COST ESTIMATES

SEGMENT: PAVAS - PACIFICO - ATLANTICO STATION ROUTE KM = 10.1
BUSES ONLY

ITEM	COST CATEGORY	QNTY	UNIT	UNIT COST	TOTAL COST	CR ADJ	ADJUSTED COST	REMARKS	LIFESPAN (YEARS)	ANNUALIZATION FACTOR	ANNUALIZED COST
3	ASPHALT BUSWAY - 2 LANE	0	KM	$500,000	$0			W/SIDE BARRIERS	10		
4	TRAFFIC INTERSECTN SIGNALS	0	EACH	$90,000	$0				30		
5	REHAB BRIDGE, + WOOD DECK	0	EACH	$60,000	$0			AVG LGTH= 30 M	30		
6	NEW CULVERT		EACH	$10,000	$0				30		
7	NEW CROSS DRAINAGE	0	EACH	$2,500	$0			3 PER KM	30		
8	NEW STATION - TERMINAL	0	EACH	$50,000	$0				30		
9	NEW STATION - INTERMEDIATE	0	EACH	$15,000	$0				30		
10	REHAB EXISTING STATION	0	EACH	$100,000	$0			PACIFIC STATION	30		
11	COMMUNICATIONS SYSTEMS	70	BUS	$20,000	$1,400,000		$1,400,000	ON BUS & WAYSIDE	15	0.1710	$239,424
12	FARE COLLECTION EQUIPMENT	70	BUS	$10,000	$700,000		$700,000	FAREBOX ON BUS	15	0.1710	$119,712
13	NEW BUS GARAGE/PARKING	0	BUS	$50,000	$0				30		
14	NEW CLEAN DIESEL BUS	70	EACH	$210,000	$14,700,000		$14,700,000	CAPACITY = 180	12	0.1845	$2,711,867
15	RIGHT-OF-WAY - URBAN		ACRE		$0						
16	RIGHT-OF-WAY - RURAL		ACRE		$0						
							ADJUSTED TOTAL		ADJUSTED AVERAGE		
	SUBTOTAL AND AVERAGE COST PER KM				$16,800,000		$16,800,000	$1,663,366	$1,663,366		$3,071,003
	DESIGN, CONSTRUCTION MGT, ETC.			20%	$3,360,000		$3,360,000				$614,201
	CONTINGENCY (on total cost, only 10% on Buses)			25%	$2,835,000		$2,835,000				$514,521
	TOTAL AND AVERAGE COST PER KM				$22,995,000		$22,995,000	$2,276,733	$2,276,733		$4,199,725

COSTA RICA STUDY - ETB ON THE BUSWAY CAPITAL COST ESTIMATES

SEGMENT: HEREDIA TO SAN PEDRO **ROUTE KM = 11**

ITEM	COST CATEGORY	QNTY	UNIT	UNIT COST	TOTAL COST		ADJUSTED COST	REMARKS	LIFESPAN (YEARS)	ANNUALIZATION FACTOR	ANNUALIZED COST
1	**NEW CONC GUIDEWAY - 2 LANE**	**11**	**KM**	**$363,600**	**$3,999,600**		**$3,999,600**	W/SIDE BARRIERS	25	0.1547	$618,736
2	STREET REPAVING - 2 LANE		KM	$330,000	$0						
3	NEW TRAFFIC INTRSCTN SIGNALS	31	EACH	$90,000	$2,790,000		$2,790,000	W/PRE-EMPTION	30	0.1523	$424,918
4	NEW ETB ELECTRIFICATION SYS	22	KM	$620,000	$13,640,000		$13,640,000		30	0.1523	$2,077,375
5	NEW BRIDGE - MAJOR SPAN		EACH	$2,625,000	$0			AVG LGTH= 100 M			
6	NEW BRIDGE - OTHER SPAN		EACH	$525,000	$0			AVG LGTH= 40 M			
7	**REHAB BRIDGE - MAJOR SPAN**	**4**	**EACH**	**$262,500**	**$1,050,000**	X	**$630,000**	AVG LGTH= 100 M	30	0.1523	$159,915
8	**REHAB BRIDGE - OTHER SPAN**	**3**	**EACH**	**$52,500**	**$157,500**	X	**$94,500**	AVG LGTH= 40 M	30	0.1523	$23,987
9	**NEW CULVERTS/DRAINAGE**	**1**	**EACH**	**$5,000**	**$5,000**	X	**$3,000**		30	0.1523	$762
10	REHAB CULVERTS/DRAINAGE		EACH	$2,500	$0						
11	EXCAVATION/GRADING - MAJOR		KM	$1,640,000	$0			INCL TUNNEL			
12	**EXCAVATION/GRADING - MEDIUM**	**2**	**KM**	**$820,000**	**$1,640,000**	X	**$984,000**	INCL CUT/FILL	30	0.1523	$249,772
13	EXCAVATION/GRADING - MINOR		KM	$400,000	$0			BASE GRADING			
14	**NEW STATION - TERMINAL**	**2**	**EACH**	**$75,000**	**$150,000**	X	**$90,000**		30	0.1523	$22,845
15	**NEW STATION - INTERMEDIATE**	**4**	**EACH**	**$15,000**	**$60,000**	X	**$36,000**		30	0.1523	$9,138
16	**REHAB EXISTING STATION**	**1**	**EACH**	**$125,000**	**$125,000**	X	**$75,000**	ATLANTIC STA	30	0.1523	$19,038
17	**REHAB MAIN YARD & SHOP**	**56**	**ETB**	**$50,000**	**$2,800,000**	X	**$1,680,000**	PACIFIC FACILITY	30	0.1523	$426,441
18	**NEW LAYOVER FACILITY**	**56**	**ETB**	**$15,000**	**$840,000**	X	**$504,000**	AT END-OF-LINE	30	0.1523	$127,932
19	NEW ELECTRIC TROLLEY BUS	56	EACH	$600,000	$33,600,000		$33,600,000		15	0.1710	$5,746,173
20	NEW DIESEL SUBURBAN BUS		EACH	$300,000	$0						
21	RIGHT-OF-WAY - URBAN		ACRE	$0	$0						
22	RIGHT-OF-WAY - RURAL		ACRE	$0	$0						
23	OTHER COST ITEM			$0	$0						
24	OTHER COST ITEM			$0	$0						
							ADJUSTED TOTAL		**ADJUSTED AVERAGE**		
	SUBTOTAL AND AVERAGE COST PER KM				$60,857,100		$58,126,100	$5,532,464	$5,284,191		$9,907,031
	DESIGN, CONSTRUCTION MGT, ETC.	20%			$12,171,420		$11,625,220				$1,981,406
	CONTINGENCY	25%			$15,214,275		$14,531,525				$2,476,758
	TOTAL AND AVERAGE COST PER KM				$88,242,795		$84,282,845	$8,022,072	$7,662,077		$14,365,194

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COSTA RICA STUDY - ETB ON THE BUSWAY CAPITAL COST ESTIMATES

SEGMENT: ALAJUELA TO SAN PEDRO **ROUTE KM = 23**

ITEM	COST CATEGORY	QNTY	UNIT	UNIT COST	TOTAL COST		ADJUSTED COST	REMARKS	LIFESPAN (YEARS)	ANNUALIZATION FACTOR	ANNUALIZED COST
1	**NEW CONC GUIDEWAY - 2 LANE**	**23**	**KM**	**$363,600**	**$8,382,800**		**$8,362,800**	W/SIDE BARRIERS	25	0.1547	$1,293,720
2	STREET REPAVING - 2 LANE		KM	$330,000	$0						
3	NEW TRAFFIC INTRSCTN SIGNALS	61	EACH	$90,000	$5,490,000		$5,490,000	W/PRE-EMPTION	30	0.1523	$836,128
4	NEW ETB ELECTRIFICATION SYS	46	KM	$620,000	$28,520,000		$28,520,000		30	0.1523	$4,343,602
5	NEW BRIDGE - MAJOR SPAN		EACH	$2,625,000	$0			AVG LGTH= 100 M			
6	NEW BRIDGE - OTHER SPAN		EACH	$525,000	$0			AVG LGTH= 40 M			
7	**REHAB BRIDGE - MAJOR SPAN**	**6**	**EACH**	**$262,500**	**$1,575,000**	x	**$945,000**	AVG LGTH= 100 M	30	0.1523	$239,873
8	**REHAB BRIDGE - OTHER SPAN**	**5**	**EACH**	**$52,500**	**$262,500**	x	**$157,500**	AVG LGTH= 40 M	30	0.1523	$39,979
9	**NEW CULVERTS/DRAINAGE**	**1**	**EACH**	**$5,000**	**$5,000**	x	**$3,000**		30	0.1523	$762
10	REHAB CULVERTS/DRAINAGE		EACH	$2,500	$0						
11	EXCAVATION/GRADING - MAJOR		KM	$1,640,000	$0			INCL TUNNEL			
12	**EXCAVATION/GRADING - MEDIUM**	**2**	**KM**	**$820,000**	**$1,640,000**	x	**$984,000**	INCL CUT/FILL	30	0.1523	$249,772
13	EXCAVATION/GRADING - MINOR		KM	$400,000	$0			BASE GRADING			
14	**NEW STATION - TERMINAL**	**2**	**EACH**	**$75,000**	**$150,000**	x	**$90,000**		30	0.1523	$22,845
15	**NEW STATION - INTERMEDIATE**	**7**	**EACH**	**$15,000**	**$105,000**	x	**$63,000**		30	0.1523	$15,992
16	**REHAB EXISTING STATION**	**1**	**EACH**	**$125,000**	**$125,000**	x	**$75,000**	ATLANTIC STA	30	0.1523	$19,038
17	**REHAB MAIN YARD & SHOP**	**100**	**ETB**	**$50,000**	**$5,000,000**	x	**$3,000,000**	PACIFIC FACILITY	30	0.1523	$761,501
18	**NEW LAYOVER FACILITY**	**100**	**ETB**	**$15,600**	**$1,500,000**	x	**$900,000**	AT END-OF-LINE	30	0.1523	$228,450
19	NEW ELECTRIC TROLLEY BUS	100	EACH	$600,000	$60,000,000		$60,000,000		15	0.1710	$10,261,023
20	NEW DIESEL SUBURBAN BUS		EACH	$300,000	$0						
21	RIGHT-OF-WAY - URBAN		ACRE	$0	$0						
22	RIGHT-OF-WAY - RURAL		ACRE	$0	$0						
23	OTHER COST ITEM			$0	$0						
24	OTHER COST ITEM			$0	$0						
							ADJUSTED TOTAL		ADJUSTED AVERAGE		
	SUBTOTAL AND AVERAGE COST PER KM				$112,735,300		$108,590,300	$4,901,535	$4,721,317		$18,312,684
	DESIGN, CONSTRUCTION MGT, ETC.		20%		$22,547,060		$21,718,060				$3,662,537
	CONTINGENCY		25%		$28,183,825		$27,147,575				$4,578,171
	TOTAL AND AVERAGE COST PER KM				$163,466,185		$157,455,935	$7,107,225	$6,845,910		$26,553,392

COSTA RICA STUDY - ETB ON THE BUSWAY CAPITAL COST ESTIMATES

SEGMENT: ALAJUELA TO CARTAGO ROUTE KM = 41.4

ITEM	COST CATEGORY	QNTY	UNIT	UNIT COST	TOTAL COST		ADJUSTED COST	REMARKS	LIFESPAN (YEARS)	ANNUALIZATION FACTOR	ANNUALIZED COST
1	NEW CONC GUIDEWAY - 2 LANE	41.4	KM	$363,600	$15,053,040		$15,053,040	W/SIDE BARRIERS	25	0.1547	$2,328,696
2	STREET REPAVING - 2 LANE		KM	$330,000	$0						
3	NEW TRAFFIC INTRSCTN SIGNALS	85	EACH	$90,000	$7,650,000		$7,650,000	W/PRE-EMPTION	30	0.1523	$1,165,097
4	NEW ETB ELECTRIFICATION SYS	82.8	KM	$620,000	$51,336,000		$51,336,000		30	0.1523	$7,818,483
5	NEW BRIDGE - MAJOR SPAN		EACH	$2,625,000	$0			AVG LGTH= 100 M			
6	NEW BRIDGE - OTHER SPAN		EACH	$525,000	$0			AVG LGTH= 40 M			
7	REHAB BRIDGE - MAJOR SPAN	7	EACH	$262,500	$1,837,500	X	$1,102,500	AVG LGTH= 100 M	30	0.1523	$279,852
8	REHAB BRIDGE - OTHER SPAN	5	EACH	$52,500	$262,500	X	$157,500	AVG LGTH= 40 M	30	0.1523	$39,979
9	NEW CULVERTS/DRAINAGE	1	EACH	$5,000	$5,000	X	$3,000		30	0.1523	$762
10	REHAB CULVERTS/DRAINAGE		EACH	$2,500	$0						
11	EXCAVATION/GRADING - MAJOR		KM	$1,640,000	$0			INCL TUNNEL			
12	EXCAVATION/GRADING - MEDIUM	2	KM	$820,000	$1,640,000	X	$984,000	INCL CUT/FILL	30	0.1523	$249,772
13	EXCAVATION/GRADING - MINOR		KM	$400,000	$0			BASE GRADING			
14	NEW STATION - TERMINAL	1	EACH	$75,000	$75,000	X	$45,000		30	0.1523	$11,423
15	NEW STATION - INTERMEDIATE	11	EACH	$15,000	$165,000	X	$99,000		30	0.1523	$25,130
16	REHAB EXISTING STATION	2	EACH	$125,000	$250,000	X	$150,000	ATLANTIC,CARTAGO	30	0.1523	$38,075
17	REHAB MAIN YARD & SHOP	111	ETB	$50,000	$5,550,000	X	$3,330,000	PACIFIC FACILITY	30	0.1523	$845,266
18	NEW LAYOVER FACILITY	111	ETB	$15,000	$1,665,000	X	$999,000	AT END-OF-LINE	30	0.1523	$253,580
19	NEW ELECTRIC TROLLEY BUS	111	EACH	$600,000	$66,600,000		$66,600,000		15	0.1710	$11,389,736
20	NEW DIESEL SUBURBAN BUS		EACH	$300,000	$0						
21	RIGHT-OF-WAY - URBAN		ACRE	$0	$0						
22	RIGHT-OF-WAY - RURAL		ACRE	$0	$0						
23	OTHER COST ITEM			$0	$0						
24	OTHER COST ITEM			$0	$0						
							ADJUSTED TOTAL		ADJUSTED AVERAGE		
	SUBTOTAL AND AVERAGE COST PER KM				$152,089,040		$147,509,040	$3,673,648	$3,563,020		$24,445,849
	DESIGN, CONSTRUCTION MGT, ETC.		20%		$30,417,808		$29,501,808				$4,889,170
	CONTINGENCY		25%		$38,022,260		$36,877,260				$6,111,462
	TOTAL AND AVERAGE COST PER KM				$220,529,108		$213,888,108	$5,326,790	$5,166,379		$35,446,481

COSTA RICA STUDY - DMU CAPITAL COST ESTIMATES

SEGMENT: HEREDIA TO SAN PEDRO ROUTE KM = 11.0

ITEM	COST CATEGORY	QNTY	UNIT	UNIT COST	TOTAL COST	CR ADJ	ADJUSTED COST	REMARKS	LIFESPAN (YEARS)	ANNUALIZATION FACTOR	ANNUALIZED COST
1	USED TRACK, 100#-112# CWR	22	KM	$400,000	$8,800,000		$8,800,000	DOUBLE TRACK	30	0.1523	$1,340,242
2	USED TRACK, 100#-112# SIDING		KM	$300,000	$0				30		
3	USED TRACK, 100#-112# YARD	4.4	KM	$300,000	$1,320,000		$1,320,000	20% OF MAIN TRACK	30	0.1523	$201,036
4	USED XOVER, #6-#10 TURNOUTS	4	EACH	$100,000	$400,000		$400,000	PAIRED CROSSOVERS	30	0.1523	$60,920
5	USED TURNOUT, #8-#10, MAIN	2	EACH	$30,000	$60,000		$60,000		30	0.1523	$9,138
6	USED TURNOUT, #6, YARD	10	EACH	$25,000	$250,000		$250,000	YARD-1 PER 5 CARS	30	0.1523	$38,075
7	NEW RAILROAD SIGNAL SYSTEM	22	KM	$625,000	$13,750,000		$13,750,000	ATC W/CAB SIGNALS	30	0.1523	$2,094,128
8	NEW RAILROAD SIGNAL SYSTEM		KM	$375,000	$0			CTC			
9	NEW LRT ELECTRIFICATION SYS		KM	$925,000	$0			CATENARY	30		
10	NEW HWY CROSSING W/GATES	31	EACH	$125,000	$3,875,000		$3,875,000	RUBBER OR CONC	15	0.1710	$662,691
11	NEW HWY CROSSING W/LIGHTS		EACH	$75,000	$0			ASPHALT			
12	NEW HWY CROSSING W/SIGNS		EACH	$10,000	$0			GRAVEL			
13	NEW BRIDGE - MAJOR SPAN		EACH	$2,625,000	$0			AVG LGTH= 100 M			
14	NEW BRIDGE - OTHER SPAN		EACH	$525,000	$0			AVG LGTH= 40 M			
15	**REHAB BRIDGE - MAJOR SPAN**	**4**	**EACH**	**$125,000**	**$500,000**	**x**	**$300,000**	AVG LGTH= 100 M	30	0.1523	$76,150
16	**REHAB BRIDGE - OTHER SPAN**	**3**	**EACH**	**$50,000**	**$150,000**	**x**	**$90,000**	AVG LGTH= 40 M	30	0.1523	$22,845
17	**NEW CULVERTS/DRAINAGE**	**1**	**EACH**	**$10,000**	**$10,000**	**x**	**$6,000**	SAN AGUSTIN	30	0.1523	$1,523
18	**REHAB CULVERTS/DRAINAGE**	**10**	**EACH**	**$2,500**	**$25,000**	**x**	**$15,000**	1 PER KM	30	0.1523	$3,808
19	**EXCAVATION/GRADING - MAJOR**		**KM**	**$1,640,000**	**$0**	**x**		INCL TUNNEL	30		
20	**EXCAVATION/GRADING - MEDIUM**	**2**	**KM**	**$820,000**	**$1,640,000**	**x**	**$984,000**	INCL CUT/FILL	30	0.1523	$249,772
21	**EXCAVATION/GRADING - MINOR**	**2**	**KM**	**$400,000**	**$800,000**	**x**	**$480,000**	BASE GRADING	30	0.1523	$121,840
22	**NEW STATION - TERMINAL**	**2**	**EACH**	**$100,000**	**$200,000**	**x**	**$120,000**		30	0.1523	$30,460
23	**NEW STATION - INTERMEDIATE**	**4**	**EACH**	**$50,000**	**$200,000**	**x**	**$120,000**		30	0.1523	$30,460
24	**REHAB EXISTING STATION**	**1**	**EACH**	**$150,000**	**$150,000**	**x**	**$90,000**	ATLANTIC STATION	30	0.1523	$22,845
25	**REHAB MAIN YARD & SHOP**	**49**	**DMU**	**$75,000**	**$3,675,000**	**x**	**$2,205,000**	PACIFIC FACILITY	30	0.1523	$559,703
26	**NEW LAYOVER FACILITY**	**49**	**DMU**	**$20,000**	**$980,000**	**x**	**$588,000**	AT END-OF-LINE	30	0.1523	$149,254
27	NEW LIGHT RAIL VEHICLE		EACH	$2,000,000	$0						
28	NEW DIESEL MULTIPLE UNIT	49	EACH	$2,500,000	$122,500,000		$122,500,000		25	0.1547	$18,950,677
29	RIGHT-OF-WAY - URBAN		ACRE	$0	$0						
30	RIGHT-OF-WAY - RURAL		ACRE	$0	$0						
31	OTHER COST ITEM			$0	$0				30		
							ADJUSTED TOTAL		**ADJUSTED AVERAGE**		
	SUBTOTAL AND AVERAGE COST PER KM				**$159,285,000**		**$155,953,000**	**$14,480,455**	**$14,177,545**		**$24,625,567**
	DESIGN, CONSTRUCTION MGT, ETC.	20%			$31,857,000		$31,190,600				$4,925,113
	CONTINGENCY	25%			$39,821,250		$38,988,250				$6,156,392
	TOTAL AND AVERAGE COST PER KM				$230,963,250		$226,131,850	$20,996,659	$20,557,441		$35,707,073

COSTA RICA STUDY - DMU CAPITAL COST ESTIMATES

SEGMENT: ALAJUELA TO SAN PEDRO **ROUTE KM = 23**

ITEM	COST CATEGORY	QNTY	UNIT	UNIT COST	TOTAL COST		ADJUSTED COST	REMARKS	LIFESPAN (YEARS)	ANNUALIZATION FACTOR	ANNUALIZED COST
1	USED TRACK, 100#-112# CWR	46	KM	$400,000	$18,400,000		$18,400,000	DOUBLE TRACK	30	0.1523	$2,802,324
2	USED TRACK, 100#-112# SIDING		KM	$300,000	$0				30		
3	USED TRACK, 100#-112# YARD	9	KM	$300,000	$2,700,000		$2,700,000	20% OF MAIN TRACK	30	0.1523	$411,211
4	USED XOVER, #6-#10 TURNOUTS	7	EACH	$100,000	$700,000		$700,000	PAIRED CROSSOVERS	30	0.1523	$106,610
5	USED TURNOUT, #8-#10, MAIN	4	EACH	$30,000	$120,000		$120,000		30	0.1523	$18,276
6	USED TURNOUT, #6, YARD	16	EACH	$25,000	$400,000		$400,000	YARD:1 PER 5 CARS	30	0.1523	$60,920
7	NEW RAILROAD SIGNAL SYSTEM	46	KM	$625,000	$28,750,000		$28,750,000	ATC W/CAB SIGNALS	30	0.1523	$4,378,631
8	NEW RAILROAD SIGNAL SYSTEM		KM	$375,000	$0			CTC			
9	NEW LRT ELECTRIFICATION SYS		KM	$925,000	$0			CATENARY	30		
10	NEW HWY CROSSING W/GATES	61	EACH	$125,000	$7,625,000		$7,625,000	RUBBER OR CONC	15	0.1710	$1,304,005
11	NEW HWY CROSSING W/LIGHTS		EACH	$75,000	$0			ASPHALT			
12	NEW HWY CROSSING W/SIGNS		EACH	$10,000	$0			GRAVEL			
13	NEW BRIDGE - MAJOR SPAN		EACH	$2,625,000	$0			AVG LGTH= 100 M			
14	NEW BRIDGE - OTHER SPAN		EACH	$525,000	$0			AVG LGTH= 40 M			
15	**REHAB BRIDGE - MAJOR SPAN**	**6**	**EACH**	**$125,000**	**$750,000**	X	**$450,000**	AVG LGTH= 100 M	30	0.1523	$114,225
16	**REHAB BRIDGE - OTHER SPAN**	**5**	**EACH**	**$50,000**	**$250,000**	X	**$150,000**	AVG LGTH= 40 M	30	0.1523	$38,075
17	**NEW CULVERTS/DRAINAGE**	**1**	**EACH**	**$10,000**	**$10,000**	X	**$6,000**	SAN AGUSTIN	30	0.1523	$1,523
18	**REHAB CULVERTS/DRAINAGE**	**22**	**EACH**	**$2,500**	**$55,000**	X	**$33,000**	1 PER KM	30	0.1523	$8,377
19	**EXCAVATION/GRADING - MAJOR**		**KM**	**$1,640,000**	**$0**	X		INCL TUNNEL	30		
20	**EXCAVATION/GRADING - MEDIUM**	**3**	**KM**	**$820,000**	**$2,460,000**	X	**$1,476,000**	INCL CUT/FILL	30	0.1523	$374,658
21	**EXCAVATION/GRADING - MINOR**	**4**	**KM**	**$400,000**	**$1,600,000**	X	**$960,000**	BASE GRADING	30	0.1523	$243,680
22	**NEW STATION - TERMINAL**	**2**	**EACH**	**$100,000**	**$200,000**	X	**$120,000**		30	0.1523	$30,460
23	**NEW STATION - INTERMEDIATE**	**7**	**EACH**	**$50,000**	**$350,000**	X	**$210,000**		30	0.1523	$53,305
24	**REHAB EXISTING STATION**	**1**	**EACH**	**$150,000**	**$150,000**	X	**$90,000**	ATLANTIC STATION	30	0.1523	$22,845
25	**REHAB MAIN YARD & SHOP**	**82**	**DMU**	**$75,000**	**$6,150,000**	X	**$3,690,000**	PACIFIC FACILITY	30	0.1523	$936,646
26	**NEW LAYOVER FACILITY**	**82**	**DMU**	**$20,000**	**$1,640,000**	X	**$984,000**	AT END-OF-LINE	30	0.1523	$249,772
27	NEW LIGHT RAIL VEHICLE		EACH	$2,000,000	$0						
28	NEW DIESEL MULTIPLE UNIT	82	EACH	$2,500,000	$205,000,000		$205,000,000		25	0.1547	$31,713,377
29	RIGHT-OF-WAY - URBAN		ACRE	$0	$0						
30	RIGHT-OF-WAY - RURAL		ACRE	$0	$0						
31	OTHER COST ITEM			$0	$0				30		
							ADJUSTED TOTAL		ADJUSTED AVERAGE		
	SUBTOTAL AND AVERAGE COST PER KM				$277,310,000		$271,864,000	$12,056,957	$11,820,174		$42,868,921
	DESIGN, CONSTRUCTION MGT, ETC.	20%			$55,462,000		$54,372,800				$8,573,784
	CONTINGENCY	25%			$69,327,500		$67,966,000				$10,717,230
	TOTAL AND AVERAGE COST PER KM				$402,099,500		$394,202,800	$17,482,587	$17,139,252		$62,159,935

COSTA RICA STUDY - DMU CAPITAL COST ESTIMATES

SEGMENT: ALAJUELA TO CARTAGO ROUTE KM = 41.4

ITEM	COST CATEGORY	QNTY	UNIT	UNIT COST	TOTAL COST		ADJUSTED COST	REMARKS	LIFESPAN (YEARS)	ANNUALIZATION FACTOR	ANNUALIZED COST
1	USED TRACK, 100#-112# CWR	82.8	KM	$400,000	$33,120,000		$33,120,000	DOUBLE TRACK	30	0.1523	$5,044,183
2	USED TRACK, 100#-112# SIDING		KM	$300,000	$0				30		
3	USED TRACK, 100#-112# YARD	17	KM	$300,000	$5,100,000		$5,100,000	20% OF MAIN TRACK	30	0.1523	$776,731
4	USED XOVER, #6-#10 TURNOUTS	10	EACH	$100,000	$1,000,000		$1,000,000	PAIRED CROSSOVERS	30	0.1523	$152,300
5	USED TURNOUT, #8-#10, MAIN	6	EACH	$30,000	$180,000		$180,000		30	0.1523	$27,414
6	USED TURNOUT, #8, YARD	18	EACH	$25,000	$450,000		$450,000	YARD:1 PER 5 CARS	30	0.1523	$68,535
7	NEW RAILROAD SIGNAL SYSTEM	82.8	KM	$625,000	$51,750,000		$51,750,000	ATC W/CAB SIGNALS	30	0.1523	$7,881,535
8	NEW RAILROAD SIGNAL SYSTEM		KM	$375,000	$0			CTC			
9	NEW LRT ELECTRIFICATION SYS		KM	$925,000	$0			CATENARY	30		
10	NEW HWY CROSSING W/GATES	85	EACH	$125,000	$10,625,000		$10,625,000	RUBBER OR CONC	15	0.1710	$1,817,056
11	NEW HWY CROSSING W/LIGHTS		EACH	$75,000	$0			ASPHALT			
12	NEW HWY CROSSING W/SIGNS		EACH	$10,000	$0			GRAVEL			
13	NEW BRIDGE - MAJOR SPAN		EACH	$2,625,000	$0			AVG LGTH= 100 M			
14	NEW BRIDGE - OTHER SPAN		EACH	$525,000	$0			AVG LGTH= 40 M			
15	**REHAB BRIDGE - MAJOR SPAN**	7	EACH	$125,000	$875,000	x	$525,000	AVG LGTH= 100 M	30	0.1523	$133,263
16	**REHAB BRIDGE - OTHER SPAN**	5	EACH	$50,000	$250,000	x	$150,000	AVG LGTH= 40 M	30	0.1523	$38,075
17	**NEW CULVERTS/DRAINAGE**	1	EACH	$10,000	$10,000	x	$6,000	SAN AGUSTIN	30	0.1523	$1,523
18	**REHAB CULVERTS/DRAINAGE**	40	EACH	$2,500	$100,000	x	$60,000	1 PER KM	30	0.1523	$15,230
19	**EXCAVATION/GRADING - MAJOR**		KM	$1,640,000	$0	x		INCL TUNNEL	30		
20	**EXCAVATION/GRADING - MEDIUM**	4	KM	$820,000	$3,280,000	x	$1,968,000	INCL CUT/FILL	30	0.1523	$499,545
21	**EXCAVATION/GRADING - MINOR**	4	KM	$400,000	$1,600,000	x	$960,000	BASE GRADING	30	0.1523	$243,680
22	**NEW STATION - TERMINAL**	1	EACH	$100,000	$100,000	x	$60,000		30	0.1523	$15,230
23	**NEW STATION - INTERMEDIATE**	11	EACH	$50,000	$550,000	x	$330,000		30	0.1523	$83,765
24	**REHAB EXISTING STATION**	2	EACH	$150,000	$300,000	x	$180,000	ATLANTIC & CARTAGO	30	0.1523	$45,690
25	**REHAB MAIN YARD & SHOP**	92	DMU	$75,000	$6,900,000	x	$4,140,000	PACIFIC FACILITY	30	0.1523	$1,050,871
26	**NEW LAYOVER FACILITY**	92	DMU	$20,000	$1,840,000	x	$1,104,000	AT END-OF-LINE	30	0.1523	$280,232
27	NEW LIGHT RAIL VEHICLE		EACH	$2,000,000	$0						
28	NEW DIESEL MULTIPLE UNIT	92	EACH	$2,500,000	$230,000,000		$230,000,000		25	0.1547	$35,580,863
29	RIGHT-OF-WAY - URBAN		ACRE	$0	$0						
30	RIGHT-OF-WAY - RURAL		ACRE	$0	$0						
31	OTHER COST ITEM			$0	$0				30		
							ADJUSTED TOTAL		ADJUSTED AVERAGE		
	SUBTOTAL AND AVERAGE COST PER KM				$348,030,000		$341,708,000	$8,406,522	$8,253,816		$53,755,722
	DESIGN, CONSTRUCTION MGT, ETC.	20%			$69,606,000		$68,341,600				$10,751,144
	CONTINGENCY	25%			$87,007,500		$85,427,000				$13,438,930
	TOTAL AND AVERAGE COST PER KM				$504,643,500		$495,476,600	$12,189,457	$11,968,034		$77,945,796

COSTA RICA STUDY - DMU CAPITAL COST ESTIMATES

SEGMENT: SAN ANTONIO DE BELEN TO PACIFIC STATION **ROUTE KM = 16**

ITEM	COST CATEGORY	QNTY	UNIT	UNIT COST	TOTAL COST		ADJUSTED COST	REMARKS	LIFESPAN (YEARS)	ANNUALIZATION FACTOR	ANNUALIZED COST
1	USED TRACK, 100#-112# CWR	32	KM	$400,000	$12,800,000		$12,800,000	DOUBLE TRACK	30	0.1523	$1,949,443
2	USED TRACK, 100#-112# SIDING		KM	$300,000	$0				30		
3	USED TRACK, 100#-112# YARD	6	KM	$300,000	$1,800,000		$1,800,000	20% OF MAIN TRACK	30	0.1523	$274,140
4	USED XOVER, #6-#10 TURNOUTS	5	EACH	$100,000	$500,000		$500,000	PAIRED CROSSOVERS	30	0.1523	$76,150
5	USED TURNOUT, #8-#10, MAIN	3	EACH	$30,000	$90,000		$90,000		30	0.1523	$13,707
6	USED TURNOUT, #6, YARD	12	EACH	$25,000	$300,000		$300,000	YARD:1 PER 5 CARS	30	0.1523	$45,690
7	NEW RAILROAD SIGNAL SYSTEM	32	KM	$625,000	$20,000,000		$20,000,000	ATC W/CAB SIGNALS	30	0.1523	$3,046,004
8	NEW RAILROAD SIGNAL SYSTEM		KM	$375,000	$0			CTC			
9	NEW LRT ELECTRIFICATION SYS		KM	$925,000	$0			CATENARY	30		
10	NEW HWY CROSSING W/GATES	38	EACH	$125,000	$4,750,000		$4,750,000	RUBBER OR CONC	15	0.1710	$812,331
11	NEW HWY CROSSING W/LIGHTS		EACH	$75,000	$0			ASPHALT			
12	NEW HWY CROSSING W/SIGNS		EACH	$10,000	$0			GRAVEL			
13	NEW BRIDGE - MAJOR SPAN		EACH	$2,625,000	$0			AVG LGTH= 100 M			
14	NEW BRIDGE - OTHER SPAN		EACH	$525,000	$0			AVG LGTH= 40 M			
15	REHAB BRIDGE - MAJOR SPAN	3	EACH	$125,000	$375,000	X	$225,000	AVG LGTH= 100 M	30	0.1523	$57,113
16	REHAB BRIDGE - OTHER SPAN	5	EACH	$50,000	$250,000	X	$150,000	AVG LGTH= 40 M	30	0.1523	$38,075
17	NEW CULVERTS/DRAINAGE		EACH	$10,000	$0				30		
18	REHAB CULVERTS/DRAINAGE	16	EACH	$2,500	$40,000	X	$24,000	1 PER KM	30	0.1523	$6,092
19	EXCAVATION/GRADING - MAJOR		KM	$1,640,000	$0			INCL TUNNEL	30		
20	EXCAVATION/GRADING - MEDIUM		KM	$820,000	$0			INCL CUT/FILL	30		
21	EXCAVATION/GRADING - MINOR	3	KM	$400,000	$1,200,000	X	$720,000	BASE GRADING	30	0.1523	$182,760
22	NEW STATION - TERMINAL	1	EACH	$100,000	$100,000	X	$60,000		30	0.1523	$15,230
23	NEW STATION - INTERMEDIATE	3	EACH	$50,000	$150,000	X	$90,000		30	0.1523	$22,845
24	REHAB EXISTING STATION	1	EACH	$150,000	$150,000	X	$90,000	PACIFIC STATION	30	0.1523	$22,845
25	REHAB MAIN YARD & SHOP	58	DMU	$75,000	$4,350,000	X	$2,610,000	PACIFIC FACILITY	30	0.1523	$662,506
26	NEW LAYOVER FACILITY	58	DMU	$20,000	$1,160,000	X	$696,000	AT END-OF-LINE	30	0.1523	$176,668
27	NEW LIGHT RAIL VEHICLE		EACH	$2,000,000	$0						
28	NEW DIESEL MULTIPLE UNIT	58	EACH	$2,500,000	$145,000,000		$145,000,000		25	0.1547	$22,431,413
29	RIGHT-OF-WAY - URBAN		ACRE	$0	$0						
30	RIGHT-OF-WAY - RURAL		ACRE	$0	$0						
31	OTHER COST ITEM			$0	$0				30		
							ADJUSTED TOTAL		ADJUSTED AVERAGE		
	SUBTOTAL AND AVERAGE COST PER KM				$193,015,000		$189,905,000	$12,063,438	$11,869,063		$29,833,012
	DESIGN, CONSTRUCTION MGT, ETC.	20%			$38,603,000		$37,981,000				$5,966,602
	CONTINGENCY	25%			$48,253,750		$47,476,250				$7,458,253
	TOTAL AND AVERAGE COST PER KM				$279,871,750		$275,362,250	$17,491,984	$17,210,141		$43,257,868

COSTA RICA STUDY - DMU CAPITAL COST ESTIMATES

SEGMENT: PAVAS TO PACIFIC STATION ROUTE KM = 7

ITEM	COST CATEGORY	QNTY	UNIT	UNIT COST	TOTAL COST		ADJUSTED COST	REMARKS	LIFESPAN (YEARS)	ANNUALIZATION FACTOR	ANNUALIZED COST
1	USED TRACK, 100#-112# CWR	14	KM	$400,000	$5,600,000		$5,600,000	DOUBLE TRACK	30	0.1523	$852,881
2	USED TRACK, 100#-112# SIDING	1	KM	$300,000	$300,000		$300,000		30	0.1523	$45,690
3	USED TRACK, 100#-112# YARD	3	KM	$300,000	$900,000		$900,000	20% OF MAIN TRACK	30	0.1523	$137,070
4	USED XOVER, #6-#10 TURNOUTS	3	EACH	$100,000	$300,000		$300,000	PAIRED CROSSOVERS	30	0.1523	$45,690
5	USED TURNOUT, #8-#10, MAIN	1	EACH	$30,000	$30,000		$30,000		30	0.1523	$4,569
6	USED TURNOUT, #6, YARD	7	EACH	$25,000	$175,000		$175,000	YARD:1 PER 5 CARS	30	0.1523	$26,653
7	NEW RAILROAD SIGNAL SYSTEM	14	KM	$625,000	$8,750,000		$8,750,000	ATC W/CAB SIGNALS	30	0.1523	$1,332,627
8	NEW RAILROAD SIGNAL SYSTEM		KM	$375,000	$0			CTC			
9	NEW LRT ELECTRIFICATION SYS		KM	$925,000	$0			CATENARY	30		
10	NEW HWY CROSSING W/GATES	23	EACH	$125,000	$2,875,000		$2,875,000	RUBBER OR CONC	15	0.1710	$491,674
11	NEW HWY CROSSING W/LIGHTS		EACH	$75,000	$0			ASPHALT			
12	NEW HWY CROSSING W/SIGNS		EACH	$10,000	$0			GRAVEL			
13	NEW BRIDGE - MAJOR SPAN		EACH	$2,625,000	$0			AVG LGTH= 100 M			
14	NEW BRIDGE - OTHER SPAN		EACH	$525,000	$0			AVG LGTH= 40 M			
15	REHAB BRIDGE - MAJOR SPAN		EACH	$125,000	$0			AVG LGTH= 100 M	30		
16	**REHAB BRIDGE - OTHER SPAN**	**4**	**EACH**	**$50,000**	**$200,000**	**X**	**$120,000**	AVG LGTH= 40 M	30	0.1523	$30,460
17	NEW CULVERTS/DRAINAGE		EACH	$10,000	$0				30		
18	**REHAB CULVERTS/DRAINAGE**	**7**	**EACH**	**$2,500**	**$17,500**	**X**	**$10,500**	1 PER KM	30	0.1523	$2,665
19	EXCAVATION/GRADING - MAJOR		KM	$1,640,000	$0			INCL TUNNEL	30		
20	EXCAVATION/GRADING - MEDIUM		KM	$820,000	$0			INCL CUT/FILL	30		
21	**EXCAVATION/GRADING - MINOR**	**1**	**KM**	**$400,000**	**$400,000**	**X**	**$240,000**	BASE GRADING	30	0.1523	$60,920
22	**NEW STATION - TERMINAL**	**1**	**EACH**	**$100,000**	**$100,000**	**X**	**$60,000**		30	0.1523	$15,230
23	**NEW STATION - INTERMEDIATE**	**2**	**EACH**	**$50,000**	**$100,000**	**X**	**$60,000**		30	0.1523	$15,230
24	**REHAB EXISTING STATION**	**1**	**EACH**	**$150,000**	**$150,000**	**X**	**$90,000**	PACIFIC STATION	30	0.1523	$22,845
25	**REHAB MAIN YARD & SHOP**	**34**	**DMU**	**$75,000**	**$2,550,000**	**X**	**$1,530,000**	PACIFIC FACILITY	30	0.1523	$388,366
26	**NEW LAYOVER FACILITY**	**34**	**DMU**	**$20,000**	**$680,000**	**X**	**$408,000**	AT END-OF-LINE	30	0.1523	$103,564
27	NEW LIGHT RAIL VEHICLE		EACH	$2,000,000	$0						
28	NEW DIESEL MULTIPLE UNIT	34	EACH	$2,500,000	$85,000,000		$85,000,000		25	0.1547	$13,149,449
29	RIGHT-OF-WAY - URBAN		ACRE	$0	$0						
30	RIGHT-OF-WAY - RURAL		ACRE	$0	$0						
31	OTHER COST ITEM			$0	$0				30		
							ADJUSTED TOTAL		ADJUSTED AVERAGE		
	SUBTOTAL AND AVERAGE COST PER KM				$108,127,500		$106,448,500	$15,446,786	$15,206,929		$16,725,583
	DESIGN, CONSTRUCTION MGT, ETC.	20%			$21,625,500		$21,289,700				$3,345,117
	CONTINGENCY	25%			$27,031,875		$26,612,125				$4,181,396
	TOTAL AND AVERAGE COST PER KM				$156,784,875		$154,350,325	$22,397,839	$22,050,046		$24,252,095

COSTA RICA STUDY - DMU CAPITAL COST ESTIMATES

SEGMENT: CIRUELAS TO PACIFIC STATION — ROUTE KM = 23.5

ITEM	COST CATEGORY	QNTY	UNIT	UNIT COST	TOTAL COST		ADJUSTED COST	REMARKS	LIFESPAN (YEARS)	ANNUALIZATION FACTOR	ANNUALIZED COST
1	USED TRACK, 100#-112# CWR	47	KM	$400,000	$18,800,000		$18,800,000	DOUBLE TRACK	30	0.1523	$2,863,244
2	USED TRACK, 100#-112# SIDING		KM	$300,000	$0				30		
3	USED TRACK, 100#-112# YARD	9	KM	$300,000	$2,700,000		$2,700,000	20% OF MAIN TRACK	30	0.1523	$411,211
4	USED XOVER, #6-#10 TURNOUTS	7	EACH	$100,000	$700,000		$700,000	PAIRED CROSSOVERS	30	0.1523	$106,610
5	USED TURNOUT, #8-#10, MAIN	4	EACH	$30,000	$120,000		$120,000		30	0.1523	$18,276
6	USED TURNOUT, #6, YARD	14	EACH	$25,000	$350,000		$350,000	YARD:1 PER 5 CARS	30	0.1523	$53,305
7	NEW RAILROAD SIGNAL SYSTEM	47	KM	$625,000	$29,375,000		$29,375,000	ATC W/CAB SIGNALS	30	0.1523	$4,473,818
8	NEW RAILROAD SIGNAL SYSTEM		KM	$375,000	$0			CTC			
9	NEW LRT ELECTRIFICATION SYS		KM	$925,000	$0			CATENARY	30		
10	NEW HWY CROSSING W/GATES	43	EACH	$125,000	$5,375,000		$5,375,000	RUBBER OR CONC	15	0.1710	$919,217
11	NEW HWY CROSSING W/LIGHTS		EACH	$75,000	$0			ASPHALT			
12	NEW HWY CROSSING W/SIGNS		EACH	$10,000	$0			GRAVEL			
13	NEW BRIDGE - MAJOR SPAN		EACH	$2,625,000	$0			AVG LGTH= 100 M			
14	NEW BRIDGE - OTHER SPAN		EACH	$525,000	$0			AVG LGTH= 40 M			
15	**REHAB BRIDGE - MAJOR SPAN**	**4**	**EACH**	**$125,000**	**$500,000**	x	**$300,000**	AVG LGTH= 100 M	30	0.1523	$76,150
16	**REHAB BRIDGE - OTHER SPAN**	**6**	**EACH**	**$50,000**	**$300,000**	x	**$180,000**	AVG LGTH= 40 M	30	0.1523	$45,690
17	NEW CULVERTS/DRAINAGE		EACH	$10,000	$0				30		
18	REHAB CULVERTS/DRAINAGE		EACH	$2,500	$0			1 PER KM	30		
19	EXCAVATION/GRADING - MAJOR		KM	$1,640,000	$0			INCL TUNNEL	30		
20	EXCAVATION/GRADING - MEDIUM		KM	$820,000	$0			INCL CUT/FILL	30		
21	**EXCAVATION/GRADING - MINOR**	**5**	**KM**	**$400,000**	**$2,000,000**	x	**$1,200,000**	BASE GRADING	30	0.1523	$304,600
22	**NEW STATION - TERMINAL**	**1**	**EACH**	**$100,000**	**$100,000**	x	**$60,000**		30	0.1523	$15,230
23	**NEW STATION - INTERMEDIATE**	**5**	**EACH**	**$50,000**	**$250,000**	x	**$150,000**		30	0.1523	$38,075
24	**REHAB EXISTING STATION**	**1**	**EACH**	**$150,000**	**$150,000**	x	**$90,000**	PACIFIC STATION	30	0.1523	$22,845
25	**REHAB MAIN YARD & SHOP**	**68**	**DMU**	**$75,000**	**$5,100,000**	x	**$3,060,000**	PACIFIC FACILITY	30	0.1523	$776,731
26	**NEW LAYOVER FACILITY**	**68**	**DMU**	**$20,000**	**$1,360,000**	x	**$616,000**	AT END-OF-LINE	30	0.1523	$207,128
27	NEW LIGHT RAIL VEHICLE		EACH	$2,000,000	$0						
28	NEW DIESEL MULTIPLE UNIT	68	EACH	$2,500,000	$170,000,000		$170,000,000		25	0.1547	$26,298,898
29	RIGHT-OF-WAY - URBAN		ACRE	$0	$0						
30	RIGHT-OF-WAY - RURAL		ACRE	$0	$0						
31	OTHER COST ITEM			$0	$0				30		
							ADJUSTED TOTAL		ADJUSTED AVERAGE		
	SUBTOTAL AND AVERAGE COST PER KM				$237,180,000		$233,276,000	$10,092,766	$9,926,638		$36,631,029
	DESIGN, CONSTRUCTION MGT, ETC.	20%			$47,436,000		$46,655,200				$7,326,206
	CONTINGENCY	25%			$59,295,000		$58,319,000				$9,157,757
	TOTAL AND AVERAGE COST PER KM				$343,911,000		$338,250,200	$14,634,511	$14,393,626		$53,114,992

COSTA RICA STUDY - DMU CAPITAL COST ESTIMATES

SEGMENT: ALAJUELA TO PACIFIC STATION VIA CIRUELAS **ROUTE KM = 31.5**

ITEM	COST CATEGORY	QNTY	UNIT	UNIT COST	TOTAL COST		ADJUSTED COST	REMARKS	LIFESPAN (YEARS)	ANNUALIZATION FACTOR	ANNUALIZED COST
1	USED TRACK, 100#-112# CWR	63	KM	$400,000	$25,200,000		$25,200,000	DOUBLE TRACK	30	0.1523	$3,837,965
2	USED TRACK, 100#-112# SIDING		KM	$300,000	$0				30		
3	USED TRACK, 100#-112# YARD	13	KM	$300,000	$3,900,000		$3,900,000	20% OF MAIN TRACK	30	0.1523	$593,971
4	USED XOVER, #6-#10 TURNOUTS	9	EACH	$100,000	$900,000		$900,000	PAIRED CROSSOVERS	30	0.1523	$137,070
5	USED TURNOUT, #8-#10, MAIN	5	EACH	$30,000	$150,000		$150,000		30	0.1523	$22,845
6	USED TURNOUT, #6, YARD	17	EACH	$25,000	$425,000		$425,000	YARD:1 PER 5 CARS	30	0.1523	$64,728
7	NEW RAILROAD SIGNAL SYSTEM	63	KM	$625,000	$39,375,000		$39,375,000	ATC W/CAB SIGNALS	30	0.1523	$5,996,820
8	NEW RAILROAD SIGNAL SYSTEM		KM	$375,000	$0			CTC			
9	NEW LRT ELECTRIFICATION SYS		KM	$925,000	$0			CATENARY	30		
10	NEW HWY CROSSING W/GATES	53	EACH	$125,000	$6,625,000		$6,625,000	RUBBER OR CONC	15	0.1710	$1,132,988
11	NEW HWY CROSSING W/LIGHTS		EACH	$75,000	$0			ASPHALT			
12	NEW HWY CROSSING W/SIGNS		EACH	$10,000	$0			GRAVEL			
13	NEW BRIDGE - MAJOR SPAN		EACH	$2,625,000	$0			AVG LGTH= 100 M			
14	NEW BRIDGE - OTHER SPAN		EACH	$525,000	$0			AVG LGTH= 40 M			
15	**REHAB BRIDGE - MAJOR SPAN**	**5**	**EACH**	**$125,000**	**$625,000**	X	**$375,000**	AVG LGTH= 100 M	30	0.1523	$95,188
16	**REHAB BRIDGE - OTHER SPAN**	**8**	**EACH**	**$50,000**	**$400,000**	X	**$240,000**	AVG LGTH= 40 M	30	0.1523	$60,920
17	NEW CULVERTS/DRAINAGE		EACH	$10,000	$0				30		
18	**REHAB CULVERTS/DRAINAGE**	**31**	**EACH**	**$2,500**	**$77,500**	X	**$46,500**	1 PER KM	30	0.1523	$11,803
19	EXCAVATION/GRADING - MAJOR		KM	$1,640,000	$0			INCL TUNNEL	30		
20	EXCAVATION/GRADING - MEDIUM		KM	$820,000	$0			INCL CUT/FILL	30		
21	**EXCAVATION/GRADING - MINOR**	**6**	**KM**	**$400,000**	**$2,400,000**	X	**$1,440,000**	BASE GRADING	30	0.1523	$365,520
22	**NEW STATION - TERMINAL**	**1**	**EACH**	**$100,000**	**$100,000**	X	**$60,000**		30	0.1523	$15,230
23	**NEW STATION - INTERMEDIATE**	**7**	**EACH**	**$50,000**	**$350,000**	X	**$210,000**		30	0.1523	$53,305
24	**REHAB EXISTING STATION**	**1**	**EACH**	**$150,000**	**$150,000**	X	**$90,000**	PACIFICSTATION	30	0.1523	$22,845
25	**REHAB MAIN YARD & SHOP**	**87**	**DMU**	**$75,000**	**$6,525,000**	X	**$3,915,000**	PACIFIC FACILITY	30	0.1523	$993,759
26	**NEW LAYOVER FACILITY**	**87**	**DMU**	**$20,000**	**$1,740,000**	X	**$1,044,000**	AT END-OF-LINE	30	0.1523	$265,002
27	NEW LIGHT RAIL VEHICLE		EACH	$2,000,000	$0						
28	NEW DIESEL MULTIPLE UNIT	87	EACH	$2,500,000	$217,500,000		$217,500,000		25	0.1547	$33,647,120
29	RIGHT-OF-WAY - URBAN		ACRE	$0	$0						
30	RIGHT-OF-WAY - RURAL		ACRE	$0	$0						
31	OTHER COST ITEM			$0	$0				30		
							ADJUSTED TOTAL		ADJUSTED AVERAGE		
	SUBTOTAL AND AVERAGE COST PER KM				$306,442,500		$301,495,500		$9,728,333	$9,571,286	$47,317,080
	DESIGN, CONSTRUCTION MGT, ETC.	20%			$61,288,500		$60,299,100				$9,463,416
	CONTINGENCY	25%			$76,610,625		$75,373,875				$11,829,270
	TOTAL AND AVERAGE COST PER KM				$444,341,625		$437,168,475		$14,106,083	$13,878,364	$68,609,765

COSTA RICA STUDY - DMU CAPITAL COST ESTIMATES

SEGMENT: ALAJUELA TO PACIFIC STA VIA SAN ANTONIO DE BELEN ROUTE KM = 22

ITEM	COST CATEGORY	QNTY	UNIT	UNIT COST	TOTAL COST		ADJUSTED COST	REMARKS	LIFESPAN (YEARS)	ANNUALIZATION FACTOR	ANNUALIZED COST
1	USED TRACK, 100#-112# CWR	44	KM	$400,000	$17,600,000		$17,600,000	DOUBLE TRACK	30	0.1523	$2,680,483
2	USED TRACK, 100#-112# SIDING		KM	$300,000	$0				30		
3	USED TRACK, 100#-112# YARD	9	KM	$300,000	$2,700,000		$2,700,000	20% OF MAIN TRACK	30	0.1523	$411,211
4	USED XOVER, #6-#10 TURNOUTS	7	EACH	$100,000	$700,000		$700,000	PAIRED CROSSOVERS	30	0.1523	$106,610
5	USED TURNOUT, #8-#10, MAIN	4	EACH	$30,000	$120,000		$120,000		30	0.1523	$18,276
6	USED TURNOUT, #6, YARD	13	EACH	$25,000	$325,000		$325,000	YARD:1 PER 5 CARS	30	0.1523	$49,498
7	NEW RAILROAD SIGNAL SYSTEM	44	KM	$625,000	$27,500,000		$27,500,000	ATC W/CAB SIGNALS	30	0.1523	$4,188,255
8	NEW RAILROAD SIGNAL SYSTEM		KM	$375,000	$0			CTC			
9	NEW LRT ELECTRIFICATION SYS		KM	$925,000	$0			CATENARY	30		
10	NEW HWY CROSSING W/GATES	41	EACH	$125,000	$5,125,000		$5,125,000	RUBBER OR CONC	15	0.1710	$876,462
11	NEW HWY CROSSING W/LIGHTS		EACH	$75,000	$0			ASPHALT			
12	NEW HWY CROSSING W/SIGNS		EACH	$10,000	$0			GRAVEL			
13	NEW BRIDGE - MAJOR SPAN		EACH	$2,625,000	$0			AVG LGTH= 100 M			
14	NEW BRIDGE - OTHER SPAN		EACH	$525,000	$0			AVG LGTH= 40 M			
15	**REHAB BRIDGE - MAJOR SPAN**	**6**	**EACH**	**$125,000**	**$750,000**	X	**$450,000**	AVG LGTH= 100 M	30	0.1523	$114,225
16	**REHAB BRIDGE - OTHER SPAN**	**7**	**EACH**	**$50,000**	**$350,000**	X	**$210,000**	AVG LGTH= 40 M	30	0.1523	$53,305
17	**NEW CULVERTS/DRAINAGE**	**6**	**EACH**	**$10,000**	**$60,000**	X	**$36,000**		30	0.1523	$9,138
18	**REHAB CULVERTS/DRAINAGE**	**16**	**EACH**	**$2,500**	**$40,000**	X	**$24,000**	1 PER KM	30	0.1523	$6,092
19	**EXCAVATION/GRADING - MAJOR**	**1**	**KM**	**$1,640,000**	**$1,640,000**	X	**$984,000**	INCL TUNNEL	30	0.1523	$249,772
20	**EXCAVATION/GRADING - MEDIUM**	**5**	**KM**	**$820,000**	**$4,100,000**	X	**$2,460,000**	INCL CUT/FILL	30	0.1523	$624,431
21	**EXCAVATION/GRADING - MINOR**	**3**	**KM**	**$400,000**	**$1,200,000**	X	**$720,000**	BASE GRADING	30	0.1523	$182,760
22	**NEW STATION - TERMINAL**	**1**	**EACH**	**$100,000**	**$100,000**	X	**$60,000**	ALAJUELA	30	0.1523	$15,230
23	**NEW STATION - INTERMEDIATE**	**4**	**EACH**	**$50,000**	**$200,000**	X	**$120,000**		30	0.1523	$30,460
24	**REHAB EXISTING STATION**	**1**	**EACH**	**$150,000**	**$150,000**	X	**$90,000**	PACIFIC STATION	30	0.1523	$22,845
25	**REHAB MAIN YARD & SHOP**	**63**	**DMU**	**$75,000**	**$4,725,000**	X	**$2,835,000**	PACIFIC FACILITY	30	0.1523	$719,618
26	**NEW LAYOVER FACILITY**	**63**	**DMU**	**$20,000**	**$1,260,000**	X	**$756,000**	AT END-OF-LINE	30	0.1523	$191,898
27	NEW LIGHT RAIL VEHICLE		EACH	$2,000,000	$0						
28	NEW DIESEL MULTIPLE UNIT	63	EACH	$2,500,000	$157,500,000		$157,500,000		25	0.1547	$24,365,156
29	RIGHT-OF-WAY - URBAN		ACRE	$0	$0						
30	RIGHT-OF-WAY - RURAL		ACRE	$0	$0						
31	NEW UNDERGROUND AIRPORT STA	1	LS	$1,000,000	$1,000,000		$1,000,000		30	0.1523	$152,300
							ADJUSTED TOTAL		**ADJUSTED AVERAGE**		
	SUBTOTAL AND AVERAGE COST PER KM				$227,145,000		$221,315,000	$10,324,773	$10,059,773		$35,068,027
	DESIGN, CONSTRUCTION MGT, ETC.	20%			$45,429,000		$44,263,000				$7,013,605
	CONTINGENCY	25%			$56,786,250		$55,328,750				$8,767,007
	TOTAL AND AVERAGE COST PER KM				$329,360,250		$320,906,750	$14,970,920	$14,586,670		$50,848,639

COSTA RICA STUDY - DMU CAPITAL COST ESTIMATES

SEGMENT: ATLANTIC TO PACIFIC STATIONS (DOUBLE TRACK) ROUTE KM = 3.1

ITEM	COST CATEGORY	QNTY	UNIT	UNIT COST	TOTAL COST		ADJUSTED COST	REMARKS	LIFESPAN (YEARS)	ANNUALIZATION FACTOR	ANNUALIZED COST
1	USED TRACK, 100#-112# CWR	6.2	KM	$400,000	$2,480,000		$2,480,000	DOUBLE TRACK	30	0.1523	$377,704
2	USED TRACK, 100#-112# SIDING		KM	$300,000	$0				30		
3	USED TRACK, 100#-112# YARD	1	KM	$300,000	$300,000		$300,000	20% OF MAIN TRACK	30	0.1523	$45,690
4	USED XOVER, #6-#10 TURNOUTS	2	EACH	$100,000	$200,000		$200,000	ON ATL & PAC LINES	30	0.1523	$30,460
5	USED TURNOUT, #8-#10, MAIN	4	EACH	$30,000	$120,000		$120,000		30	0.1523	$18,276
6	USED TURNOUT, #6, YARD	6	EACH	$25,000	$150,000		$150,000	YARD:1 PER 5 CARS	30	0.1523	$22,845
7	NEW RAILROAD SIGNAL SYSTEM	6.2	KM	$625,000	$3,875,000		$3,875,000	ATC W/CAB SIGNALS	30	0.1523	$590,163
8	NEW RAILROAD SIGNAL SYSTEM		KM	$375,000	$0			CTC			
9	NEW LRT ELECTRIFICATION SYS		KM	$925,000	$0			CATENARY	30		
10	NEW HWY CROSSING W/GATES	18	EACH	$125,000	$2,250,000		$2,250,000	RUBBER OR CONC	15	0.1710	$384,788
11	NEW HWY CROSSING W/LIGHTS		EACH	$75,000	$0			ASPHALT			
12	NEW HWY CROSSING W/SIGNS		EACH	$10,000	$0			GRAVEL			
13	NEW BRIDGE - MAJOR SPAN		EACH	$2,625,000	$0			AVG LGTH= 100 M			
14	NEW BRIDGE - OTHER SPAN		EACH	$525,000	$0			AVG LGTH= 40 M			
15	REHAB BRIDGE - MAJOR SPAN		EACH	$125,000	$0			AVG LGTH= 100 M	30		
16	REHAB BRIDGE - OTHER SPAN		EACH	$50,000	$0			AVG LGTH= 40 M	30		
17	NEW CULVERTS/DRAINAGE		EACH	$10,000	$0				30		
18	REHAB CULVERTS/DRAINAGE		EACH	$2,500	$0			1 PER KM	30		
19	EXCAVATION/GRADING - MAJOR		KM	$1,640,000	$0			INCL TUNNEL	30		
20	EXCAVATION/GRADING - MEDIUM		KM	$820,000	$0			INCL CUT/FILL	30		
21	**EXCAVATION/GRADING - MINOR**	**3.1**	**KM**	**$400,000**	**$1,240,000**	X	**$744,000**	BASE GRADING	30	0.1523	$188,852
22	NEW STATION - TERMINAL		EACH	$100,000	$0				30		
23	**NEW STATION - INTERMEDIATE**	**4**	**EACH**	**$50,000**	**$200,000**	X	**$120,000**		30	0.1523	$30,460
24	REHAB EXISTING STATION		EACH	$150,000	$0				30		
25	**REHAB MAIN YARD & SHOP**	**30**	**DMU**	**$75,000**	**$2,250,000**	X	**$1,350,000**	PACIFIC FACILITY	30	0.1523	$342,675
26	**NEW LAYOVER FACILITY**	**30**	**DMU**	**$20,000**	**$600,000**	X	**$360,000**	AT END-OF-LINE	30	0.1523	$91,380
27	NEW LIGHT RAIL VEHICLE		EACH	$2,000,000	$0						
28	NEW DIESEL MULTIPLE UNIT	30	EACH	$2,500,000	$75,000,000		$75,000,000		25	0.1547	$11,602,455
29	RIGHT-OF-WAY - URBAN		ACRE	$0	$0						
30	RIGHT-OF-WAY - RURAL		ACRE	$0	$0						
31	RAILROAD DIAMOND CROSSING	1	EACH	$100,000	$100,000		$100,000	ON ATLANTIC LINE	30	0.1523	$15,230
							ADJUSTED TOTAL		**ADJUSTED AVERAGE**		
	SUBTOTAL AND AVERAGE COST PER KM				$88,765,000		$87,049,000	$28,633,871	$28,080,323		$13,740,980
	DESIGN, CONSTRUCTION MGT, ETC.	20%			$17,753,000		$17,409,800				$2,748,196
	CONTINGENCY	25%			$22,191,250		$21,762,250				$3,435,245
	TOTAL AND AVERAGE COST PER KM				$128,709,250		$126,221,050	$41,519,113	$40,716,468		$19,924,421

COSTA RICA STUDY - DMU CAPITAL COST ESTIMATES

SEGMENT: ATLANTIC TO PACIFIC STATIONS (SINGLE TRACK) **ROUTE KM = 3.1**

ITEM	COST CATEGORY	QNTY	UNIT	UNIT COST	TOTAL COST		ADJUSTED COST	REMARKS	LIFESPAN (YEARS)	ANNUALIZATION FACTOR	ANNUALIZED COST
1	USED TRACK, 100#-112# CWR	3.1	KM	$400,000	$1,240,000		$1,240,000	SINGLE TRACK	30	0.1523	$188,852
2	USED TRACK, 100#-112# SIDING		KM	$300,000	$0				30		
3	USED TRACK, 100#-112# YARD	1	KM	$300,000	$300,000		$300,000		30	0.1523	$45,690
4	USED XOVER, #6-#10 TURNOUTS	2	EACH	$100,000	$200,000		$200,000	ON ATL & PAC LINES	30	0.1523	$30,460
5	USED TURNOUT, #8-#10, MAIN	2	EACH	$30,000	$60,000		$60,000		30	0.1523	$9,138
6	USED TURNOUT, #6, YARD	3	EACH	$25,000	$75,000		$75,000	YARD:1 PER 5 CARS	30	0.1523	$11,423
7	NEW RAILROAD SIGNAL SYSTEM	3.1	KM	$625,000	$1,937,500		$1,937,500	ATC W/CAB SIGNALS	30	0.1523	$295,082
8	NEW RAILROAD SIGNAL SYSTEM		KM	$375,000	$0			CTC			
9	NEW LRT ELECTRIFICATION SYS		KM	$925,000	$0			CATENARY	30		
10	NEW HWY CROSSING W/GATES	18	EACH	$125,000	$2,250,000		$2,250,000	RUBBER OR CONC	15	0.1710	$384,788
11	NEW HWY CROSSING W/LIGHTS		EACH	$75,000	$0			ASPHALT			
12	NEW HWY CROSSING W/SIGNS		EACH	$10,000	$0			GRAVEL			
13	NEW BRIDGE - MAJOR SPAN		EACH	$2,625,000	$0			AVG LGTH= 100 M			
14	NEW BRIDGE - OTHER SPAN		EACH	$525,000	$0			AVG LGTH= 40 M			
15	REHAB BRIDGE - MAJOR SPAN		EACH	$125,000	$0			AVG LGTH= 100 M	30		
16	REHAB BRIDGE - OTHER SPAN		EACH	$50,000	$0			AVG LGTH= 40 M	30		
17	NEW CULVERTS/DRAINAGE		EACH	$10,000	$0				30		
18	REHAB CULVERTS/DRAINAGE		EACH	$2,500	$0			1 PER KM	30		
19	EXCAVATION/GRADING - MAJOR		KM	$1,640,000	$0			INCL TUNNEL	30		
20	EXCAVATION/GRADING - MEDIUM		KM	$820,000	$0			INCL CUT/FILL	30		
21	**EXCAVATION/GRADING - MINOR**	3.1	KM	$400,000	$1,240,000	x	$744,000	BASE GRADING	30	0.1523	$188,852
22	NEW STATION - TERMINAL		EACH	$100,000	$0				30		
23	**NEW STATION - INTERMEDIATE**	4	EACH	$50,000	$200,000	x	$120,000		30	0.1523	$30,460
24	REHAB EXISTING STATION		EACH	$150,000	$0				30		
25	**REHAB MAIN YARD & SHOP**	15	DMU	$75,000	$1,125,000	x	$675,000	PACIFIC FACILITY	30	0.1523	$171,338
26	**NEW LAYOVER FACILITY**	15	DMU	$20,000	$300,000	x	$180,000	AT END-OF-LINE	30	0.1523	$45,690
27	NEW LIGHT RAIL VEHICLE		EACH	$2,000,000	$0						
28	NEW DIESEL MULTIPLE UNIT	15	EACH	$2,500,000	$37,500,000		$37,500,000		25	0.1547	$5,801,228
29	RIGHT-OF-WAY - URBAN		ACRE	$0	$0						
30	RIGHT-OF-WAY - RURAL		ACRE	$0	$0						
31	OTHER COST ITEM			$0	$0				30		
							ADJUSTED TOTAL		ADJUSTED AVERAGE		
	SUBTOTAL AND AVERAGE COST PER KM				$46,427,500		$45,281,500	$14,976,613	$14,606,935		$7,203,001
	DESIGN, CONSTRUCTION MGT, ETC.	20%			$9,285,500		$9,056,300				$1,440,600
	CONTINGENCY	25%			$11,606,875		$11,320,375				$1,800,750
	TOTAL AND AVERAGE COST PER KM				$67,319,875		$65,658,175	$21,716,089	$21,180,056		$10,444,351

COSTA RICA STUDY - LRT CAPITAL COST ESTIMATES

SEGMENT: HEREDIA TO SAN PEDRO   ROUTE KM = 11.0

ITEM	COST CATEGORY	QNTY	UNIT	UNIT COST	TOTAL COST		ADJUSTED COST	REMARKS	LIFESPAN (YEARS)	ANNUALIZATION FACTOR	ANNUALIZED COST
1	USED TRACK, 100#-112# CWR	22	KM	$400,000	$8,800,000		$8,800,000	DOUBLE TRACK	30	0.1523	$1,340,242
2	USED TRACK, 100#-112# SIDING		KM	$300,000	$0				30		
3	USED TRACK, 100#-112# YARD	4.4	KM	$300,000	$1,320,000		$1,320,000	20% OF MAIN TRACK	30	0.1523	$201,036
4	USED XOVER, #6-#10 TURNOUTS	4	EACH	$100,000	$400,000		$400,000	PAIRED CROSSOVERS	30	0.1523	$60,920
5	USED TURNOUT, #8-#10, MAIN	2	EACH	$30,000	$60,000		$60,000		30	0.1523	$9,138
6	USED TURNOUT, #6, YARD	10	EACH	$25,000	$250,000		$250,000	YARD-1 PER 5 CARS	30	0.1523	$38,075
7	NEW RAILROAD SIGNAL SYSTEM	22	KM	$625,000	$13,750,000		$13,750,000	ATC W/CAB SIGNALS	30	0.1523	$2,094,128
8	NEW RAILROAD SIGNAL SYSTEM		KM	$375,000	$0			CTC			
9	NEW LRT ELECTRIFICATION SYS	26.4	KM	$925,000	$24,420,000		$24,420,000	CATENARY	30	0.1523	$3,719,171
10	NEW HWY CROSSING W/GATES	31	EACH	$125,000	$3,875,000		$3,875,000	RUBBER OR CONC	15	0.1710	$662,691
11	NEW HWY CROSSING W/LIGHTS		EACH	$75,000	$0			ASPHALT			
12	NEW HWY CROSSING W/SIGNS		EACH	$10,000	$0			GRAVEL			
13	NEW BRIDGE - MAJOR SPAN		EACH	$2,625,000	$0			AVG LGTH= 100 M			
14	NEW BRIDGE - OTHER SPAN		EACH	$525,000	$0			AVG LGTH= 40 M			
15	**REHAB BRIDGE - MAJOR SPAN**	**4**	**EACH**	**$125,000**	**$500,000**	X	**$300,000**	AVG LGTH= 100 M	30	0.1523	$76,150
16	**REHAB BRIDGE - OTHER SPAN**	**3**	**EACH**	**$50,000**	**$150,000**	X	**$90,000**	AVG LGTH= 40 M	30	0.1523	$22,845
17	**NEW CULVERTS/DRAINAGE**	**1**	**EACH**	**$10,000**	**$10,000**	X	**$6,000**	SAN AGUSTIN	30	0.1523	$1,523
18	**REHAB CULVERTS/DRAINAGE**	**10**	**EACH**	**$2,500**	**$25,000**	X	**$15,000**	1 PER KM	30	0.1523	$3,808
19	EXCAVATION/GRADING - MAJOR		KM	$1,640,000	$0			INCL TUNNEL	30		
20	EXCAVATION/GRADING - MEDIUM	2	KM	$820,000	$1,640,000	X	$984,000	INCL CUT/FILL	30	0.1523	$249,772
21	EXCAVATION/GRADING - MINOR	2	KM	$400,000	$800,000	X	$480,000	BASE GRADING	30	0.1523	$121,840
22	NEW STATION - TERMINAL	2	EACH	$100,000	$200,000	X	$120,000		30	0.1523	$30,460
23	NEW STATION - INTERMEDIATE	4	EACH	$50,000	$200,000	X	$120,000		30	0.1523	$30,460
24	REHAB EXISTING STATION	1	EACH	$150,000	$150,000	X	$90,000	ATLANTIC STATION	30	0.1523	$22,845
25	REHAB MAIN YARD & SHOP	49	LRV	$75,000	$3,675,000	X	$2,205,000	PACIFIC FACILITY	30	0.1523	$559,703
26	NEW LAYOVER FACILITY	49	LRV	$20,000	$980,000	X	$588,000	AT END-OF-LINE	30	0.1523	$149,254
27	NEW LIGHT RAIL VEHICLE	49	EACH	$2,000,000	$98,000,000		$98,000,000		25	0.1547	$15,160,541
28	NEW DIESEL MULTIPLE UNIT		EACH	$2,500,000	$0						
29	RIGHT-OF-WAY - URBAN		ACRE	$0	$0						
30	RIGHT-OF-WAY - RURAL		ACRE	$0	$0						
31	OTHER COST ITEM			$0	$0						
							ADJUSTED TOTAL		ADJUSTED AVERAGE		
	SUBTOTAL AND AVERAGE COST PER KM				$159,205,000		$155,873,000	$14,473,182	$14,170,273		$24,554,603
	DESIGN, CONSTRUCTION MGT, ETC.		20%		$31,841,000		$31,174,600				$4,910,921
	CONTINGENCY		25%		$39,801,250		$38,968,250				$6,138,651
	TOTAL AND AVERAGE COST PER KM				$230,847,250		$226,015,850	$20,986,114	$20,546,895		$35,604,174

COSTA RICA STUDY - LRT CAPITAL COST ESTIMATES

SEGMENT: ALAJUELA TO SAN PEDRO **ROUTE KM = 23**

ITEM	COST CATEGORY	QNTY	UNIT	UNIT COST	TOTAL COST		ADJUSTED COST	REMARKS	LIFESPAN (YEARS)	ANNUALIZATION FACTOR	ANNUALIZED COST
1	USED TRACK, 100#-112# CWR	46	KM	$400,000	$18,400,000		$18,400,000	DOUBLE TRACK	30	0.1523	$2,802,324
2	USED TRACK, 100#-112# SIDING		KM	$300,000	$0				30		
3	USED TRACK, 100#-112# YARD	9	KM	$300,000	$2,700,000		$2,700,000	20% OF MAIN TRACK	30	0.1523	$411,211
4	USED XOVER, #6-#10 TURNOUTS	7	EACH	$100,000	$700,000		$700,000	PAIRED CROSSOVERS	30	0.1523	$106,610
5	USED TURNOUT, #8-#10, MAIN	4	EACH	$30,000	$120,000		$120,000		30	0.1523	$18,276
6	USED TURNOUT, #6, YARD	16	EACH	$25,000	$400,000		$400,000	YARD:1 PER 5 CARS	30	0.1523	$60,920
7	NEW RAILROAD SIGNAL SYSTEM	46	KM	$625,000	$28,750,000		$28,750,000	ATC W/CAB SIGNALS	30	0.1523	$4,378,631
8	NEW RAILROAD SIGNAL SYSTEM		KM	$375,000	$0			CTC			
9	NEW LRT ELECTRIFICATION SYS	55	KM	$925,000	$50,875,000		$50,875,000	CATENARY	30	0.1523	$7,748,273
10	NEW HWY CROSSING W/GATES	61	EACH	$125,000	$7,625,000		$7,625,000	RUBBER OR CONC	15	0.1710	$1,304,005
11	NEW HWY CROSSING W/LIGHTS		EACH	$75,000	$0			ASPHALT			
12	NEW HWY CROSSING W/SIGNS		EACH	$10,000	$0			GRAVEL			
13	NEW BRIDGE - MAJOR SPAN		EACH	$2,625,000	$0			AVG LGTH= 100 M			
14	NEW BRIDGE - OTHER SPAN		EACH	$525,000	$0			AVG LGTH= 40 M			
15	**REHAB BRIDGE - MAJOR SPAN**	6	EACH	$125,000	$750,000	X	$450,000	AVG LGTH= 100 M	30	0.1523	$114,225
16	**REHAB BRIDGE - OTHER SPAN**	5	EACH	$50,000	$250,000	X	$150,000	AVG LGTH= 40 M	30	0.1523	$38,075
17	**NEW CULVERTS/DRAINAGE**	1	EACH	$10,000	$10,000	X	$6,000	SAN AGUSTIN	30	0.1523	$1,523
18	**REHAB CULVERTS/DRAINAGE**	22	EACH	$2,500	$55,000	X	$33,000	1 PER KM	30	0.1523	$8,377
19	EXCAVATION/GRADING - MAJOR		KM	$1,640,000	$0			INCL TUNNEL	30		
20	**EXCAVATION/GRADING - MEDIU**	3	KM	$620,000	$2,460,000	X	$1,476,000	INCL CUT/FILL	30	0.1523	$374,658
21	**EXCAVATION/GRADING - MINOR**	4	KM	$400,000	$1,600,000	X	$960,000	BASE GRADING	30	0.1523	$243,680
22	**NEW STATION - TERMINAL**	2	EACH	$100,000	$200,000	X	$120,000		30	0.1523	$30,460
23	**NEW STATION - INTERMEDIATE**	7	EACH	$50,000	$350,000	X	$210,000		30	0.1523	$53,305
24	**REHAB EXISTING STATION**	1	EACH	$150,000	$150,000	X	$90,000	ATLANTIC STATION	30	0.1523	$22,845
25	**REHAB MAIN YARD & SHOP**	82	LRV	$75,000	$6,150,000	X	$3,690,000	PACIFIC FACILITY	30	0.1523	$936,646
26	**NEW LAYOVER FACILITY**	82	LRV	$20,000	$1,640,000	X	$984,000	AT END-OF-LINE	30	0.1523	$249,772
27	NEW LIGHT RAIL VEHICLE	82	EACH	$2,000,000	$164,000,000		$164,000,000		25	0.1547	$25,370,702
28	NEW DIESEL MULTIPLE UNIT		EACH	$2,500,000	$0						
29	RIGHT-OF-WAY - URBAN		ACRE	$0	$0						
30	RIGHT-OF-WAY - RURAL		ACRE	$0	$0						
31	OTHER COST ITEM			$0	$0						
							ADJUSTED TOTAL		ADJUSTED AVERAGE		
	SUBTOTAL AND AVERAGE COST PER KM				$287,185,000		$281,739,000	$12,486,304	$12,249,522		$44,274,518
	DESIGN, CONSTRUCTION MGT, ETC.	20%			$57,437,000		$56,347,800				$8,854,904
	CONTINGENCY	25%			$71,796,250		$70,434,750				$11,068,629
	TOTAL AND AVERAGE COST PER KM				$416,418,250		$408,521,550	$18,105,141	$17,761,807		$64,198,051

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COSTA RICA STUDY - LRT CAPITAL COST ESTIMATES

SEGMENT: ALAJUELA TO CARTAGO ROUTE KM = 41.4

ITEM	COST CATEGORY	QNTY	UNIT	UNIT COST	TOTAL COST		ADJUSTED COST	REMARKS	LIFESPAN (YEARS)	ANNUALIZATION FACTOR	ANNUALIZED COST
1	USED TRACK, 100#-112# CWR	82.8	KM	$400,000	$33,120,000		$33,120,000	DOUBLE TRACK	30	0.1523	$5,044,183
2	USED TRACK, 100#-112# SIDING		KM	$300,000	$0				30		
3	USED TRACK, 100#-112# YARD	17	KM	$300,000	$5,100,000		$5,100,000	20% OF MAIN TRACK	30	0.1523	$776,731
4	USED XOVER, #6-#10 TURNOUTS	10	EACH	$100,000	$1,000,000		$1,000,000	PAIRED CROSSOVERS	30	0.1523	$152,300
5	USED TURNOUT, #8-#10, MAIN	6	EACH	$30,000	$180,000		$180,000		30	0.1523	$27,414
6	USED TURNOUT, #6, YARD	18	EACH	$25,000	$450,000		$450,000	YARD:1 PER 5 CARS	30	0.1523	$68,535
7	NEW RAILROAD SIGNAL SYSTEM	82.8	KM	$625,000	$51,750,000		$51,750,000	ATC W/CAB SIGNALS	30	0.1523	$7,881,535
8	NEW RAILROAD SIGNAL SYSTEM		KM	$375,000	$0			CTC			
9	NEW LRT ELECTRIFICATION SYS	99.8	KM	$925,000	$92,315,000		$92,315,000	CATENARY	30	0.1523	$14,059,593
10	NEW HWY CROSSING W/GATES	85	EACH	$125,000	$10,825,000		$10,625,000	RUBBER OR CONC	15	0.1710	$1,617,056
11	NEW HWY CROSSING W/LIGHTS		EACH	$75,000	$0			ASPHALT			
12	NEW HWY CROSSING W/SIGNS		EACH	$10,000	$0			GRAVEL			
13	NEW BRIDGE - MAJOR SPAN		EACH	$2,625,000	$0			AVG LGTH= 100 M			
14	NEW BRIDGE - OTHER SPAN		EACH	$525,000	$0			AVG LGTH= 40 M			
15	**REHAB BRIDGE - MAJOR SPAN**	7	EACH	$125,000	$875,000	x	$525,000	AVG LGTH= 100 M	30	0.1523	$133,263
16	**REHAB BRIDGE - OTHER SPAN**	5	EACH	$50,000	$250,000	x	$150,000	AVG LGTH= 40 M	30	0.1523	$38,075
17	**NEW CULVERTS/DRAINAGE**	1	EACH	$10,000	$10,000	x	$6,000	SAN AGUSTIN	30	0.1523	$1,523
18	**REHAB CULVERTS/DRAINAGE**	40	EACH	$2,500	$100,000	x	$60,000	1 PER KM	30	0.1523	$15,230
19	EXCAVATION/GRADING - MAJOR		KM	$1,640,000	$0			INCL TUNNEL	30		
20	**EXCAVATION/GRADING - MEDIUI**	4	KM	$820,000	$3,280,000	x	$1,968,000	INCL CUT/FILL	30	0.1523	$499,545
21	**EXCAVATION/GRADING - MINOR**	4	KM	$400,000	$1,600,000	x	$960,000	BASE GRADING	30	0.1523	$243,680
22	**NEW STATION - TERMINAL**	1	EACH	$100,000	$100,000	x	$60,000		30	0.1523	$15,230
23	**NEW STATION - INTERMEDIATE**	11	EACH	$50,000	$550,000	x	$330,000		30	0.1523	$83,765
24	**REHAB EXISTING STATION**	2	EACH	$150,000	$300,000	x	$180,000	ATLANTIC & CARTAGO	30	0.1523	$45,690
25	**REHAB MAIN YARD & SHOP**	92	LRV	$75,000	$6,900,000	x	$4,140,000	PACIFIC FACILITY	30	0.1523	$1,050,871
26	**NEW LAYOVER FACILITY**	92	LRV	$20,000	$1,840,000	x	$1,104,000	AT END-OF-LINE	30	0.1523	$280,232
27	NEW LIGHT RAIL VEHICLE	92	EACH	$2,000,000	$184,000,000		$184,000,000		25	0.1547	$28,464,690
28	NEW DIESEL MULTIPLE UNIT		EACH	$2,500,000	$0						
29	RIGHT-OF-WAY - URBAN		ACRE	$0	$0						
30	RIGHT-OF-WAY - RURAL		ACRE	$0	$0						
31	OTHER COST ITEM			$0	$0						
							ADJUSTED TOTAL		ADJUSTED AVERAGE		
	SUBTOTAL AND AVERAGE COST PER KM				$394,345,000		$388,023,000	$9,525,242	$9,372,538		$60,699,142
	DESIGN, CONSTRUCTION MGT, ETC.		20%		$78,869,000		$77,604,600				$12,139,828
	CONTINGENCY		25%		$98,586,250		$97,005,750				$15,174,785
	TOTAL AND AVERAGE COST PER KM				$571,800,250		$582,633,350	$13,811,600	$13,590,178		$88,013,756

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COSTA RICA STUDY - LRT CAPITAL COST ESTIMATES

SEGMENT: SAN ANTONIO DE BELEN TO PACIFIC STATION   ROUTE KM = 16

ITEM	COST CATEGORY	QNTY	UNIT	UNIT COST	TOTAL COST		ADJUSTED COST	REMARKS	LIFESPAN (YEARS)	ANNUALIZATION FACTOR	ANNUALIZED COST
1	USED TRACK, 100#-112# CWR	32	KM	$400,000	$12,800,000		$12,800,000	DOUBLE TRACK	30	0.1523	$1,949,443
2	USED TRACK, 100#-112# SIDING		KM	$300,000	$0				30		
3	USED TRACK, 100#-112# YARD	6	KM	$300,000	$1,800,000		$1,800,000	20% OF MAIN TRACK	30	0.1523	$274,140
4	USED XOVER, #6-#10 TURNOUTS	5	EACH	$100,000	$500,000		$500,000	PAIRED CROSSOVERS	30	0.1523	$76,150
5	USED TURNOUT, #8-#10, MAIN	3	EACH	$30,000	$90,000		$90,000		30	0.1523	$13,707
6	USED TURNOUT, #6, YARD	12	EACH	$25,000	$300,000		$300,000	YARD:1 PER 5 CARS	30	0.1523	$45,690
7	NEW RAILROAD SIGNAL SYSTEM	32	KM	$625,000	$20,000,000		$20,000,000	ATC W/CAB SIGNALS	30	0.1523	$3,046,004
8	NEW RAILROAD SIGNAL SYSTEM		KM	$375,000	$0			CTC			
9	NEW LRT ELECTRIFICATION SYS	38	KM	$925,000	$35,150,000		$35,150,000	CATENARY	30	0.1523	$5,353,352
10	NEW HWY CROSSING W/GATES	38	EACH	$125,000	$4,750,000		$4,750,000	RUBBER OR CONC	15	0.1710	$812,331
11	NEW HWY CROSSING W/LIGHTS		EACH	$75,000	$0			ASPHALT			
12	NEW HWY CROSSING W/SIGNS		EACH	$10,000	$0			GRAVEL			
13	NEW BRIDGE - MAJOR SPAN		EACH	$2,625,000	$0			AVG LGTH= 100 M			
14	NEW BRIDGE - OTHER SPAN		EACH	$525,000	$0			AVG LGTH= 40 M			
15	**REHAB BRIDGE - MAJOR SPAN**	**3**	**EACH**	**$125,000**	**$375,000**	**X**	**$225,000**	AVG LGTH= 100 M	30	0.1523	$57,113
16	**REHAB BRIDGE - OTHER SPAN**	**5**	**EACH**	**$50,000**	**$250,000**	**X**	**$150,000**	AVG LGTH= 40 M	30	0.1523	$38,075
17	NEW CULVERTS/DRAINAGE		EACH	$10,000	$0				30		
18	**REHAB CULVERTS/DRAINAGE**	**16**	**EACH**	**$2,500**	**$40,000**	**X**	**$24,000**	1 PER KM	30	0.1523	$6,092
19	EXCAVATION/GRADING - MAJOR		KM	$1,640,000	$0			INCL TUNNEL	30		
20	EXCAVATION/GRADING - MEDIUM		KM	$820,000	$0			INCL CUT/FILL	30		
21	**EXCAVATION/GRADING - MINOR**	**3**	**KM**	**$400,000**	**$1,200,000**	**X**	**$720,000**	BASE GRADING	30	0.1523	$182,760
22	**NEW STATION - TERMINAL**	**1**	**EACH**	**$100,000**	**$100,000**	**X**	**$60,000**		30	0.1523	$15,230
23	**NEW STATION - INTERMEDIATE**	**3**	**EACH**	**$50,000**	**$150,000**	**X**	**$90,000**		30	0.1523	$22,845
24	**REHAB EXISTING STATION**	**1**	**EACH**	**$150,000**	**$150,000**	**X**	**$90,000**	PACIFIC STATION	30	0.1523	$22,845
25	**REHAB MAIN YARD & SHOP**	**58**	**LRV**	**$75,000**	**$4,350,000**	**X**	**$2,610,000**	PACIFIC FACILITY	30	0.1523	$662,506
26	**NEW LAYOVER FACILITY**	**58**	**LRV**	**$20,000**	**$1,160,000**	**X**	**$696,000**	AT END-OF-LINE	30	0.1523	$176,668
27	NEW LIGHT RAIL VEHICLE	58	EACH	$2,000,000	$116,000,000		$116,000,000		25	0.1547	$17,945,131
28	NEW DIESEL MULTIPLE UNIT		EACH	$2,500,000	$0						
29	RIGHT-OF-WAY - URBAN		ACRE	$0	$0						
30	RIGHT-OF-WAY - RURAL		ACRE	$0	$0						
31	OTHER COST ITEM			$0	$0						
							ADJUSTED TOTAL		ADJUSTED AVERAGE		
	SUBTOTAL AND AVERAGE COST PER KM				$199,165,000		$196,055,000	$12,447,813	$12,253,438		$30,700,082
	DESIGN, CONSTRUCTION MGT, ETC.	20%			$39,833,000		$39,211,000				$6,140,016
	CONTINGENCY	25%			$49,791,250		$49,013,750				$7,675,020
	TOTAL AND AVERAGE COST PER KM				$288,789,250		$284,279,750	$18,049,328	$17,767,484		$44,515,118

COSTA RICA STUDY - LRT CAPITAL COST ESTIMATES

SEGMENT: PAVAS TO PACIFIC STATION **ROUTE KM = 7**

ITEM	COST CATEGORY	QNTY	UNIT	UNIT COST	TOTAL COST		ADJUSTED COST	REMARKS	LIFESPAN (YEARS)	ANNUALIZATION FACTOR	ANNUALIZED COST
1	USED TRACK, 100#-112# CWR	14	KM	$400,000	$5,600,000		$5,600,000	DOUBLE TRACK	30	0.1523	$852,881
2	USED TRACK, 100#-112# SIDING	1	KM	$300,000	$300,000		$300,000		30	0.1523	$45,690
3	USED TRACK, 100#-112# YARD	3	KM	$300,000	$900,000		$900,000	20% OF MAIN TRACK	30	0.1523	$137,070
4	USED XOVER, #6-#10 TURNOUTS	3	EACH	$100,000	$300,000		$300,000	PAIRED CROSSOVERS	30	0.1523	$45,690
5	USED TURNOUT, #8-#10, MAIN	1	EACH	$30,000	$30,000		$30,000		30	0.1523	$4,569
6	USED TURNOUT, #6, YARD	7	EACH	$25,000	$175,000		$175,000	YARD:1 PER 5 CARS	30	0.1523	$26,653
7	NEW RAILROAD SIGNAL SYSTEM	14	KM	$625,000	$8,750,000		$8,750,000	ATC W/CAB SIGNALS	30	0.1523	$1,332,627
8	NEW RAILROAD SIGNAL SYSTEM		KM	$375,000	$0			CTC			
9	NEW LRT ELECTRIFICATION SYS	17	KM	$925,000	$15,725,000		$15,725,000	CATENARY	30	0.1523	$2,394,921
10	NEW HWY CROSSING W/GATES	23	EACH	$125,000	$2,875,000		$2,875,000	RUBBER OR CONC	15	0.1710	$491,674
11	NEW HWY CROSSING W/LIGHTS		EACH	$75,000	$0			ASPHALT			
12	NEW HWY CROSSING W/SIGNS		EACH	$10,000	$0			GRAVEL			
13	NEW BRIDGE - MAJOR SPAN		EACH	$2,625,000	$0			AVG LGTH= 100 M			
14	NEW BRIDGE - OTHER SPAN		EACH	$525,000	$0			AVG LGTH= 40 M			
15	REHAB BRIDGE - MAJOR SPAN		EACH	$125,000	$0			AVG LGTH= 100 M	30		
16	**REHAB BRIDGE - OTHER SPAN**	**4**	**EACH**	**$50,000**	**$200,000**	X	**$120,000**	AVG LGTH= 40 M	30	0.1523	$30,460
17	NEW CULVERTS/DRAINAGE		EACH	$10,000	$0				30		
18	**REHAB CULVERTS/DRAINAGE**	**7**	**EACH**	**$2,500**	**$17,500**	X	**$10,500**	1 PER KM	30	0.1523	$2,665
19	EXCAVATION/GRADING - MAJOR		KM	$1,640,000	$0			INCL TUNNEL	30		
20	EXCAVATION/GRADING - MEDIUM		KM	$820,000	$0			INCL CUT/FILL	30		
21	**EXCAVATION/GRADING - MINOR**	**1**	**KM**	**$400,000**	**$400,000**	X	**$240,000**	BASE GRADING	30	0.1523	$60,920
22	**NEW STATION - TERMINAL**	**1**	**EACH**	**$100,000**	**$100,000**	X	**$60,000**		30	0.1523	$15,230
23	**NEW STATION - INTERMEDIATE**	**2**	**EACH**	**$50,000**	**$100,000**	X	**$60,000**		30	0.1523	$15,230
24	**REHAB EXISTING STATION**	**1**	**EACH**	**$150,000**	**$150,000**	X	**$90,000**	PACIFIC STATION	30	0.1523	$22,845
25	**REHAB MAIN YARD & SHOP**	**34**	**LRV**	**$75,000**	**$2,550,000**	X	**$1,530,000**	PACIFIC FACILITY	30	0.1523	$388,366
26	**NEW LAYOVER FACILITY**	**34**	**LRV**	**$20,000**	**$680,000**	X	**$408,000**	AT END-OF-LINE	30	0.1523	$103,564
27	NEW LIGHT RAIL VEHICLE	34	EACH	$2,000,000	$68,000,000		$68,000,000		25	0.1547	$10,519,559
28	NEW DIESEL MULTIPLE UNIT		EACH	$2,500,000	$0						
29	RIGHT-OF-WAY - URBAN		ACRE	$0	$0						
30	RIGHT-OF-WAY - RURAL		ACRE	$0	$0						
31	OTHER COST ITEM			$0	$0						
							ADJUSTED TOTAL		**ADJUSTED AVERAGE**		
	SUBTOTAL AND AVERAGE COST PER KM				$106,852,500		$105,173,500	$15,264,643	$15,024,786		$16,490,614
	DESIGN, CONSTRUCTION MGT, ETC.	20%			$21,370,500		$21,034,700				$3,298,123
	CONTINGENCY	25%			$26,713,125		$26,293,375				$4,122,653
	TOTAL AND AVERAGE COST PER KM				$154,936,125		$152,501,575	$22,133,732	$21,785,939		$23,911,390

COSTA RICA STUDY - LRT CAPITAL COST ESTIMATES

SEGMENT: CIRUELAS TO PACIFIC STATION **ROUTE KM = 23.5**

ITEM	COST CATEGORY	QNTY	UNIT	UNIT COST	TOTAL COST		ADJUSTED COST	REMARKS	LIFESPAN (YEARS)	ANNUALIZATION FACTOR	ANNUALIZED COST
1	USED TRACK, 100#-112# CWR	47	KM	$400,000	$16,800,000		$18,800,000	DOUBLE TRACK	30	0.1523	$2,863,244
2	USED TRACK, 100#-112# SIDING		KM	$300,000	$0				30		
3	USED TRACK, 100#-112# YARD	9	KM	$300,000	$2,700,000		$2,700,000	20% OF MAIN TRAOK	30	0.1523	$411,211
4	USED XOVER, #6-#10 TURNOUTS	7	EACH	$100,000	$700,000		$700,000	PAIRED CROSSOVERS	30	0.1523	$106,610
5	USED TURNOUT, #8-#10, MAIN	4	EACH	$30,000	$120,000		$120,000		30	0.1523	$18,276
6	USED TURNOUT, #6, YARD	14	EACH	$25,000	$350,000		$350,000	YARD:1 PER 5 CARS	30	0.1523	$53,305
7	NEW RAILROAD SIGNAL SYSTEM	47	KM	$625,000	$29,375,000		$29,375,000	ATC W/CAB SIGNALS	30	0.1523	$4,473,818
8	NEW RAILROAD SIGNAL SYSTEM		KM	$375,000	$0			CTC			
9	NEW LRT ELECTRIFICATION SYS	56	KM	$925,000	$51,800,000		$51,800,000	CATENARY	30	0.1523	$7,889,150
10	NEW HWY CROSSING W/GATES	43	EACH	$125,000	$5,375,000		$5,375,000	RUBBER OR CONC	15	0.1710	$919,217
11	NEW HWY CROSSING W/LIGHTS		EACH	$75,000	$0			ASPHALT			
12	NEW HWY CROSSING W/SIGNS		EACH	$10,000	$0			GRAVEL			
13	NEW BRIDGE - MAJOR SPAN		EACH	$2,625,000	$0			AVG LGTH= 100 M			
14	NEW BRIDGE - OTHER SPAN		EACH	$525,000	$0			AVG LGTH= 40 M			
15	**REHAB BRIDGE - MAJOR SPAN**	**4**	**EACH**	**$125,000**	**$500,000**	X	**$300,000**	AVG LGTH= 100 M	30	0.1523	$76,150
16	**REHAB BRIDGE - OTHER SPAN**	**6**	**EACH**	**$50,000**	**$300,000**	X	**$180,000**	AVG LGTH= 40 M	30	0.1523	$45,690
17	NEW CULVERTS/DRAINAGE		EACH	$10,000	$0				30		
18	REHAB CULVERTS/DRAINAGE		EACH	$2,500	$0			1 PER KM	30		
19	EXCAVATION/GRADING - MAJOR		KM	$1,640,000	$0			INCL TUNNEL	30		
20	EXCAVATION/GRADING - MEDIUM		KM	$820,000	$0			INCL CUT/FILL	30		
21	**EXCAVATION/GRADING - MINOR**	**5**	**KM**	**$400,000**	**$2,000,000**	X	**$1,200,000**	BASE GRADING	30	0.1523	$304,600
22	**NEW STATION - TERMINAL**	**1**	**EACH**	**$100,000**	**$100,000**	X	**$60,000**		30	0.1523	$15,230
23	**NEW STATION - INTERMEDIATE**	**5**	**EACH**	**$50,000**	**$250,000**	X	**$150,000**		30	0.1523	$38,075
24	**REHAB EXISTING STATION**	**1**	**EACH**	**$150,000**	**$150,000**	X	**$90,000**	PACIFIC STATION	30	0.1523	$22,845
25	**REHAB MAIN YARD & SHOP**	**68**	**LRV**	**$75,000**	**$5,100,000**	X	**$3,060,000**	PACIFIC FACILITY	30	0.1523	$776,731
26	**NEW LAYOVER FACILITY**	**68**	**LRV**	**$20,000**	**$1,360,000**	X	**$816,000**	AT END-OF-LINE	30	0.1523	$207,128
27	NEW LIGHT RAIL VEHICLE	68	EACH	$2,000,000	$136,000,000		$136,000,000		25	0.1547	$21,039,119
28	NEW DIESEL MULTIPLE UNIT		EACH	$2,500,000	$0						
29	RIGHT-OF-WAY - URBAN		ACRE	$0	$0						
30	RIGHT-OF-WAY - RURAL		ACRE	$0	$0						
31	OTHER COST ITEM			$0	$0						
							ADJUSTED TOTAL		ADJUSTED AVERAGE		
	SUBTOTAL AND AVERAGE COST PER KM				$254,980,000		$251,076,000	$10,850,213	$10,684,085		$39,260,399
	DESIGN, CONSTRUCTION MGT, ETC.		20%		$50,996,000		$50,215,200				$7,852,080
	CONTINGENCY		25%		$63,745,000		$62,769,000				$9,815,100
	TOTAL AND AVERAGE COST PER KM				$369,721,000		$364,060,200	$15,732,809	$15,491,923		$56,927,579

COSTA RICA STUDY - LRT CAPITAL COST ESTIMATES

SEGMENT: ALAJUELA TO PACIFIC STATION VIA CIRUELAS ROUTE KM = 31.5

ITEM	COST CATEGORY	QNTY	UNIT	UNIT COST	TOTAL COST		ADJUSTED COST	REMARKS	LIFESPAN (YEARS)	ANNUALIZATION FACTOR	ANNUALIZED COST
1	USED TRACK, 100#-112# CWR	63	KM	$400,000	$25,200,000		$25,200,000	DOUBLE TRACK	30	0.1523	$3,837,965
2	USED TRACK, 100#-112# SIDING		KM	$300,000	$0				30		
3	USED TRACK, 100#-112# YARD	13	KM	$300,000	$3,900,000		$3,900,000	20% OF MAIN TRACK	30	0.1523	$593,971
4	USED XOVER, #6-#10 TURNOUTS	9	EACH	$100,000	$900,000		$900,000	PAIRED CROSSOVERS	30	0.1523	$137,070
5	USED TURNOUT, #8-#10, MAIN	5	EACH	$30,000	$150,000		$150,000		30	0.1523	$22,845
6	USED TURNOUT, #6, YARD	17	EACH	$25,000	$425,000		$425,000	YARD:1 PER 5 CARS	30	0.1523	$64,728
7	NEW RAILROAD SIGNAL SYSTEM	63	KM	$625,000	$39,375,000		$39,375,000	ATC W/CAB SIGNALS	30	0.1523	$5,996,820
8	NEW RAILROAD SIGNAL SYSTEM		KM	$375,000	$0			CTC			
9	NEW LRT ELECTRIFICATION SYS	76	KM	$925,000	$70,300,000		$70,300,000	CATENARY	30	0.1523	$10,706,704
10	NEW HWY CROSSING W/GATES	53	EACH	$125,000	$6,625,000		$6,625,000	RUBBER OR CONC	15	0.1710	$1,132,988
11	NEW HWY CROSSING W/LIGHTS		EACH	$75,000	$0			ASPHALT			
12	NEW HWY CROSSING W/SIGNS		EACH	$10,000	$0			GRAVEL			
13	NEW BRIDGE - MAJOR SPAN		EACH	$2,625,000	$0			AVG LGTH= 100 M			
14	NEW BRIDGE - OTHER SPAN		EACH	$525,000	$0			AVG LGTH= 40 M			
15	**REHAB BRIDGE - MAJOR SPAN**	**5**	**EACH**	**$125,000**	**$625,000**	x	**$375,000**	AVG LGTH= 100 M	30	0.1523	$95,188
16	**REHAB BRIDGE - OTHER SPAN**	**8**	**EACH**	**$50,000**	**$400,000**	x	**$240,000**	AVG LGTH= 40 M	30	0.1523	$60,920
17	NEW CULVERTS/DRAINAGE		EACH	$10,000	$0				30		
18	**REHAB CULVERTS/DRAINAGE**	**31**	**EACH**	**$2,500**	**$77,500**	x	**$46,500**	1 PER KM	30	0.1523	$11,803
19	EXCAVATION/GRADING - MAJOR		KM	$1,640,000	$0			INCL TUNNEL	30		
20	EXCAVATION/GRADING - MEDIUM		KM	$820,000	$0			INCL CUT/FILL	30		
21	**EXCAVATION/GRADING - MINOR**	**6**	**KM**	**$400,000**	**$2,400,000**	x	**$1,440,000**	BASE GRADING	30	0.1523	$365,520
22	**NEW STATION - TERMINAL**	**1**	**EACH**	**$100,000**	**$100,000**	x	**$60,000**		30	0.1523	$15,230
23	**NEW STATION - INTERMEDIATE**	**7**	**EACH**	**$50,000**	**$350,000**	x	**$210,000**		30	0.1523	$53,305
24	**REHAB EXISTING STATION**	**1**	**EACH**	**$150,000**	**$150,000**	x	**$90,000**	PACIFICSTATION	30	0.1523	$22,845
25	**REHAB MAIN YARD & SHOP**	**87**	**LRV**	**$75,000**	**$6,525,000**	x	**$3,915,000**	PACIFIC FACILITY	30	0.1523	$993,759
26	**NEW LAYOVER FACILITY**	**87**	**LRV**	**$20,000**	**$1,740,000**	x	**$1,044,000**	AT END-OF-LINE	30	0.1523	$265,002
27	NEW LIGHT RAIL VEHICLE	87	EACH	$2,000,000	$174,000,000		$174,000,000		25	0.1547	$26,917,696
28	NEW DIESEL MULTIPLE UNIT		EACH	$2,500,000	$0						
29	RIGHT-OF-WAY - URBAN		ACRE	$0	$0						
30	RIGHT-OF-WAY - RURAL		ACRE	$0	$0						
31	OTHER COST ITEM			$0	$0						
							ADJUSTED TOTAL		**ADJUSTED AVERAGE**		
	SUBTOTAL AND AVERAGE COST PER KM				$333,242,500		$328,295,500	$10,579,127	$10,422,079		$51,294,359
	DESIGN, CONSTRUCTION MGT, ETC.		20%		$66,648,500		$65,659,100				$10,258,872
	CONTINGENCY		25%		$83,310,625		$82,073,875				$12,823,590
	TOTAL AND AVERAGE COST PER KM				$483,201,625		$476,028,475	$15,339,734	$15,112,015		$74,376,821

COSTA RICA STUDY - LRT CAPITAL COST ESTIMATES

SEGMENT: ALAJUELA TO PACIFIC STA VIA SAN ANTONIO DE BEL ROUTE KM = 22

ITEM	COST CATEGORY	QNTY	UNIT	UNIT COST	TOTAL COST		ADJUSTED COST	REMARKS	LIFESPAN (YEARS)	ANNUALIZATION FACTOR	ANNUALIZED COST
1	USED TRACK, 100#-112# CWR	44	KM	$400,000	$17,600,000		$17,600,000	DOUBLE TRACK	30	0.1523	$2,680,483
2	USED TRACK, 100#-112# SIDING		KM	$300,000	$0				30		
3	USED TRACK, 100#-112# YARD	9	KM	$300,000	$2,700,000		$2,700,000	20% OF MAIN TRACK	30	0.1523	$411,211
4	USED XOVER, #6-#10 TURNOUTS	7	EACH	$100,000	$700,000		$700,000	PAIRED CROSSOVERS	30	0.1523	$106,610
5	USED TURNOUT, #8-#10, MAIN	4	EACH	$30,000	$120,000		$120,000		30	0.1523	$18,276
6	USED TURNOUT, #6, YARD	13	EACH	$25,000	$325,000		$325,000	YARD:1 PER 5 CARS	30	0.1523	$49,498
7	NEW RAILROAD SIGNAL SYSTEM	44	KM	$625,000	$27,500,000		$27,500,000	ATC W/CAB SIGNALS	30	0.1523	$4,188,255
8	NEW RAILROAD SIGNAL SYSTEM		KM	$375,000	$0			CTC			
9	NEW LRT ELECTRIFICATION SYS	53	KM	$925,000	$49,025,000		$49,025,000	CATENARY	30	0.1523	$7,466,517
10	NEW HWY CROSSING W/GATES	41	EACH	$125,000	$5,125,000		$5,125,000	RUBBER OR CONC	15	0.1710	$876,462
11	NEW HWY CROSSING W/LIGHTS		EACH	$75,000	$0			ASPHALT			
12	NEW HWY CROSSING W/SIGNS		EACH	$10,000	$0			GRAVEL			
13	NEW BRIDGE - MAJOR SPAN		EACH	$2,625,000	$0			AVG LGTH= 100 M			
14	NEW BRIDGE - OTHER SPAN		EACH	$525,000	$0			AVG LGTH= 40 M			
15	**REHAB BRIDGE - MAJOR SPAN**	**6**	**EACH**	**$125,000**	**$750,000**	x	**$450,000**	AVG LGTH= 100 M	30	0.1523	$114,225
16	**REHAB BRIDGE - OTHER SPAN**	**7**	**EACH**	**$50,000**	**$350,000**	x	**$210,000**	AVG LGTH= 40 M	30	0.1523	$53,305
17	**NEW CULVERTS/DRAINAGE**	**6**	**EACH**	**$10,000**	**$60,000**	x	**$36,000**		30	0.1523	$9,138
18	**REHAB CULVERTS/DRAINAGE**	**16**	**EACH**	**$2,500**	**$40,000**	x	**$24,000**	1 PER KM	30	0.1523	$6,092
19	**EXCAVATION/GRADING - MAJOR**	**1**	**KM**	**$1,640,000**	**$1,640,000**	x	**$984,000**	INCL TUNNEL	30	0.1523	$249,772
20	**EXCAVATION/GRADING - MEDIUI**	**5**	**KM**	**$820,000**	**$4,100,000**	x	**$2,460,000**	INCL CUT/FILL	30	0.1523	$624,431
21	**EXCAVATION/GRADING - MINOR**	**3**	**KM**	**$400,000**	**$1,200,000**	x	**$720,000**	BASE GRADING	30	0.1523	$182,760
22	**NEW STATION - TERMINAL**	**1**	**EACH**	**$100,000**	**$100,000**	x	**$60,000**	ALAJUELA	30	0.1523	$15,230
23	**NEW STATION - INTERMEDIATE**	**4**	**EACH**	**$50,000**	**$200,000**	x	**$120,000**		30	0.1523	$30,460
24	**REHAB EXISTING STATION**	**1**	**EACH**	**$150,000**	**$150,000**	x	**$90,000**	PACIFIC STATION	30	0.1523	$22,845
25	**REHAB MAIN YARD & SHOP**	**63**	**LRV**	**$75,000**	**$4,725,000**	x	**$2,835,000**	PACIFIC FACILITY	30	0.1523	$719,618
26	**NEW LAYOVER FACILITY**	**63**	**LRV**	**$20,000**	**$1,260,000**	x	**$756,000**	AT END-OF-LINE	30	0.1523	$191,898
27	NEW LIGHT RAIL VEHICLE	63	EACH	$2,000,000	$126,000,000		$126,000,000		25	0.1547	$19,492,125
28	NEW DIESEL MULTIPLE UNIT		EACH	$2,500,000	$0						
29	RIGHT-OF-WAY - URBAN		ACRE	$0	$0						
30	RIGHT-OF-WAY - RURAL		ACRE	$0	$0						
31	NEW UNDERGROUND AIRPORT (	1	LS	$1,000,000	$1,000,000		$1,000,000		30	0.1523	$152,300
							ADJUSTED TOTAL		**ADJUSTED AVERAGE**		
	SUBTOTAL AND AVERAGE COST PER KM				$244,670,000		$238,840,000	$11,121,364	$10,856,364		$37,661,513
	DESIGN, CONSTRUCTION MGT, ETC.	20%			$48,934,000		$47,768,000				$7,532,303
	CONTINGENCY	25%			$61,167,500		$59,710,000				$9,415,378
	TOTAL AND AVERAGE COST PER KM				$354,771,500		$346,318,000	$16,125,977	$15,741,727		$54,609,194

COSTA RICA STUDY - LRT CAPITAL COST ESTIMATES

SEGMENT: ATLANTIC TO PACIFIC STATIONS (DOUBLE TRACK) ROUTE KM = 3.1

ITEM	COST CATEGORY	QNTY	UNIT	UNIT COST	TOTAL COST		ADJUSTED COST	REMARKS	LIFESPAN (YEARS)	ANNUALIZATION FACTOR	ANNUALIZED COST
1	USED TRACK, 100#-112# CWR	6.2	KM	$400,000	$2,480,000		$2,480,000	DOUBLE TRACK	30	0.1523	$377,704
2	USED TRACK, 100#-112# SIDING		KM	$300,000	$0				30		
3	USED TRACK, 100#-112# YARD	1	KM	$300,000	$300,000		$300,000	20% OF MAIN TRACK	30	0.1523	$45,690
4	USED XOVER, #6-#10 TURNOUTS	2	EACH	$100,000	$200,000		$200,000	ON ATL & PAC LINES	30	0.1523	$30,460
5	USED TURNOUT, #8-#10, MAIN	4	EACH	$30,000	$120,000		$120,000		30	0.1523	$18,276
6	USED TURNOUT, #6, YARD	6	EACH	$25,000	$150,000		$150,000	YARD:1 PER 5 CARS	30	0.1523	$22,845
7	NEW RAILROAD SIGNAL SYSTEM	6.2	KM	$625,000	$3,875,000		$3,875,000	ATC W/CAB SIGNALS	30	0.1523	$590,163
8	NEW RAILROAD SIGNAL SYSTEM		KM	$375,000	$0			CTC			
9	NEW LRT ELECTRIFICATION SYS	7.2	KM	$925,000	$6,660,000		$6,660,000	CATENARY	30	0.1523	$1,014,319
10	NEW HWY CROSSING W/GATES	18	EACH	$125,000	$2,250,000		$2,250,000	RUBBER OR CONC	15	0.1710	$384,788
11	NEW HWY CROSSING W/LIGHTS		EACH	$75,000	$0			ASPHALT			
12	NEW HWY CROSSING W/SIGNS		EACH	$10,000	$0			GRAVEL			
13	NEW BRIDGE - MAJOR SPAN		EACH	$2,625,000	$0			AVG LGTH= 100 M			
14	NEW BRIDGE - OTHER SPAN		EACH	$525,000	$0			AVG LGTH= 40 M			
15	REHAB BRIDGE - MAJOR SPAN		EACH	$125,000	$0			AVG LGTH= 100 M	30		
16	REHAB BRIDGE - OTHER SPAN		EACH	$50,000	$0			AVG LGTH= 40 M	30		
17	NEW CULVERTS/DRAINAGE		EACH	$10,000	$0				30		
18	REHAB CULVERTS/DRAINAGE		EACH	$2,500	$0			1 PER KM	30		
19	EXCAVATION/GRADING - MAJOR		KM	$1,640,000	$0			INCL TUNNEL	30		
20	EXCAVATION/GRADING - MEDIUM		KM	$820,000	$0			INCL CUT/FILL	30		
21	**EXCAVATION/GRADING - MINOR**	**3.1**	**KM**	**$400,000**	**$1,240,000**	X	**$744,000**	BASE GRADING	30	0.1523	$188,852
22	NEW STATION - TERMINAL		EACH	$100,000	$0	X			30		
23	**NEW STATION - INTERMEDIATE**	**4**	**EACH**	**$50,000**	**$200,000**	X	**$120,000**		30	0.1523	$30,460
24	REHAB EXISTING STATION		EACH	$150,000	$0				30		
25	**REHAB MAIN YARD & SHOP**	**30**	**LRV**	**$75,000**	**$2,250,000**	X	**$1,350,000**	PACIFIC FACILITY	30	0.1523	$342,675
26	**NEW LAYOVER FACILITY**	**30**	**LRV**	**$20,000**	**$600,000**	X	**$360,000**	AT END-OF-LINE	30	0.1523	$91,380
27	NEW LIGHT RAIL VEHICLE	30	EACH	$2,000,000	$60,000,000		$60,000,000		25	0.1547	$9,281,964
28	NEW DIESEL MULTIPLE UNIT		EACH	$2,500,000	$0						
29	RIGHT-OF-WAY - URBAN		ACRE	$0	$0						
30	RIGHT-OF-WAY - RURAL		ACRE	$0	$0						
31	RAILROAD DIAMOND CROSSING	1	EACH	$100,000	$100,000		$100,000	ON ATLANTIC LINE	30	0.1523	$15,230
							ADJUSTED TOTAL		**ADJUSTED AVERAGE**		
	SUBTOTAL AND AVERAGE COST PER KM				$80,425,000		$78,709,000	$25,943,548	$25,390,000		$12,434,809
	DESIGN, CONSTRUCTION MGT, ETC.	20%			$16,085,000		$15,741,800				$2,486,962
	CONTINGENCY	25%			$20,106,250		$19,677,250				$3,108,702
	TOTAL AND AVERAGE COST PER KM				$116,616,250		$114,128,050	$37,618,145	$36,815,500		$18,030,472

COSTA RICA STUDY - LRT CAPITAL COST ESTIMATES

SEGMENT: ATLANTIC TO PACIFIC STATIONS (SINGLE TRACK) ROUTE KM = 3.1

ITEM	COST CATEGORY	QNTY	UNIT	UNIT COST	TOTAL COST		ADJUSTED COST	REMARKS	LIFESPAN (YEARS)	ANNUALIZATION FACTOR	ANNUALIZED COST
1	USED TRACK, 100#-112# CWR	3.1	KM	$400,000	$1,240,000		$1,240,000	SINGLE TRACK	30	0.1523	$188,852
2	USED TRACK, 100#-112# SIDING		KM	$300,000	$0				30		
3	USED TRACK, 100#-112# YARD	1	KM	$300,000	$300,000		$300,000		30	0.1523	$45,690
4	USED XOVER, #6-#10 TURNOUTS	2	EACH	$100,000	$200,000		$200,000	ON ATL & PAC LINES	30	0.1523	$30,460
5	USED TURNOUT, #8-#10, MAIN	2	EACH	$30,000	$60,000		$60,000		30	0.1523	$9,138
6	USED TURNOUT, #6, YARD	3	EACH	$25,000	$75,000		$75,000	YARD:1 PER 5 CARS	30	0.1523	$11,423
7	NEW RAILROAD SIGNAL SYSTEM	3.1	KM	$625,000	$1,937,500		$1,937,500	ATC W/CAB SIGNALS	30	0.1523	$295,082
8	NEW RAILROAD SIGNAL SYSTEM		KM	$375,000	$0			CTC			
9	NEW LRT ELECTRIFICATION SYS	4.1	KM	$925,000	$3,792,500		$3,792,500	CATENARY	30	0.1523	$577,599
10	NEW HWY CROSSING W/GATES	18	EACH	$125,000	$2,250,000		$2,250,000	RUBBER OR CONC	15	0.1710	$384,788
11	NEW HWY CROSSING W/LIGHTS		EACH	$75,000	$0			ASPHALT			
12	NEW HWY CROSSING W/SIGNS		EACH	$10,000	$0			GRAVEL			
13	NEW BRIDGE - MAJOR SPAN		EACH	$2,625,000	$0			AVG LGTH= 100 M			
14	NEW BRIDGE - OTHER SPAN		EACH	$525,000	$0			AVG LGTH= 40 M			
15	REHAB BRIDGE - MAJOR SPAN		EACH	$125,000	$0			AVG LGTH= 100 M	30		
16	REHAB BRIDGE - OTHER SPAN		EACH	$50,000	$0			AVG LGTH= 40 M	30		
17	NEW CULVERTS/DRAINAGE		EACH	$10,000	$0				30		
18	REHAB CULVERTS/DRAINAGE		EACH	$2,500	$0			1 PER KM	30		
19	EXCAVATION/GRADING - MAJOR		KM	$1,640,000	$0			INCL TUNNEL	30		
20	EXCAVATION/GRADING - MEDIUM		KM	$820,000	$0			INCL CUT/FILL	30		
21	**EXCAVATION/GRADING - MINOR**	**3.1**	**KM**	**$400,000**	**$1,240,000**	✗	**$744,000**	BASE GRADING	30	0.1523	$188,852
22	NEW STATION - TERMINAL		EACH	$100,000	$0				30		
23	**NEW STATION - INTERMEDIATE**	**4**	**EACH**	**$50,000**	**$200,000**	✗	**$120,000**		30	0.1523	$30,460
24	REHAB EXISTING STATION		EACH	$150,000	$0				30		
25	**REHAB MAIN YARD & SHOP**	**15**	**LRV**	**$75,000**	**$1,125,000**	✗	**$675,000**	PACIFIC FACILITY	30	0.1523	$171,338
26	**NEW LAYOVER FACILITY**	**15**	**LRV**	**$20,000**	**$300,000**	✗	**$180,000**	AT END-OF-LINE	30	0.1523	$45,690
27	NEW LIGHT RAIL VEHICLE	15	EACH	$2,000,000	$30,000,000		$30,000,000		25	0.1547	$4,640,982
28	NEW DIESEL MULTIPLE UNIT		EACH	$2,500,000	$0						
29	RIGHT-OF-WAY - URBAN		ACRE	$0	$0						
30	RIGHT-OF-WAY - RURAL		ACRE	$0	$0						
31	OTHER COST ITEM			$0	$0						
							ADJUSTED TOTAL		ADJUSTED AVERAGE		
	SUBTOTAL AND AVERAGE COST PER KM				$42,720,000		$41,574,000	$13,780,645	$13,410,968		$6,620,354
	DESIGN, CONSTRUCTION MGT, ETC.	20%			$8,544,000		$8,314,800				$1,324,071
	CONTINGENCY	25%			$10,680,000		$10,393,500				$1,655,088
	TOTAL AND AVERAGE COST PER KM				$61,944,000		$60,282,300	$19,981,935	$19,445,903		$9,599,513

SEGMENT: DIAMETRAL ROUTE KM = $10

ITEM	COST CATEGORY	QNTY	UNIT	UNIT COST	TOTAL COST	ADJUSTED COST	REMARKS	LIFESPAN (YEARS)	ANNUALIZATION FACTOR	ANNUALIZED COST
1	USED TRACK, 100#-112# CWR	20	KM	$400,000	$8,000,000	$8,000,000	DOUBLE TRACK	30	0.1523	1,218,402
2	USED TRACK, 100#-112# SIDING		KM	$300,000	$0			30		
3	USED TRACK, 100#-112# YARD	4	KM	$300,000	$1,200,000	$1,200,000	20% OF MAIN TRACK	30	0.1523	182,760

COSTA RICA STUDY - LRT CAPITAL COST ESTIMATES

4	USED XOVER, #6-#10 TURNOUTS	4	EACH	$100,000	$400,000		$400,000	PAIRED CROSSOVERS	30	0.1523	60,920
5	USED TURNOUT, #8-#10, MAIN		EACH	$30,000	$0				30		
6	USED TURNOUT, #6, YARD	12	EACH	$25,000	$300,000		$300,000	YARD-1 PER 5 CARS	30	0.1523	45,690
7	NEW RAILROAD SIGNAL SYSTEM		KM	$625,000	$0			ATC W/CAB SIGNALS			
8	NEW RAILROAD SIGNAL SYSTEM	20	KM	$375,000	$7,500,000		$7,500,000	TRAIN DETECTION	30	0.1523	1,142,251
9	NEW LRT ELECTRIFICATION SYS	24	KM	$925,000	$22,200,000		$22,200,000	CATENARY	30	0.1523	3,381,064
10	NEW HWY CROSSING W/GATES		EACH	$125,000	$0			RUBBER OR CONC			
11	NEW HWY CROSSING W/LIGHTS		EACH	$75,000	$0			ASPHALT			
12	NEW TRAFFIC INTRSCTN SIGNAL	10	EACH	$10,000	$100,000		$100,000	1 PER KM	15	0.1710	17,102
13	NEW BRIDGE - MAJOR SPAN		EACH	$2,625,000	$0			AVG LGTH= 100 M			
14	NEW BRIDGE - OTHER SPAN		EACH	$525,000	$0			AVG LGTH= 40 M			
15	REHAB BRIDGE - MAJOR SPAN		EACH	$125,000	$0			AVG LGTH= 100 M	30		
16	REHAB BRIDGE - OTHER SPAN		EACH	$50,000	$0			AVG LGTH= 40 M	30		
17	NEW CULVERTS/DRAINAGE		EACH	$10,000	$0			SAN AGUSTIN	30		
18	REHAB CULVERTS/DRAINAGE		EACH	$2,500	$0			1 PER KM	30		
19	EXCAVATION/GRADING - MAJOR		KM	$1,640,000	$0			INCL TUNNEL	30		
20	EXCAVATION/GRADING - MEDIUM		KM	$820,000	$0			INCL CUT/FILL	30		
21	**EXCAVATION/GRADING - MINOR**	**10**	**KM**	**$400,000**	**$4,000,000**	✗	$2,400,000	BASE GRADING	30	0.1523	609,201
22	**NEW STATION - TERMINAL**	**2**	**EACH**	**$100,000**	**$200,000**	✗	**$120,000**		30	0.1523	30,460
23	**NEW STATION - INTERMEDIATE**	**6**	**EACH**	**$50,000**	**$400,000**	✗	**$240,000**		30	0.1523	60,920
24	REHAB EXISTING STATION		EACH	$150,000	$0			ATLANTIC STATION	30		
25	**REHAB MAIN YARD & SHOP**	**63**	**LRV**	**$75,000**	**$4,725,000**	✗	**$2,835,000**	PACIFIC FACILITY	30	0.1523	719,618
26	**NEW LAYOVER FACILITY**	**63**	**LRV**	**$20,000**	**$1,260,000**	✗	**$756,000**	AT END-OF-LINE	30	0.1523	191,898
27	NEW LIGHT RAIL VEHICLE	63	EACH	$2,000,000	$126,000,000		$126,000,000		25	0.1547	19,492,125
28	NEW DIESEL MULTIPLE UNIT		EACH	$2,500,000	$0						
29	RIGHT-OF-WAY - URBAN		ACRE	$0	$0						
30	RIGHT-OF-WAY - RURAL		ACRE	$0	$0						
31	OTHER COST ITEM			$0	$0						
							ADJUSTED TOTAL		**ADJUSTED AVERAGE**		
	SUBTOTAL AND AVERAGE COST PER KM				$176,285,000		$172,051,000	$17,628,500	$17,205,100		$27,152,412
	DESIGN, CONSTRUCTION MGT, ETC.		20%		$35,257,000		$34,410,200				$5,430,482
	CONTINGENCY		25%		$44,071,250		$43,012,750				$6,788,103
	TOTAL AND AVERAGE COST PER KM				$255,613,250		$249,473,950	$25,561,325	$24,947,395		$39,370,997

COSTA RICA STUDY - LRT CAPITAL COST ESTIMATES

PER MI	PER KM	PER MI
1000000	621370	999784
528000	328083	527886
1046500	650264	1046274
600000	372822	599871
2000000	1242740	1999569
400000	248548	399914
1500000	932055	1499676
	0	0
	0	0

PER LF	PER LM	PER LF
8000	26246	8000
4000	13123	4000
500	1640	500
	0	0
	0	0
	0	0
	0	0
	0	0

APPENDIX VI

INVESTOR/OPERATOR/SUPPLIER SURVEY AND LIST OF PEOPLE CONTACTED

INVESTOR QUESTIONNAIRE
CNFL Project

BACKGROUND for the Interviewer

Objective: The main point of this questionnaire is to interview U.S. firms that could be interested in participating in some fashion in a solution to the commuter congestion problems in San Jose. We are focusing on U.S. firms alone because ICF Kaiser is performing an analysis of various transport options in San Jose and our work is partially funded by the U.S. Trade and Development Agency, an export promotion agency in the U.S. Government.

The attached list consists of all firms that attended a Costa Rican Government sponsored conference in San Jose in February, 1996, at which the current situation in San Jose was presented, CNFL made arguments for the use of electric transport (to clean the air, use a renewal resource (hydro-power), and help in reducing commuting times to/from San Jose). However, at this session, no solid, well-thought-out project plan was presented, and no concessioning plan was put forth to the audience.

Our Job: When ICF Kaiser presented its proposal to TDA to examine the feasibility of introducing electric transport to San Jose, in the form of a Light Rail Transit system (LRT) and Electric Trolley Buses or Trams (ETB), the TDA hired an outside consultant for 2 weeks to review our proposal. He contacted many of the U.S. participants on the attached list. In general, they voiced concern over the project in the following areas:

- There is no real project as yet, nothing defined
- It is not clear what the CR Government really wants
- We think there are too many risks, including political, exchange rates, etc.
- There is no long term commitment that we can be sure of, by the CR Government
- There is a suit against the CR Government by a U.S. firm that is still unresolved and whose outcome might make it difficult to do business in CR
- Etc.

Therefore, when our final TOR was completed, he suggested that we contact potential U.S. investors to discuss their concerns, the risks, their desires, what they think should be done to make this market interesting for them, etc., as part of our study.

To be done: Attached is a suggested list of questions and a structure for asking questions. Please follow this list in order to be certain that each company is asked the same set of questions. Also, we must send this list to CNFL before we act on it, to obtain their approval and ideas.

Select only U.S. firms, then contact the person whose name appears in the attached list of firms.

Potential U.S. Investors - Suppliers, Operators, etc. Questionnaire

Company: ______________________
Person: ______________________
Title: ______________________
Date: ______________________

Introduction:

"I am from ICF Kaiser in Fairfax, VA, and we are working on a project in San Jose, Costa Rica, funded by the U.S. Government, for the national electricity distribution company (CNFL). The purpose of our work is to examine the feasibility of introducing electric transport into the commuting environment in the capitol city and to figure out a strategy to attract private operators and suppliers once the project is clearly defined. One of the outputs from our work will be a formal Request for Bids from companies such as COMPANY NAME. Given that you attended the Conference in San Jose last February, I have some questions concerning COMPANY NAME's interest in the potential in Costa Rica, if you have a few minutes."

If you receive a NO answer, ask for an appropriate time to call back again to go through the questions.

Costa Rica As a Market

QUESTION 1 After attending the Conference last February, what was your opinion of the overall conceptual plan for transport modernization presented at the Conference? *(insert comments)*

Did you feel that Costa Rica had the potential to be a viable market for your products and services?

YES NO

If YES, what were the particular aspects of the market that it attractive?

If NOT, why not?

QUESTION 2 What products and/or services does your company provide and how do you see these services fitting with the market in San Jose, based on your visit there and the Conference?

QUESTION 3 Does Costa Rica fit into your overall international marketing efforts? If YES, then HOW?

or would you treat Costa Rica as a special case? Why?

The Urban Transport Market

Key facts to know when talking about this market to the potential investors:

- Costa Rica Population = 3.5 million
  50% live in the Greater Metropolitan Area (GAM)
- About 1 million commuters use some form of transit every day to/from work.
- About 70% use public transit (very high by international standards).
- About 400,000 vehicles are in the country, and 300,000 are in the San Jose metropolitan area.
- Bus service in the GAM is provided by 60 independent, private bus operators.
- There are 1,200 diesel buses on the roads
- The traffic grid is radial, with increased congestion toward the center
- The LRT that used to run between Alajuela, Heredia, San Jose, and Cartago was closed in 1994 and is one of the subjects of our study. These cities are the four largest in the country.

QUESTION 4 In any venture such as this, where changes are introduced in the ways in which people commute into and out of San Jose, there are always risks to the investors and to the equipment suppliers. Could you please give me an idea of what risks you see in this particular case? *(Get initial comments)*

I have a list of some areas that are typically viewed as risky, and I would like to run through them - please give me your assessment of your perceived level of risk from 1 (low) to 5 (high).

	Level of Concern: 1=low, 5=high				
Area	**1**	**2**	**3**	**4**	**5**
Project not yet well-defined					
Not clear who's in charge in the CR govt					
Currency Risk					
Political shake-up's					
Fear of next Govt changing the rules					
Govt subsidy policy not clear					
Don't understand the legal issues					
Inflexible labor laws					
Govt expropriation					

Are there any other comments that you would like to make concerning perceived risks for this type of project in San Jose?

QUESTION 5 I would like to get your ideas of ways in which these risks could be minimized from the perspective of COMPANY NAME. Our intention here is to develop actions to mitigate the risks so that the final Request for Bids will be attractive to U.S. investors. *(Get initial comments)*

I have some suggestions of actions that could be taken to make this opportunity more attractive to U.S. investors, and I would like to get your reaction to each .

I will read a suggestion, and I would appreciate your response:
1 = Would not affect my company's level of interest
5 = Could have a great impact on my company's level of interest

Suggestion	Level of Interest: 1=low, 5=high				
	1	**2**	**3**	**4**	**5**
CR Govt would set up an autonomous agency to deal with SJ transport development, making the contracting simpler and transparent					
Operating concessions for a Light Rail Transit system would be granted for only 10 years but would be renewable based on performance					
Results of solid analysis of the local market must be provided in the RFB					
The Govt must provide a clear long-term transport plan for SJ and indicate its willingness to carry it out					
Get The World Bank involved in order to cover some of the country (sovereign), political, and currency risks					

Have a U.S. Project Manager with experience in urban transit projects of this type					

Comments/other ideas:

QUESTION 6 What is the preferred length of an operating concession, in your mind?

10 **15** **20** **>20**

Comments:

QUESTION 7 Do you have any other concerns about contracting in Costa Rica for a project of this type? *(e.g. legal issues, government bureaucracy, decision time, government and SJ commitment, conceptual plan presented at the Conference, etc.)*

Comments:

***

Thank you for your time.

We expect to complete our work at the end of April. At that time, assuming that COMPANY NAME is still interested in this opportunity, someone from the Costa Rican Government will likely contact you to discuss the next steps.

In the meantime, if you have other questions about our project, or if you would like to stay in contact with someone during the next few months, please contact

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APPENDIX VII

FIELD TRIP INFORMATION

Field trip information

Results of a field trip - January, 1997
Ronald Rypinski, P.E. ICF Kaiser Engineers

AUTHOR'S NOTE

The following consists of notes that were made by Ronald Rypinski during his first review of the INCFOER right-of-way, January, 1997. The suggestions regarding the implementation of ETB and/or LRT solutions to San Jose's congestion problems were made prior to the development of the busway concept.

The purpose of this paper is to describe the current conditions which exist relative to urban transportation in the Greater Metropolitan Area (GAM) of San Jose, Costa Rica and to describe potential approaches for implementing various urban rail and bus transportation improvements.

CURRENT CONDITIONS — BUSES

There are some 60 private bus operations currently providing service under a large variety of urban and interurban routes (see Figure 1). The buses bring people into San Jose in the morning (between 6:00 a.m. and 8:00 a.m with a peak between 6:45 and 7:45 AM) and take people out of town in the evening (between 4:00 p.m. and 6:00 p.m.). In some instances, the bus routes pass directly through San Jose. This occurs when origins/destinations are located outside of downtown San Jose. But most corridors are radial and the buses arrive in town at a small number of congested stations and transfer points.

The majority of the buses are old diesel powered buses which emit very noticeable (to both sight and smell) exhaust emissions, principally particulate. Many of the buses are secondhand school buses. The buses used in interurban service are newer and are in better condition than buses used in local San Jose service.

Some 70 percent of the metropolitan area population uses the public transportation system. The majority of the public transportation users are captive riders because they cannot afford automobiles and must use buses. The typical one-way interurban bus fare ranges from 15 colon to 35 colon ($.07 to $.16 at 214 colon per U.S. dollar).

Concentrations of buses and automobiles on preferred streets in downtown San Jose create severe traffic congestion and obvious air pollution from exhaust emissions. Many of the streets are narrow (7 meters from curb to curb) and many are on grades, due to the local geography. A project is currently underway to relocate the multitude of overhead power lines underground. Unfortunately, it could take 5 or 6 years to complete the project just over the streets which are potential future electric trolley bus (ETB) routes, based on the current rate of progress.

CURRENT CONDITIONS — RAILWAY

The Costa Rican railway system is operated by Instituto Costaricenso de Ferrocarril (INCOFER). The railway currently does not operate any revenue freight or passenger trains over any portion of the system. As in the United States, railway traffic declined as the highway network was improved. INCFOER, therefore, is a caretaker organization consisting of less than 30 employees at the present time. The railway system exists from the Atlantic Ocean at the port of Limon to the Pacific Ocean at the ports of Caldera and Puntarenas, a track distance of approximately 283 Km (176 miles), excluding branch lines. The Atlantic Line between Limon and San Jose is approximately 167 Km (104 miles) in length. The line was constructed in 1871-1890. Service between San Jose and La Junta was suspended in 1991 due to an earthquake which caused an avalanche, burying approximately 102 Km (63 miles) of the railway right-of-way. The remainder of the Atlantic line exists in the banana-growing lowlands along the Caribbean coast, and INCOFER is seeking investment from a foreign operator for this freight service.

The Pacific Line between San Jose and Puntarenas is approximately 116 Km (72 miles) in length, constructed in 1890-1910. Service was suspended over the line on June 30, 1995.

Railway trackage within the greater metropolitan San Jose area totals approximately 76.0 route Km (47.2 miles) of track. Of the total, 41.4 Km (25.7 miles) is on the Atlantic Line between Cartago and

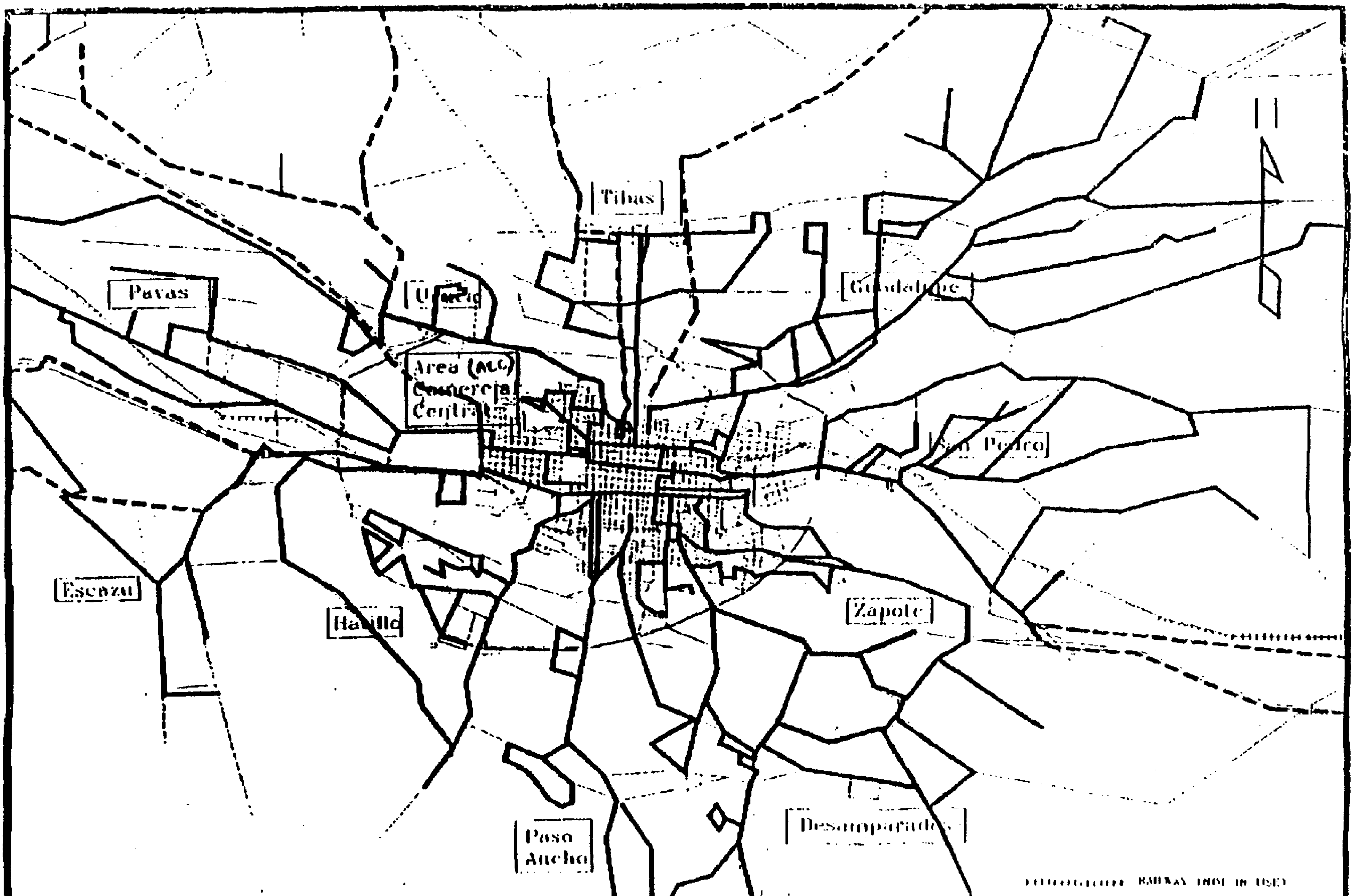


FIGURE 1
AREA METROPOLITANA DE SAN JOSE
LOCAL BUS NETWORK (1996)

Alajuela, 23.5 Km (14.6 miles) is on the Pacific Line between Ciruelas and the Pacific Station in San Jose and 8.0 Km (5.0 miles) on the line between Ciruelas and Alajuela (the right of way exists for some, but not all, of this line, and track does not exist) and 3.1 Km (1.9 miles) is on the connection between the Atlantic and the Pacific Lines (see Figure 2). Service was suspended between Alajuela and Heredia in 1991, between Heredia and San Pedro on June 30, 1995, between San Pedro and Cartago in September 1994, and between Ciruelas and San Jose on June 30, 1995. The only train movements over any part of the railway at present are work trains for maintenance-of-way purposes.

The railway right-of-way (legally) is typically 15 meters (approximately 49 feet) in width with one-half of the width (7.5 meters) measured each direction from the track centerline. The right-of-way for the connection between the Atlantic and the Pacific Lines is 10 meters (about 33 feet) in width. The effective right-of-way is less than the typical 15 meters in some locations.

Unfortunately, the railway is rapidly losing its right-of-way because of encroachment by residential and commercial structures and uses of all kinds. ICF Kaiser railway specialists examined the entire right-of-way. Encroachment onto railway right-of-way is especially prevalent between Alajuela and San Jose. Houses, gardens, animal enclosures, business structures, walls, fences, parking lots, and streets encroach into the right-of-way; sometimes as far as the end of the ties. Other obstructions which appear on the railway right-of-way at any time include pedestrians (lots of them), parked automobiles, construction equipment, piles of dirt and sand, fires (from burning trash) and anything that anyone wants to throw away. In addition, the track has been paved over in downtown Heredia. INCOFER is currently clearing vegetation, trash, and other obstructions from the right-of-way.

Because trains are not operated on a daily basis and because staff has been drastically reduced (only six employees are available to clean and inspect the right-of-way), encroachments occur daily. The legal process involved to regain the right-of-way where significant encroachments have occurred should be started immediately.

Other noteworthy conditions related to the railway right-of-way include the following:

- A washout in San Agustin where the track crosses Quebrada Rivera has left part of the track hanging in mid-air;
- The Atlantic Station site is owned by the National Bank. A hospital parking lot and a railway museum are located on the site. The railway has rights to use only one track through the station;
- The station in Cartago is currently in dispute between INCOFER and the municipality;
- The Atlantic Station in Alajuela was sold and has been destroyed and a hospital is being constructed on the site; and
- A new underpass for the railway is being constructed at Highway 108 in San Francisco. The new underpass is being constructed utilizing Armco corrugated steel but has space for only a single track.

The basic characteristics of the railway network in the greater metropolitan San Jose areas are discussed below.

The track gauge is 1,067 mm (42 inches). Rail is generally of 25 kg/m (about 50 pounds/yard) and 30 kg/m (about 60 pounds/yard) section and is very old (estimated to be from the 1920s or 1930s). Newer rail installations use 42 kg/m (about 85 pounds/yard) section. While some of the rail joints are

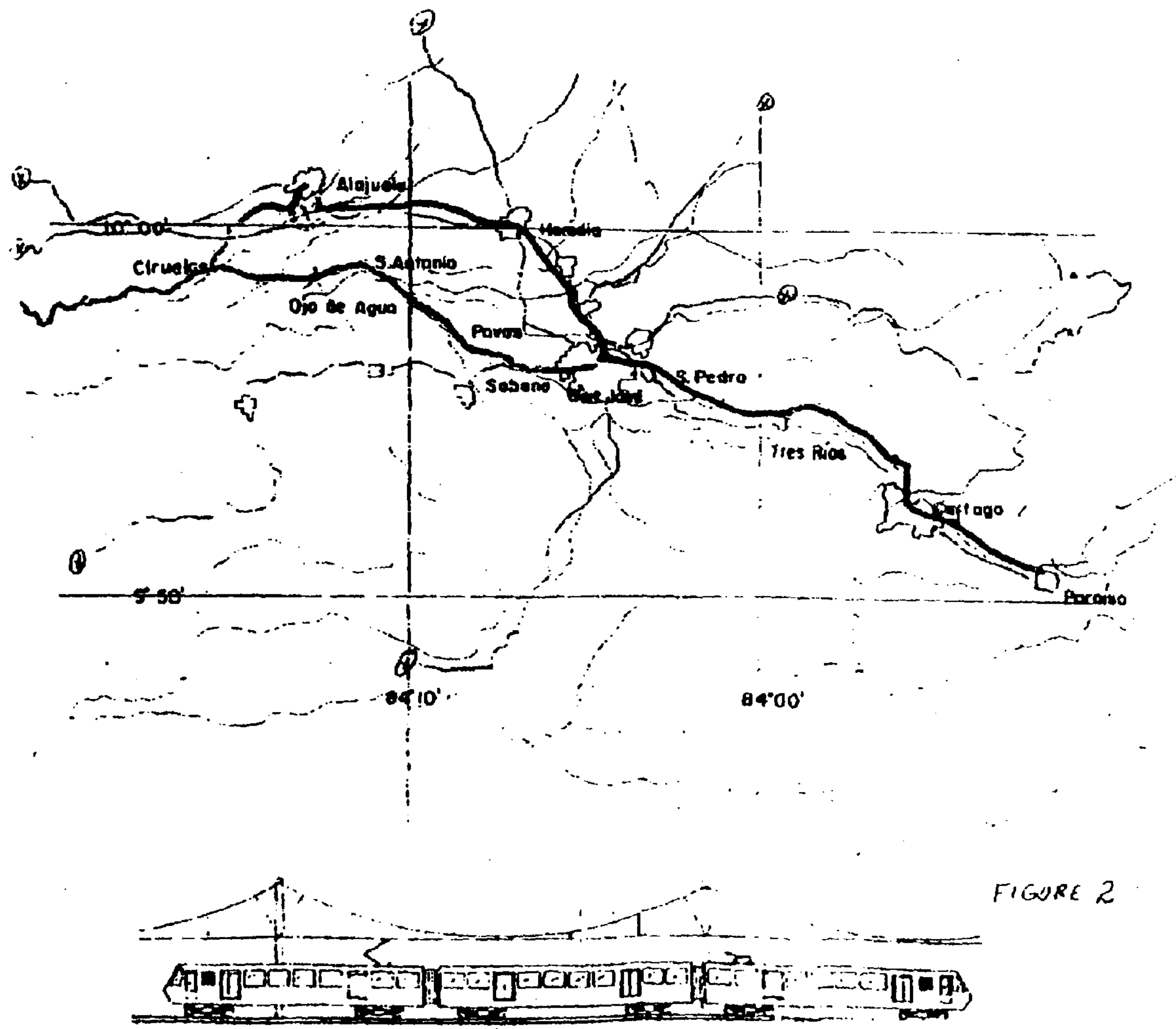

Alajuela
10°00'
Heredia
Ciruelas
S.Antonio
Ojo de Agua
Pavas
Sabana
San José
S.Pedro
Tres Ríos
Cartago
Paraiso
9°50'
84°10'
84°00'

FIGURE 2

welded, most have 4-hole joint bars. Tie spacing is typically 600 mm (approximately 23.5 inches). Many of the ties are in poor condition. Some concrete ties have been installed, but mostly on the main track outside of the San Jose area. Rail is fastened to the ties using cut track spikes and single-shoulder tie plates. Rail anchors are seldom used. Ballast is crushed rock, but is missing or is badly fouled in most locations. Drainage of the track structure is generally poor. Curves are commonplace and are as sharp as 100 m (328 feet) in radius. There are 98 curves in the 41.4 Km distance between Alajuela and Cartago. The line between Ciruelas and Alajuela has five consecutive horseshoe curves located just south of Alajuela. Maximum gradient is 4 percent.
At-grade highway crossings are frequent. There are 106 crossings in the 41.3 Km distance between Alajuela and Cartago. Most crossings only have yellow railway crossbuck signs and asphalt crossing surfaces.

Bridges are mostly of steel construction and, except for the double-track bridge over Calle 17 adjacent to the Atlantic Station, are all single-track structures. The bridges vary from 10 m (about 33 feet) to 60 m (about 197 feet) in length. Several bridges are 40 m to 60 m above the river or gorge. While the structural condition of each bridge is not known at this time, a previous study (by Canadian Pacific Consulting Services, Ltd., February 1989) noted, at that point in time, that all of the bridges could support the maximum loading allowed on the railway system of 16 metric tons (17.6 U.S. tons) per axle.

POTENTIAL IMPLEMENTATION APPROACHES

The potential considerations and implementation approaches for improving urban transportation in the greater metropolitan area of San Jose which have been identified thus far are presented below.

Considerations

The primary considerations to be kept in mind relative to the improvement of urban transport for the San Jose metropolitan area are as follows:

- High demand for service exists as 70 percent of the population use public transportation;
- The San Jose metropolitan area constitutes 4 percent of the territory with 60 percent of the population of Costa Rica;
- Air pollution in San Jose is considered to be the most serious environmental problem in the country;
- Inadequate road infrastructure is reaching the saturation point — especially in the downtown area of San Jose;
- Costa Rica produces all of its electricity, but imports all of its petroleum products;
- Use of electric-powered vehicles is part of the long-term national strategy for achieving sustainable development and a better livelihood for the country; and

- Public transportation should be "optimized" so that that users have better options for travel, at minimal cost, with improved transit times.

The last consideration represents the best summary of the goal for improving urban transport in San Jose. Costa Rica does not want to copy the mistakes that other nations have made in their development.

Potential Approaches

The potential approaches for improving urban transportation in the greater San Jose metropolitan area are presented below. The potential approaches were developed with consideration for the stated policy of the government; discussions with CNFL, INCOFER, World Bank, and other transportation-orientated agencies and personnel; review of previous studies and documentation; program schedule; and site field trips.

The specific goals to be achieved by the potential approaches for improving urban transportation in the greater metropolitan area of San Jose are as follows:

- Reduce congestion and air pollution in downtown San Jose;
- Provide alternative transportation choices to the use of automobiles and buses;
- Provide improved transportation for the maximum population while minimizing user cost;
- Reclaiming and using or preserving the existing railway right-of-way;
- Reducing dependency upon petroleum-based fuels;.
- Providing frequent service and trip times which are comparable to those of buses and automobiles whenever possible;
- Allow phased implementation of an integrated urban transportation system within a reasonable time period (i.e., 2 to 10 years) at reasonable cost;
- Encourage controlled development in designated metropolitan areas; and
- Not preclude the restoration of freight service over the Pacific and Atlantic Lines of the railway.

The master plan for an integrated urban transportation system should include, as a minimum, the following characteristics:

- Downtown area shuttle distribution network operating with electric-powered vehicles;
- Rail passenger service over existing railway right-of-way and new routes such as to the airport operating with electric-powered trains;
- Bus service over major routes between urban areas and downtown areas where rail service is not available operated with electric trolley buses;
- Feeder bus routes in urban areas providing service to designated terminals served by rail, electric trolley buses, and/or the downtown shuttle network. This feeder network could be operated with buses using clean diesel fuel,

electricity (i.e., battery-powered), or a combination of each (i.e., diesel buses, electric buses, and dual mode buses);

- Bus routes providing interurban service between urban areas where rail or electric trolley bus service is not available or is not practical. This service could be operated with clean diesel buses, electric-powered buses, or a combination of each;
- Improved routing and control of private automobile traffic in the downtown area of San Jose to reduce congestion (note: this approach is being implemented);
- Additional pedestrian and pedestrian/electric shuttle bus only malls in downtown San Jose (note: additional pedestrian malls are currently planned);
- Improved and additional highways to provide more direct access between urban areas for commercial and private automobiles without the need to pass through downtown San Jose (note: improved highway access becomes very important should freight service be restored over the Atlantic and Pacific railway lines); and
- Implementation of public awareness campaigns to encourage the use of electrified transportation rather than private automobiles.

PHASING OF THE URBAN TRANSPORTATION SYSTEM

The potential approaches for phasing the implementation of the urban transportation system for the greater metropolitan San Jose area are as follows:

Phase 1:

1a. Reclaim and preserve the existing railway right-of-way consisting of the following segments:

Alajuela - San Jose	21.0 Km
San Jose - Cartago	20.4 Km
Ciruelas - San Jose	23.5 Km (estimated)
Ciruelas - Alajuela	8.0 Km
Pacific - Atlantic connection	3.1 Km (estimated)
	76.0 Km total

1b. Implement the downtown shuttle bus network and other electric-powered vehicle usage. Designate terminal stations for connections between urban routes and the shuttle network.

1c. Improve routing and control of private automobile traffic in downtown areas. MOPT is considering plans to eliminate some of the current "T" road configurations that impede bus and automobile traffic flows.

1d. Implement additional pedestrian/shuttle bus only malls. MOPT is intending to implement a North-South version of the successful pedestrian walkway that currently runs East-West.

1e. Initiate conceptual designs for passenger rail service and electric trolley bus (ETB) service. This effort should include an inventory and condition of railway bridges and other fixed facilities and ETB routes relative to overhead power lines and intersections where bus turning movements will occur.

1f. Include in any freight concession documents for the Atlantic and/or Pacific railway lines the rehabilitation of some or all of the potential passenger service railway segments and the operation of passenger. (Note: Any freight concession should encourage any rebuilding of the railway to use the North American standard track gauge of 4'-8½").

Phase 2:

2a. Implement rail passenger service over at least part of the existing railway right-of-way (the Ciruelas to San Jose and the Ciruelas to Alajuela segments may be the least costly and quickest to implement). This initial service could begin utilizing single track with passing sidings located at stations and other required locations and diesel powered trains (either self-propelled rail cars or push-pull style locomotive and coaches). When the initial rehabilitation of the railway is performed, the future installation of a second main track and overhead catenary wires should not be precluded. Ideally, of course, the initial rail service would be electrified.

2b. Provide feeder bus service to/from outlying urban areas to the rail passenger stations.

2c. Complete the underground relocation of overhead power lines as is currently in progress. Modify any intersections where obstructions to bus turning movements are present.

2d. Implement service over future ETB routes using clean diesel fuel, battery, and/or dual mode buses. Revise interurban bus routes as may be necessary.

Phase 3:

3a. Expand and electrify rail passenger service over all segments, including a connection between the ends of the Pacific and the Atlantic line tracks in Alajuela (see Figure 3). Coordinate feeder bus routes.

3b. Implement electric trolley bus service over some or all of the proposed routes. Coordinate feeder bus routes (note: construction for ETB service could begin in Phase 2 if funding is available).

3c. Improve highway access over highways with a high volume of feeder bus traffic.

Phase 4:

4a. Complete ETB service implementation if not accomplished in Phase 3.

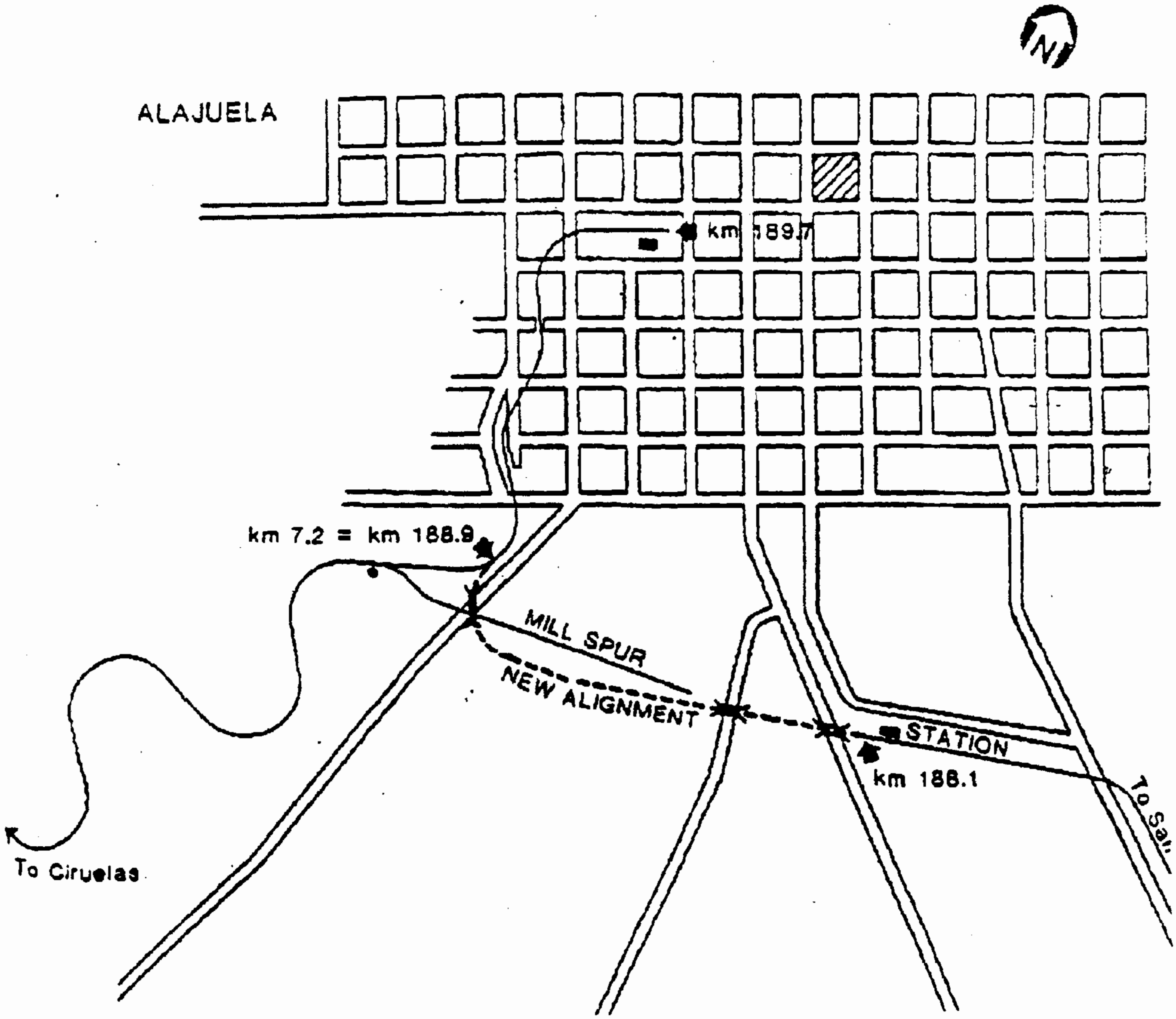
4b. Extend electrified rail passenger service or electric trolley bus service to the airport and other high demand origins/destinations.

4c. Expand highway access between outlying urban areas.

OTHER OPTIONS

Other possible options or alternatives which should be evaluated include the following:
Phase 2, 2a — Instead of implementing rail passenger service, the railway right-of-way could be paved and electric trolley buses could be operated instead of trains. Consideration should be given to the fact that once the railway right-of-way is paved, train service may never be implemented and many people will likely drive their cars over the paved right-of-way even though it is for ETB use only.

NEW ALIGNMENT (km 188.1-188.9)
OF INTERURBAN COMMUTER SYSTEM



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Consider expanding highway access between urban areas via toll roads. This could help to discourage use of private automobiles.

APPENDIX VIII

CONCEPTUAL DESIGN

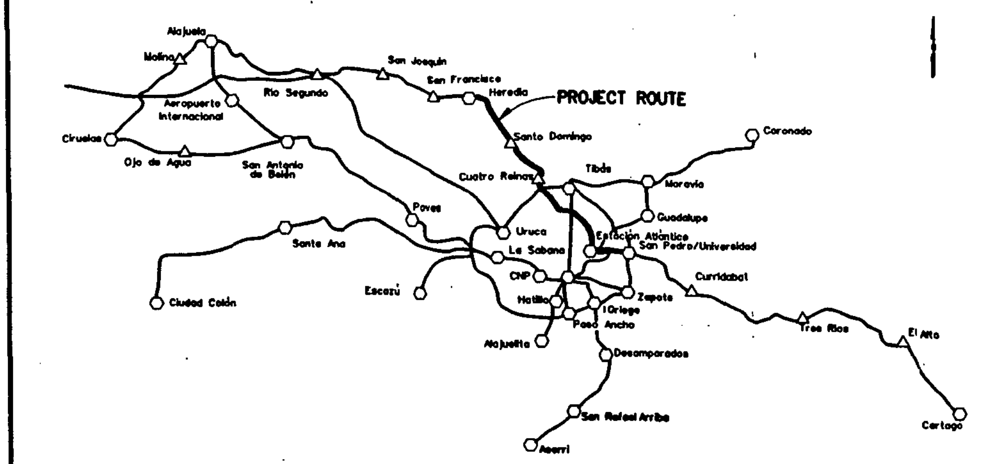
Plan and Profile Sheets for the Heredia-San Pedro Busway

CONCEPTUAL (20%) DESIGN

PLAN & PROFILE SHEETS FOR A

BUSWAY BETWEEN HEREDIA AND SAN PEDRO ALONG THE INCOFER RIGHT-OF-WAY

INDEX OF SHEETS



SAN JOSE GREATER METROPOLITAN AREA

PLANS PREPARED BY:

◆ICF KAISER ENGINEERS

5718 Westheimer, Suite 1000
Houston, TX 77057

PROJECT MANAGER

DATE

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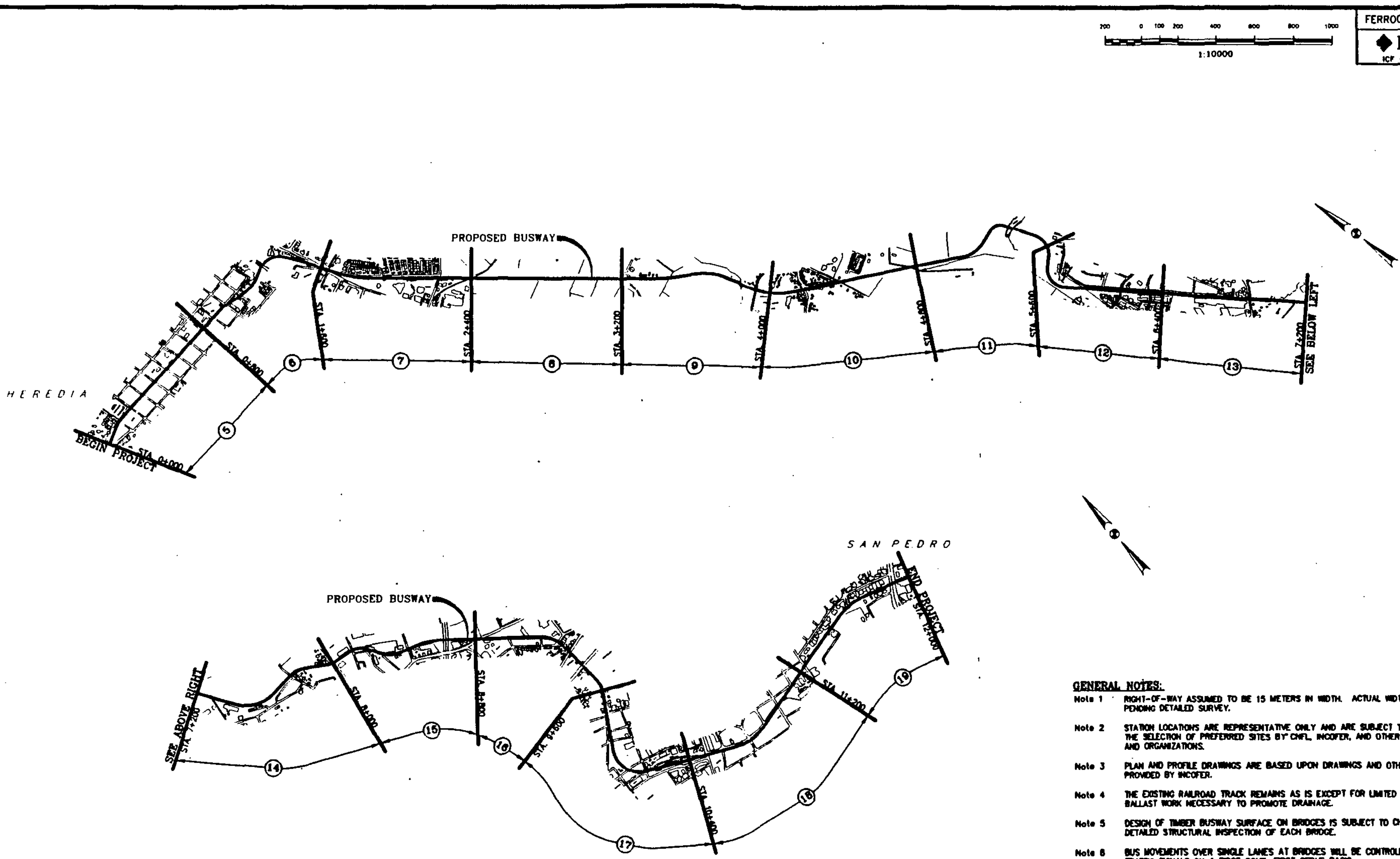

GENERAL NOTES:

Note 1 RIGHT-OF-WAY ASSUMED TO BE 15 METERS IN WIDTH. ACTUAL WIDTH MAY VARY PENDING DETAILED SURVEY.

Note 2 STATION LOCATIONS ARE REPRESENTATIVE ONLY AND ARE SUBJECT TO CHANGE PENDING THE SELECTION OF PREFERRED SITES BY CNFL, INCOFER, AND OTHER LOCAL AUTHORITIES AND ORGANIZATIONS.

Note 3 PLAN AND PROFILE DRAWINGS ARE BASED UPON DRAWINGS AND OTHER INFORMATION PROVIDED BY INCOFER.

Note 4 THE EXISTING RAILROAD TRACK REMAINS AS IS EXCEPT FOR LIMITED UNDERCUTTING AND BALLAST WORK NECESSARY TO PROMOTE DRAINAGE.

Note 5 DESIGN OF TIMBER BUSWAY SURFACE ON BRIDGES IS SUBJECT TO CHANGE PENDING DETAILED STRUCTURAL INSPECTION OF EACH BRIDGE.

Note 6 BUS MOVEMENTS OVER SINGLE LANES AT BRIDGES WILL BE CONTROLLED BY A SYSTEM OF TRAFFIC SIGNALS ON A FIRST COME, FIRST SERVE BASIS.

Note 7 BUS AND AUTOMOBILE TRAFFIC FLOW AT MOST BUSWAY/ROADWAY AT-GRADE CROSSINGS WILL BE CONTROLLED BY TRAFFIC SIGNALS. BUSES OPERATING ON THE BUSWAY WILL BE GIVEN PRIORITY OVER CROSS-TRAFFIC.

Note 8 THE DRAWINGS ARE CONSIDERED TO BE CONCEPTUAL IN NATURE AND REPRESENT A DESIGN LEVEL OF APPROXIMATELY 20%.

INDEX MAP AND GENERAL NOTES

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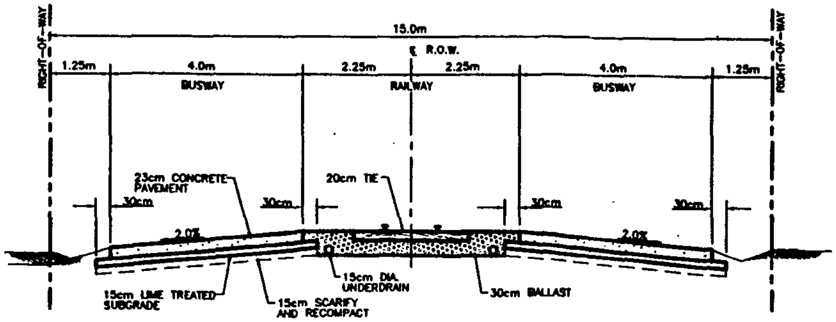
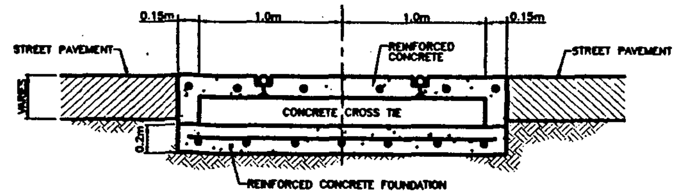
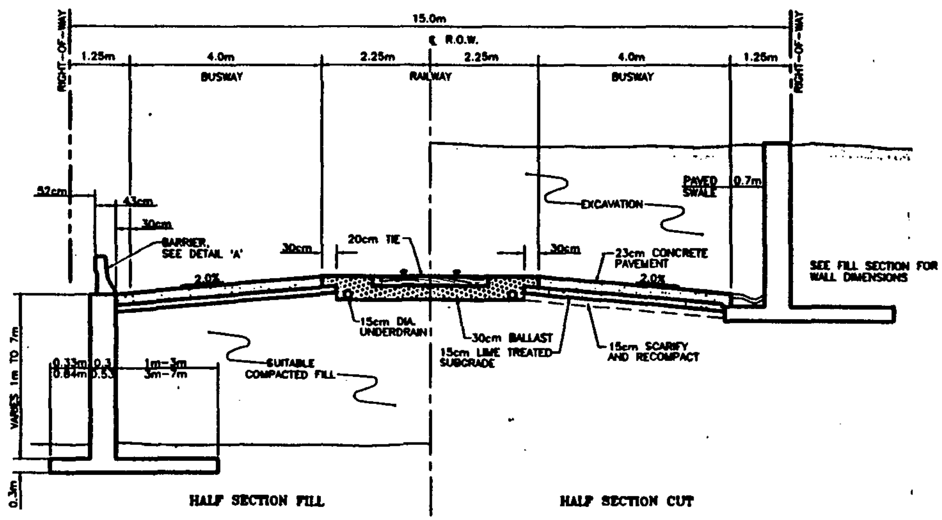


NOTE:
UNDERDRAINS TO BE CONNECTED TO CROSS DRAINS AT MINIMUM 100m SPACING.

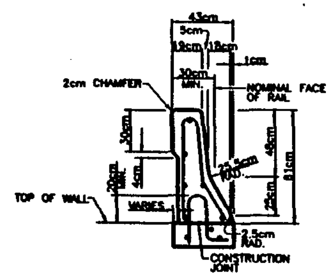
TYPICAL RURAL SECTION AT EXISTING GRADE



TYPICAL SECTION IN PAVED STREETS AND AT-GRADE CROSSINGS
Not To Scale



TYPICAL RURAL SECTION IN CUT OR FILL



TYPICAL BARRIER DETAIL
Not To Scale

NOTE:
UNDERDRAINS TO BE CONNECTED TO CROSS DRAINS AT MINIMUM 100m SPACING.

TYPICAL SECTIONS

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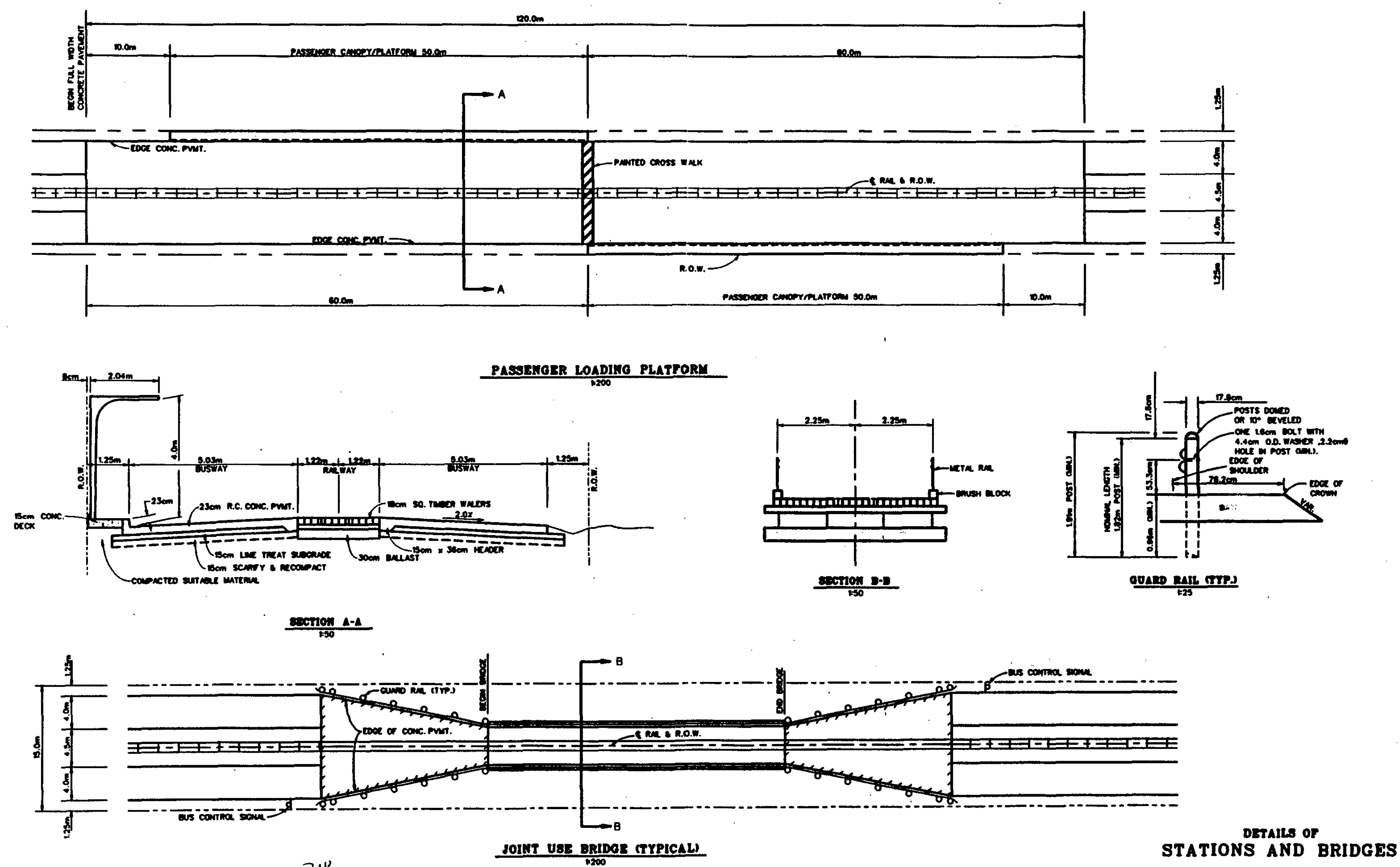
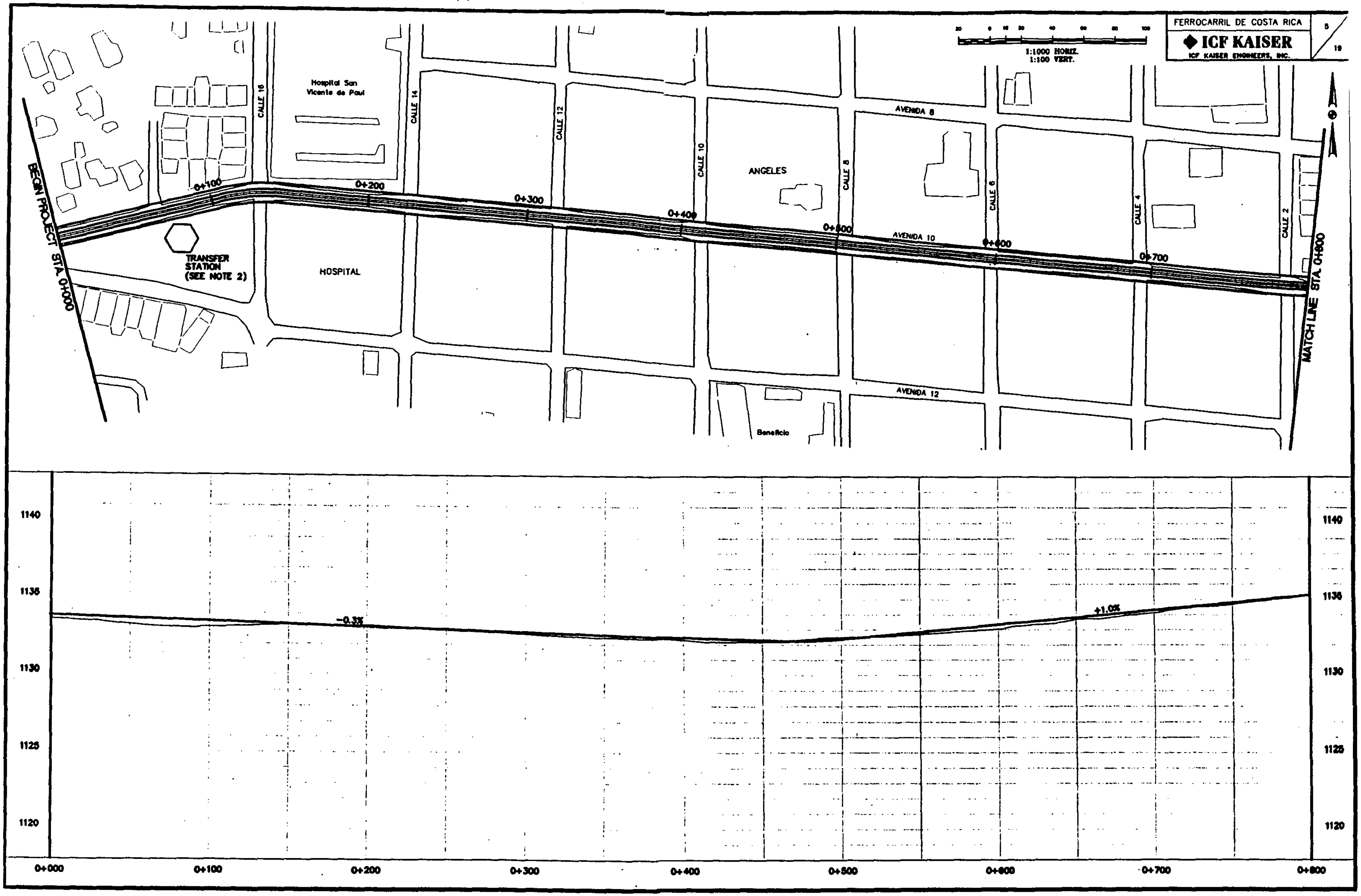
ICF KAISER ENGINEERS, INC.

4/10

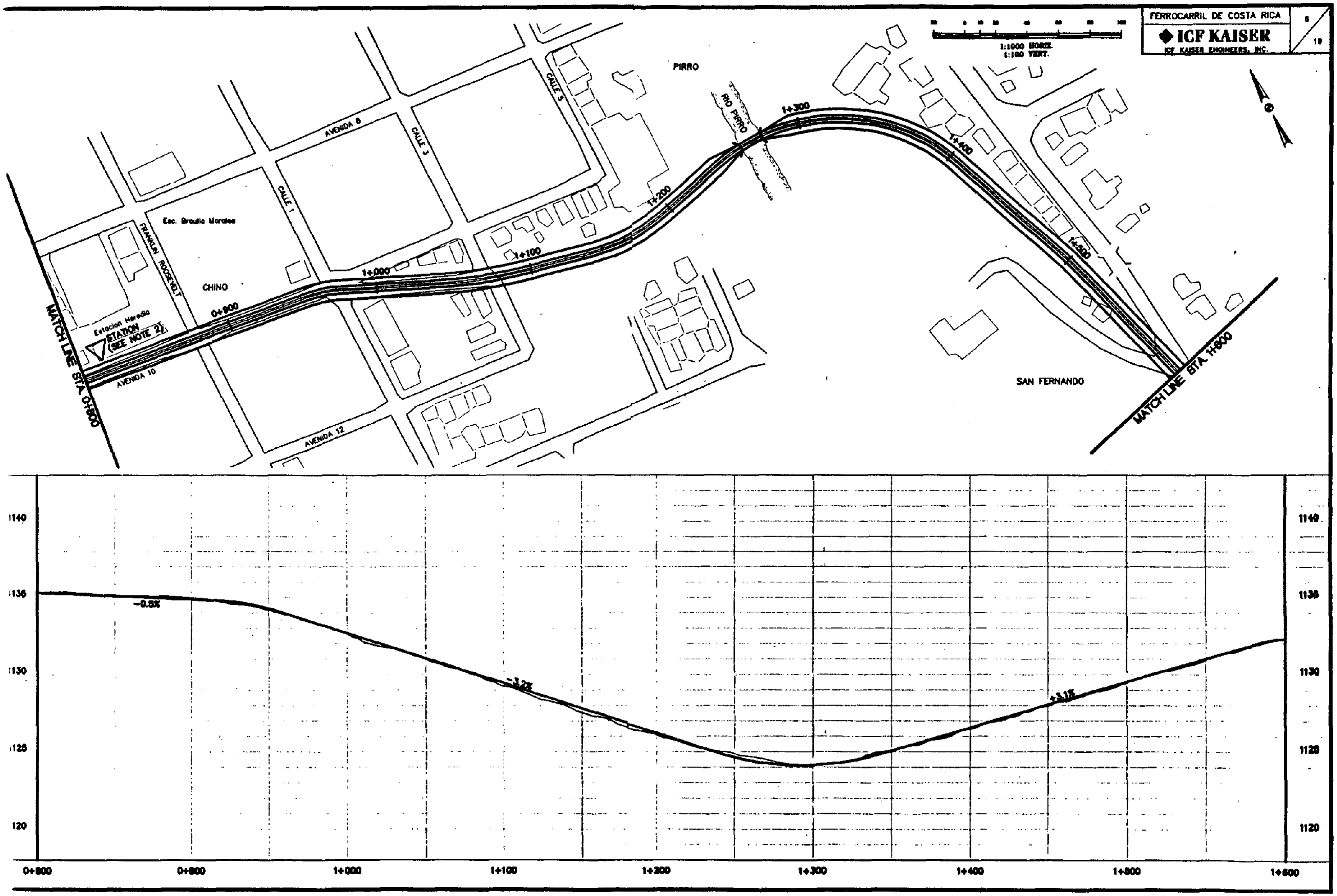


DETAILS OF
STATIONS AND BRIDGES

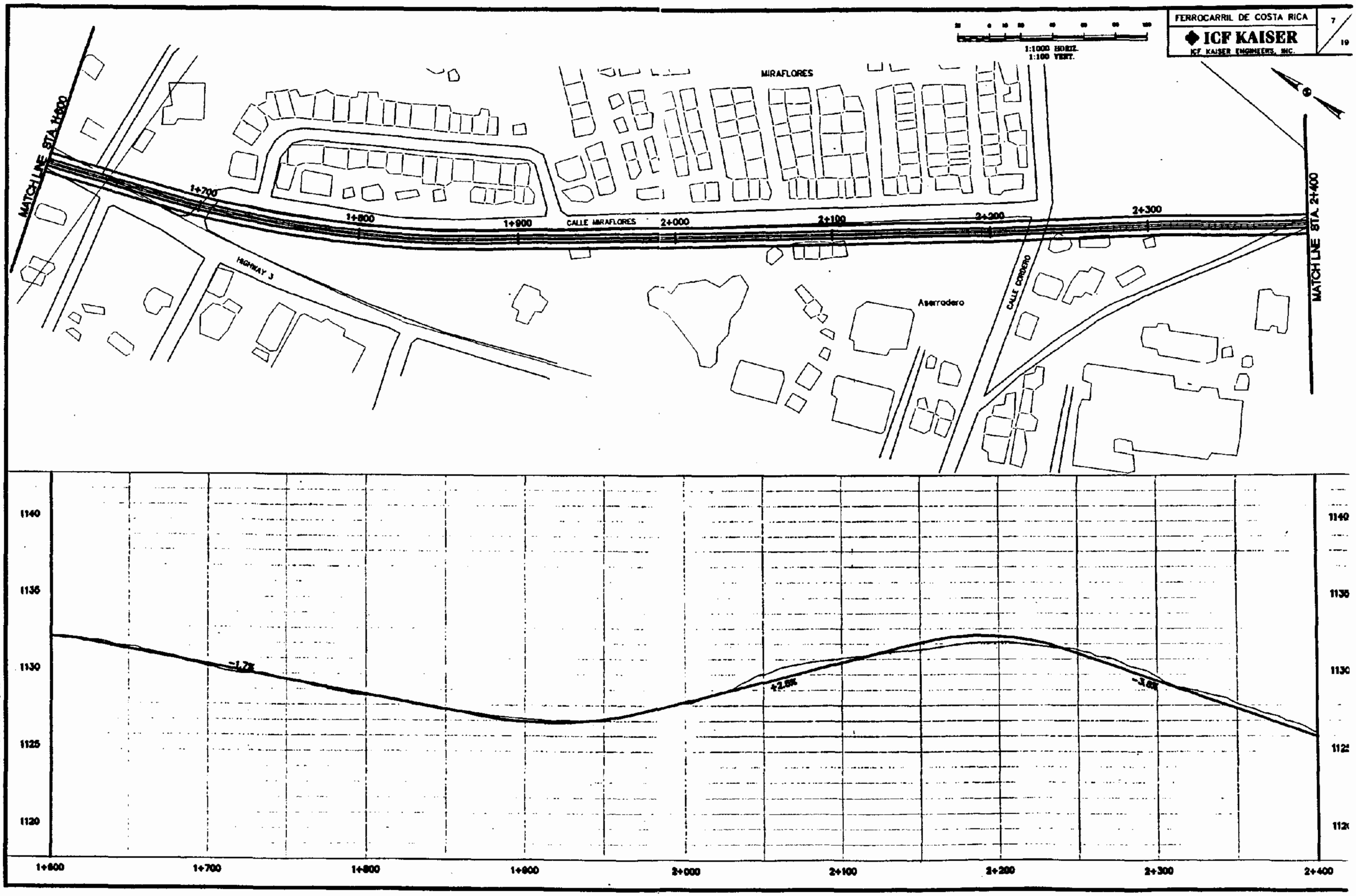
218

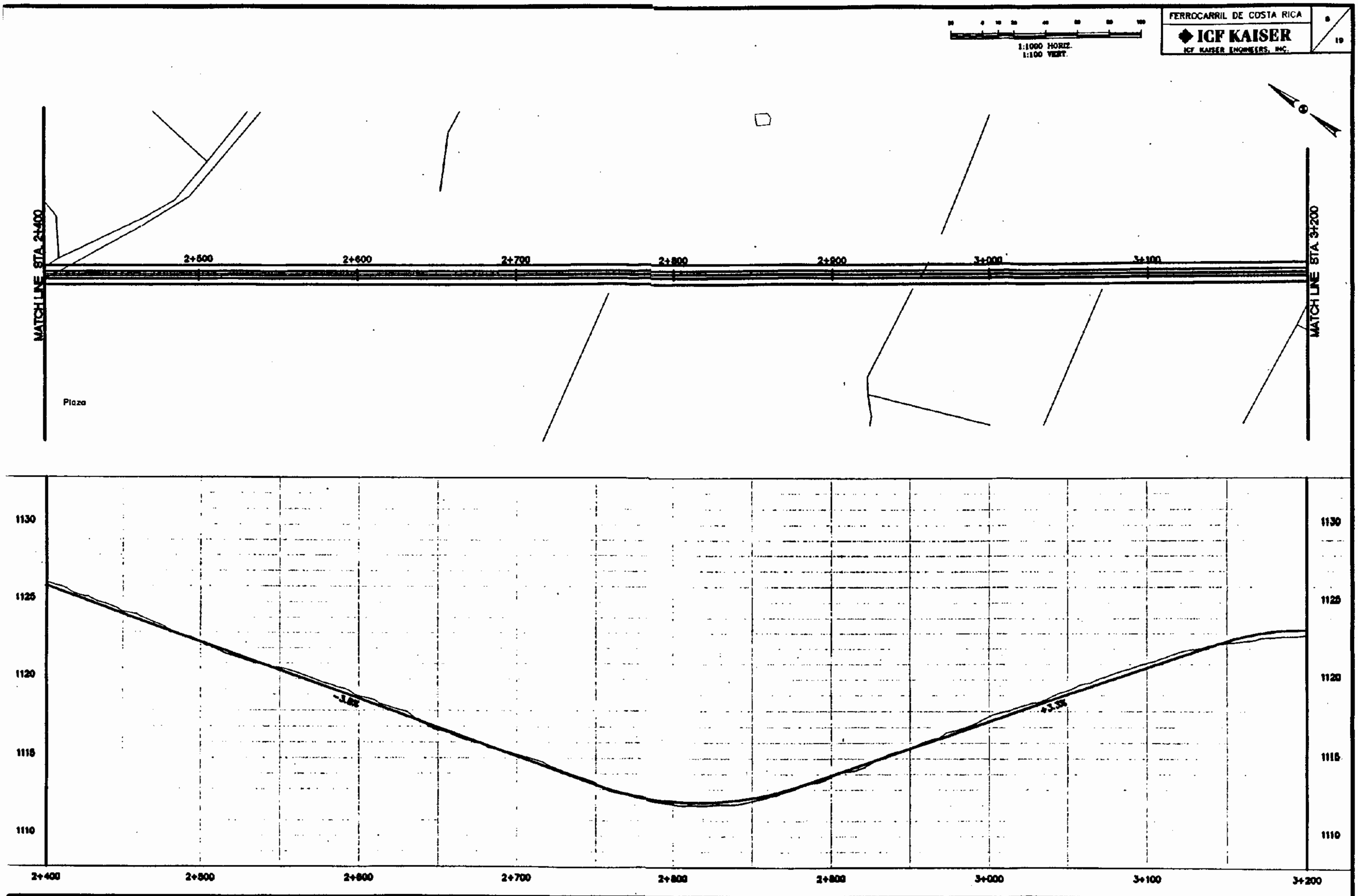


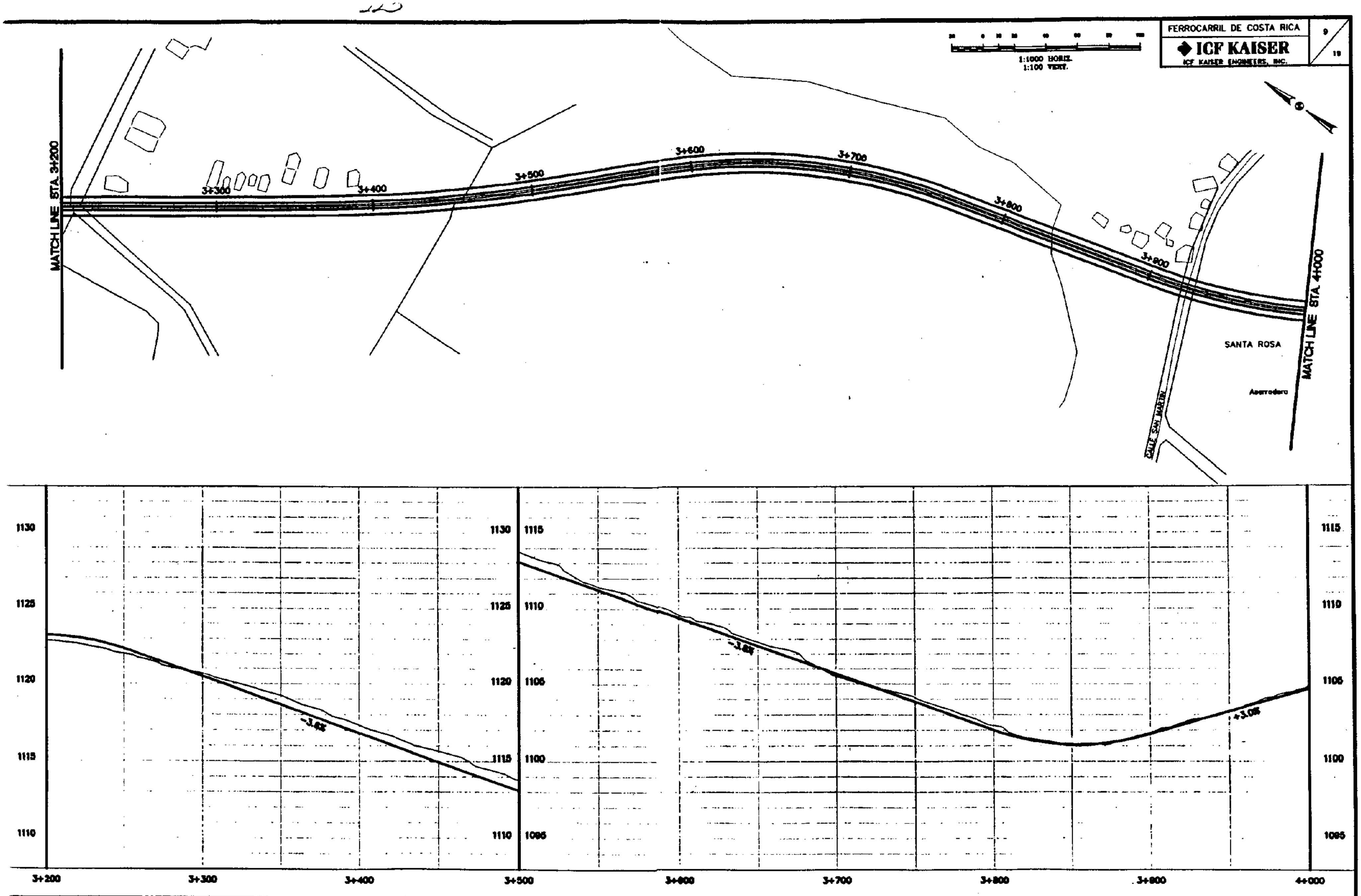
FERROCARRIL DE COSTA RICA
ICF KAISER
ICF KAISER ENGINEERS, INC.
1:1000 HORIZ.
1:100 VERT.
5
19
BEGIN PROJECT STA. 0+000
MATCH LINE STA. 0+800
TRANSFER STATION (SEE NOTE 2)
Hospital San Vicente de Paul
HOSPITAL
ANGELES
Beneficio
CALLE 16
CALLE 14
CALLE 12
CALLE 10
CALLE 8
CALLE 6
CALLE 4
CALLE 2
AVENIDA 8
AVENIDA 10
AVENIDA 12
0+100
0+200
0+300
0+400
0+500
0+600
0+700
-0.3%
+1.0%
1140
1135
1130
1125
1120
0+000
0+100
0+200
0+300
0+400
0+500
0+600
0+700
0+800


FERROCARRIL DE COSTA RICA
ICF KAISER
ICF KAISER ENGINEERS, INC.
1:1000 HORIZ.
1:100 VERT.
PIRRO
RIO PIRRO
CHINO
SAN FERNANDO
Esc. Braulio Morales
FRANKLIN ROOSEVELT
AVENIDA 8
AVENIDA 10
AVENIDA 12
CALLE 1
CALLE 3
CALLE 5
Estacion Heredia
STATION (SEE NOTE 2)
MATCH LINE STA. 0+800
MATCH LINE STA. 1+600
0+900
1+000
1+100
1+200
1+300
1+400
1+500
-0.5%
-3.2%
+3.1%
1140
1135
1130
1125
1120
0+800
0+900
1+000
1+100
1+200
1+300
1+400
1+500
1+600

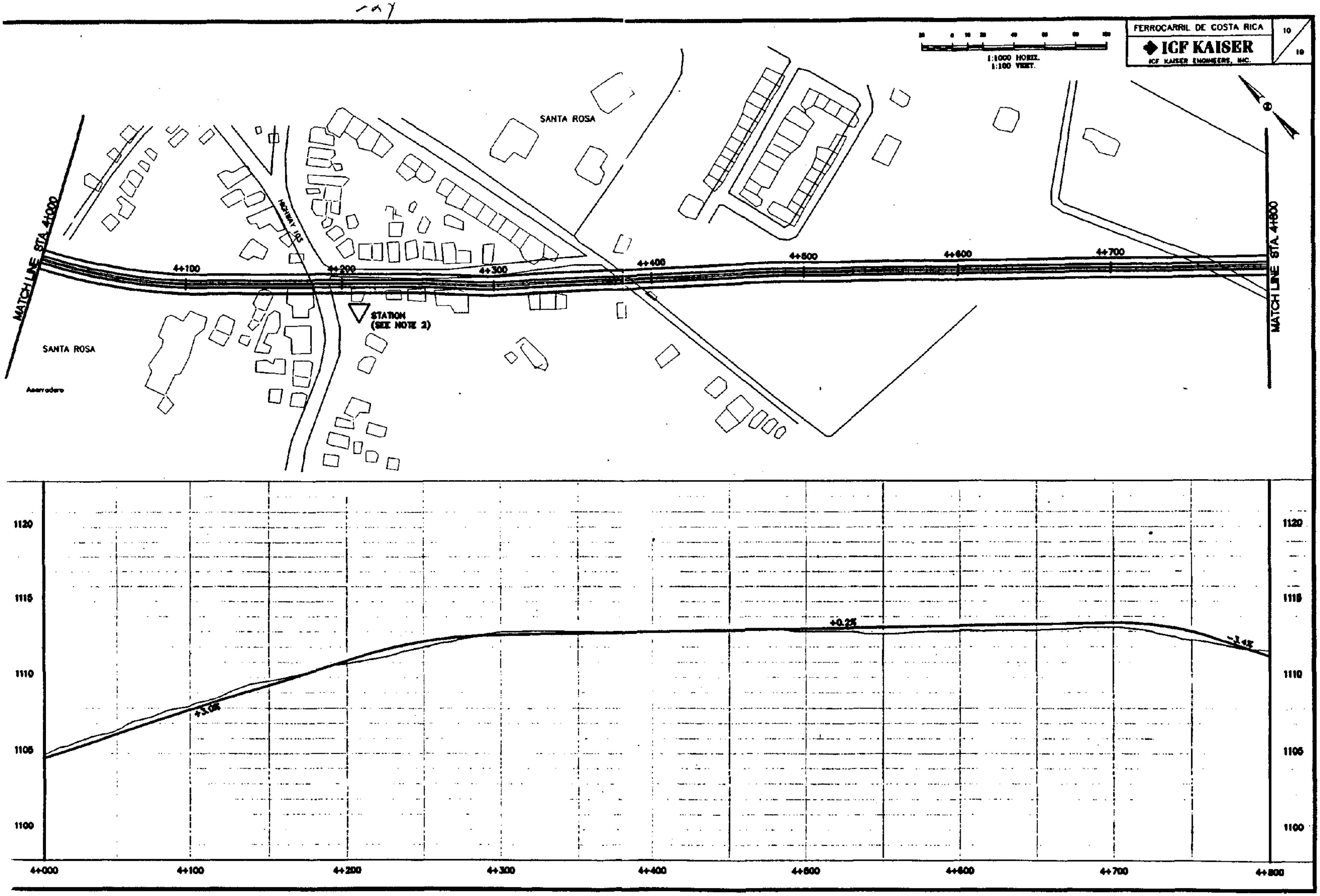
221

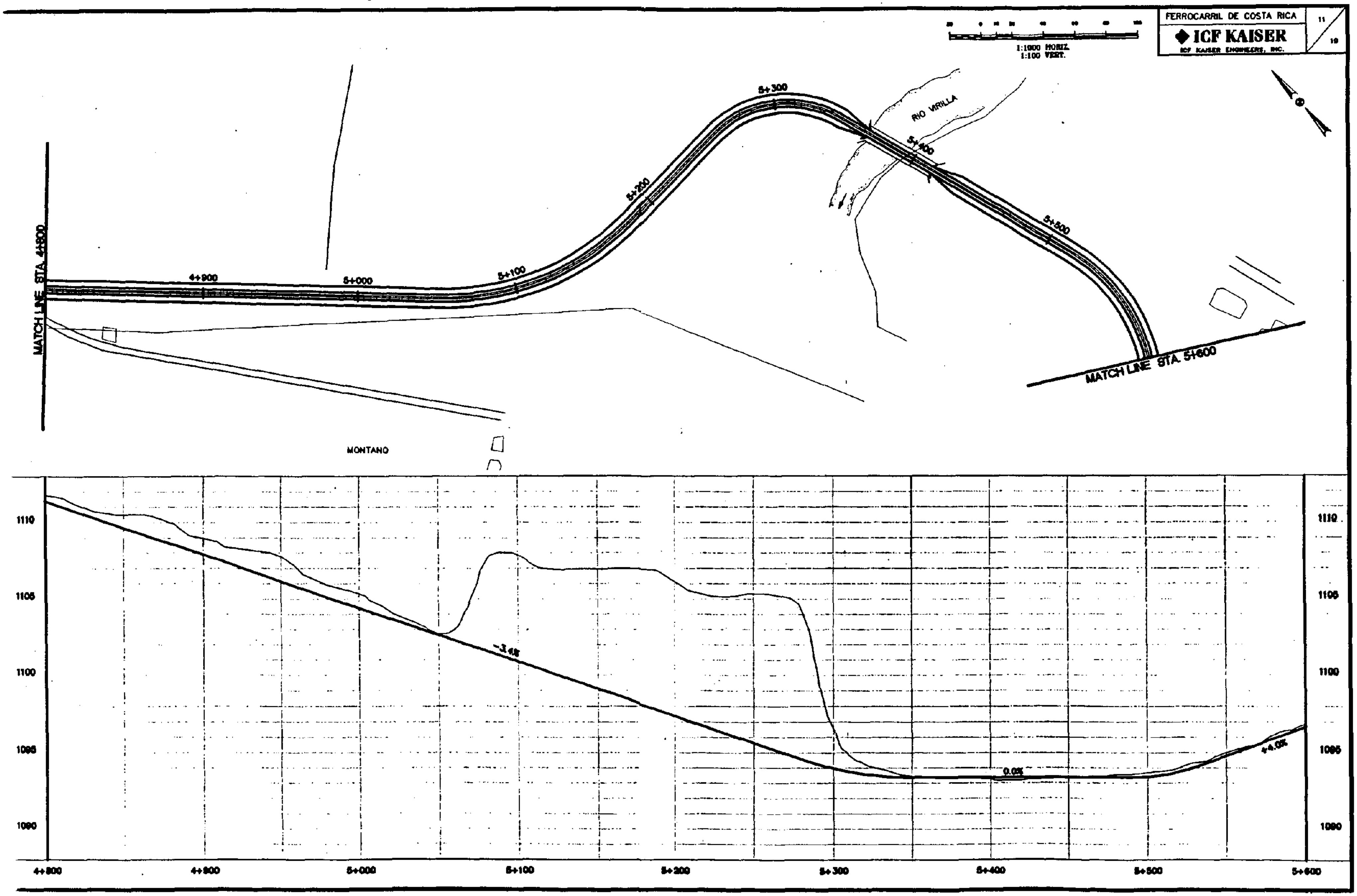

FERROCARRIL DE COSTA RICA
ICF KAISER
ICF KAISER ENGINEERS, INC.
7
19
1:1000 HORIZ.
1:100 VERT.
MATCH LINE STA. 1+600
MATCH LINE STA. 2+400
MIRAFLORES
CALLE MIRAFLORES
HIGHWAY 3
CALLE CORDERO
Aserradero
1+700
1+800
1+900
2+000
2+100
2+200
2+300
2+400
-1.7%
+2.8%
-3.6%
1120
1125
1130
1135
1140


FERROCARRIL DE COSTA RICA
ICF KAISER
ICF KAISER ENGINEERS, INC.
1:1000 HORIZ.
1:100 VERT.
MATCH LINE STA 2+400
MATCH LINE STA 3+200
Plaza
2+500
2+600
2+700
2+800
2+900
3+000
3+100
3+200
2+400
1130
1125
1120
1115
1110
-3.62
+3.35



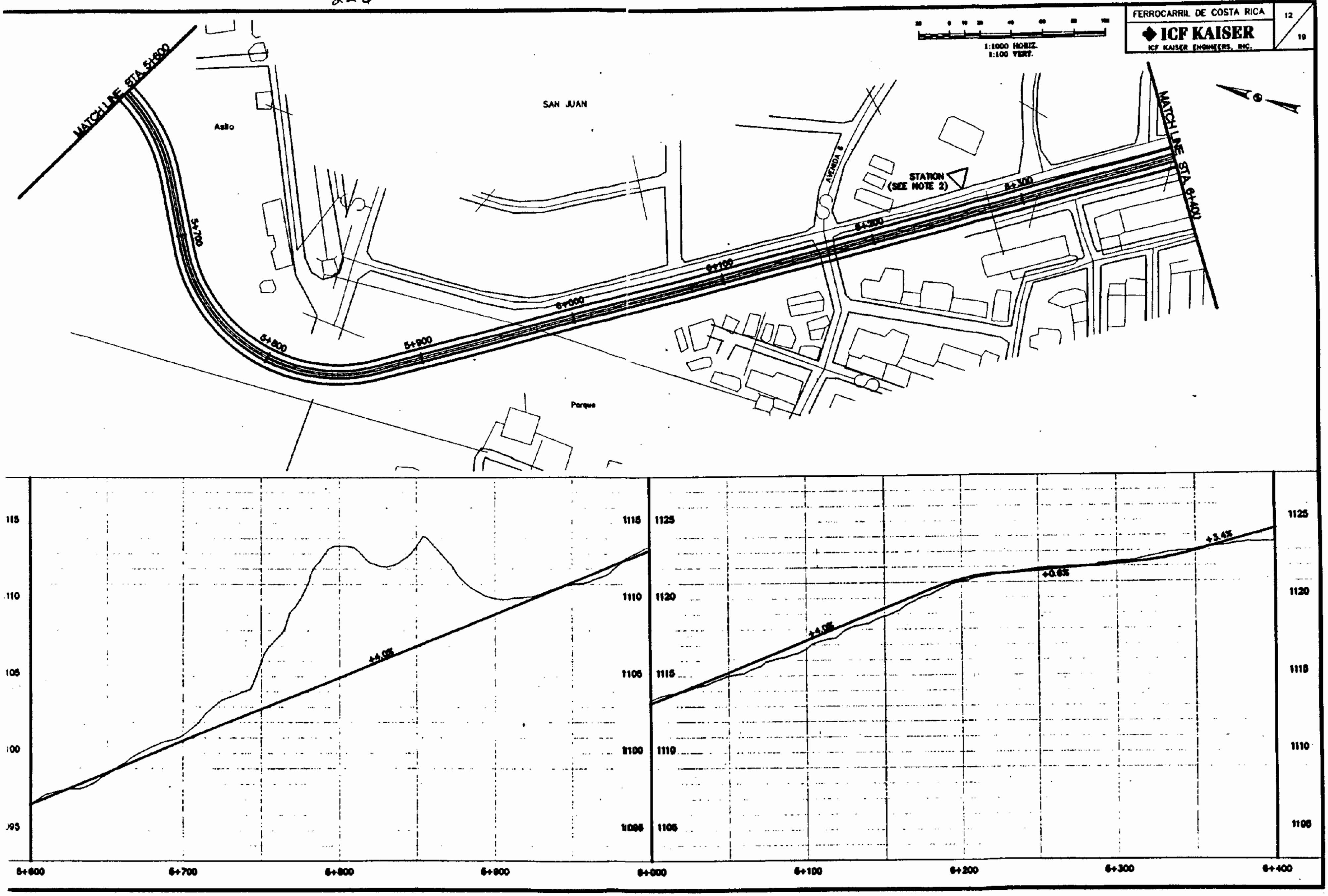
FERROCARRIL DE COSTA RICA
ICF KAISER
ICF KAISER ENGINEERS, INC.
9
19
1:1000 HORIZ.
1:100 VERT.
MATCH LINE STA. 3+200
MATCH LINE STA. 4+000
3+300
3+400
3+500
3+600
3+700
3+800
3+900
SANTA ROSA
Aserradero
CALLE SAN MARTIN
-3.6%
+3.0%
1130
1125
1120
1115
1110
1105
1100
1095
3+200
4+000


FERROCARRIL DE COSTA RICA
ICF KAISER
ICF KAISER ENGINEERS, INC.
10
10
1:1000 HORIZ.
1:100 VERT.
MATCH LINE STA. 4+000
MATCH LINE STA. 4+800
SANTA ROSA
SANTA ROSA
Aserradero
HIGHWAY 103
STATION
(SEE NOTE 2)
4+100
4+200
4+300
4+400
4+500
4+600
4+700
1120
1115
1110
1105
1100
+3.0%
+0.2%
-3.4%
4+000
4+800



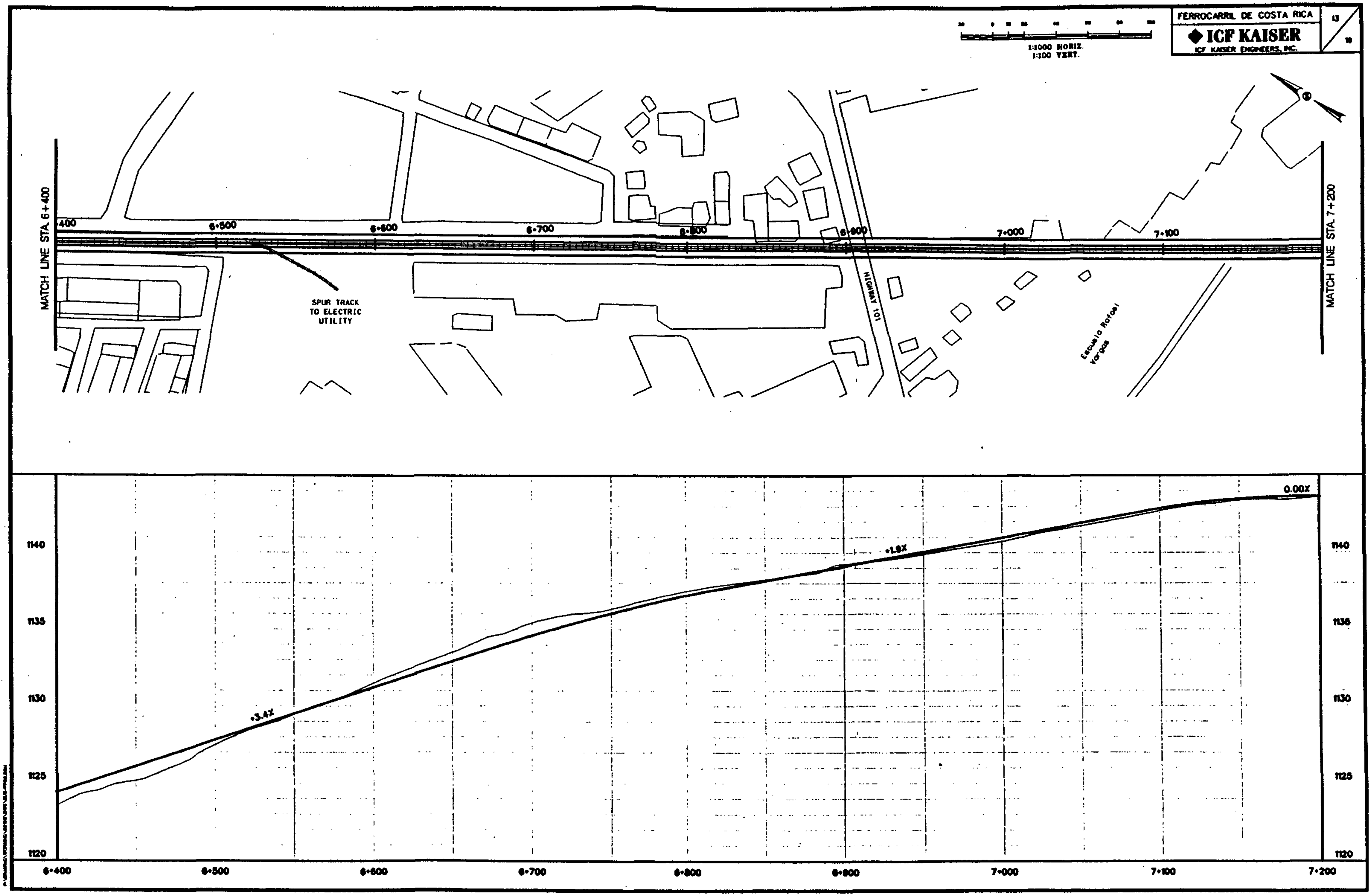
FERROCARRIL DE COSTA RICA
ICF KAISER
ICF KAISER ENGINEERS, INC.
11
19
1:1000 HORIZ.
1:100 VERT.
MATCH LINE STA. 4+800
MATCH LINE STA. 5+600
4+900
5+000
5+100
5+200
5+300
5+400
5+500
RIO VIRILLA
MONTANO
-3.4%
0.0%
+4.0%
1110
1105
1100
1095
1090
4+800
5+600

224



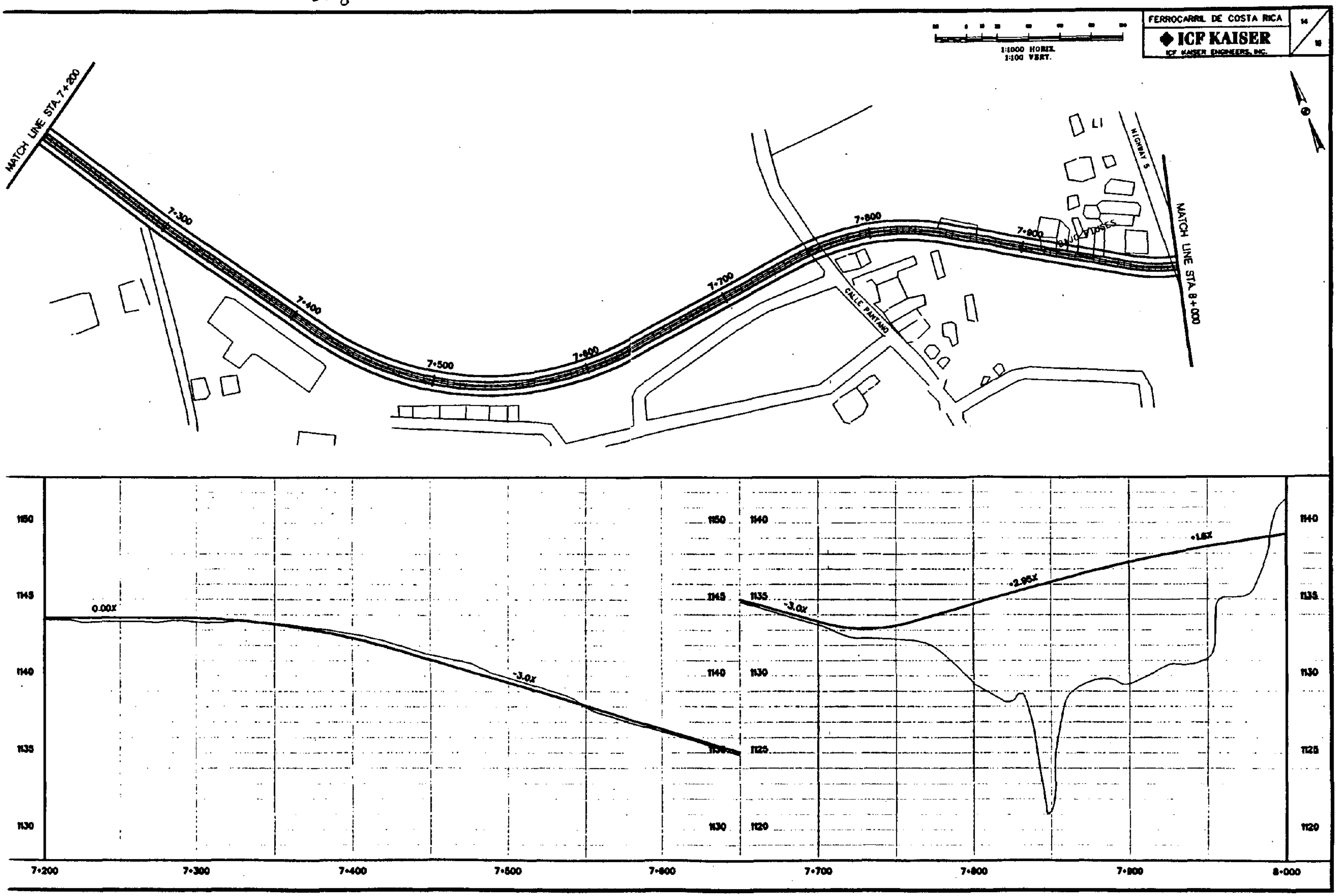
FERROCARRIL DE COSTA RICA
ICF KAISER
ICF KAISER ENGINEERS, INC.
12
19
1:1000 HORIZ.
1:100 VERT.
MATCH LINE STA 5+600
MATCH LINE STA 6+400
SAN JUAN
Asilo
Parque
AVENIDA 6
STATION (SEE NOTE 2)
5+700
5+800
5+900
6+000
6+100
6+200
6+300
+4.0%
+0.6%
+3.4%
1095
1100
1105
1110
1115
1120
1125
5+600
6+400

227



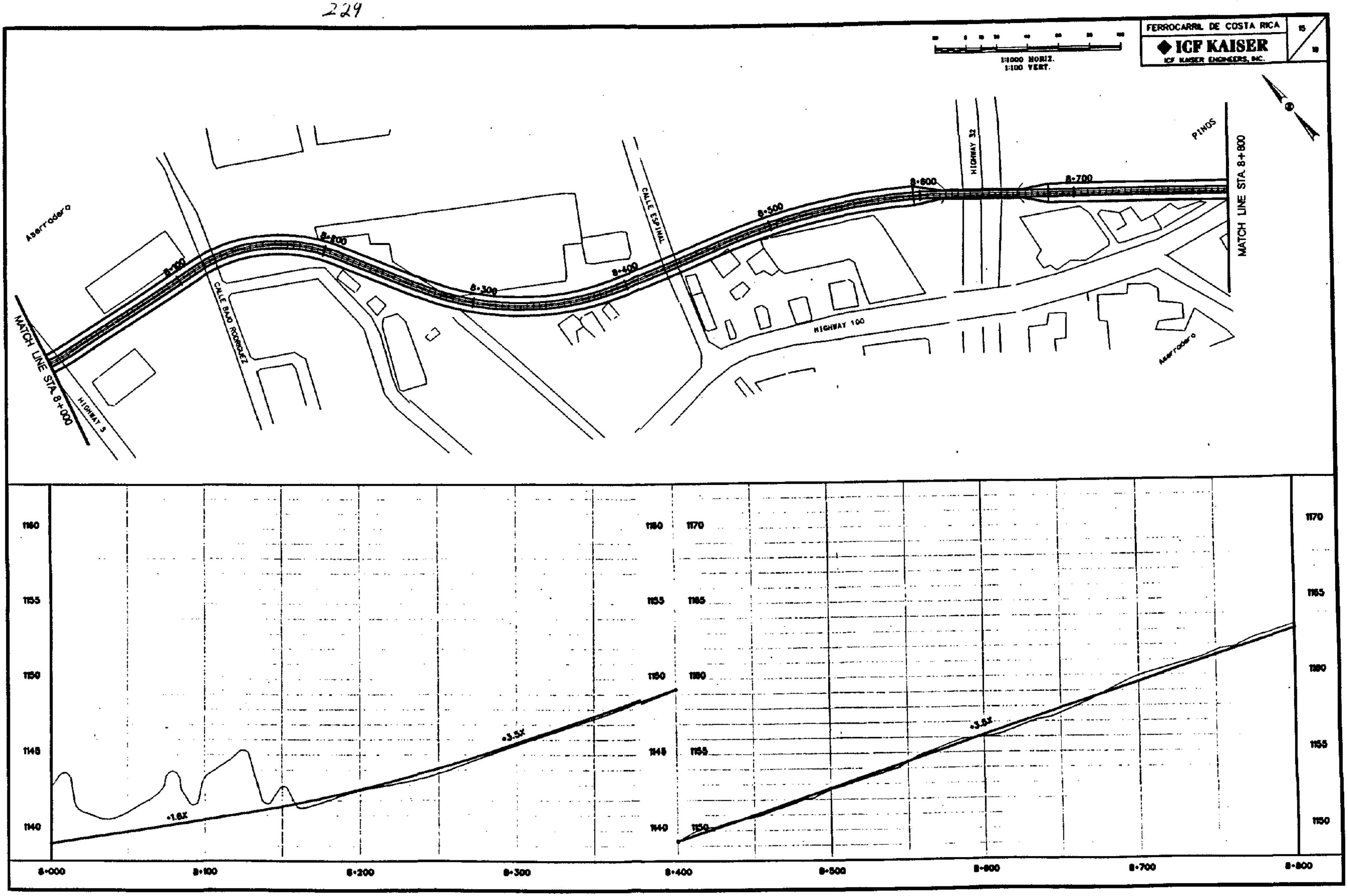
FERROCARRIL DE COSTA RICA
ICF KAISER
ICF KAISER ENGINEERS, INC.
13
19
1:1000 HORIZ.
1:100 VERT.
MATCH LINE STA 6+400
MATCH LINE STA 7+200
6+400
6+500
6+600
6+700
6+800
6+900
7+000
7+100
7+200
SPUR TRACK
TO ELECTRIC
UTILITY
HIGHWAY 101
Escuela Rafael
Vargas
+3.4%
+1.8%
0.00%
1140
1135
1130
1125
1120

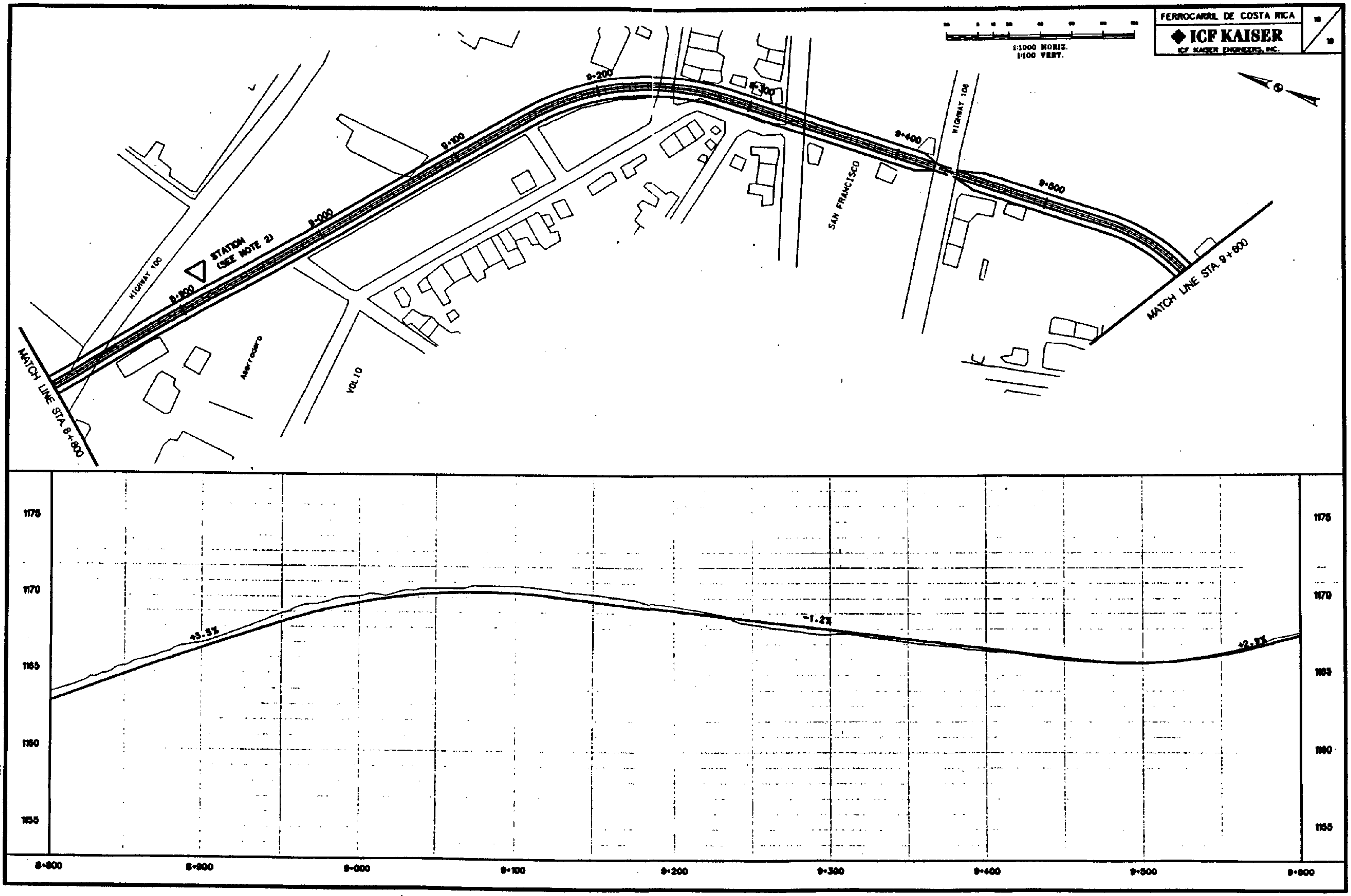
228



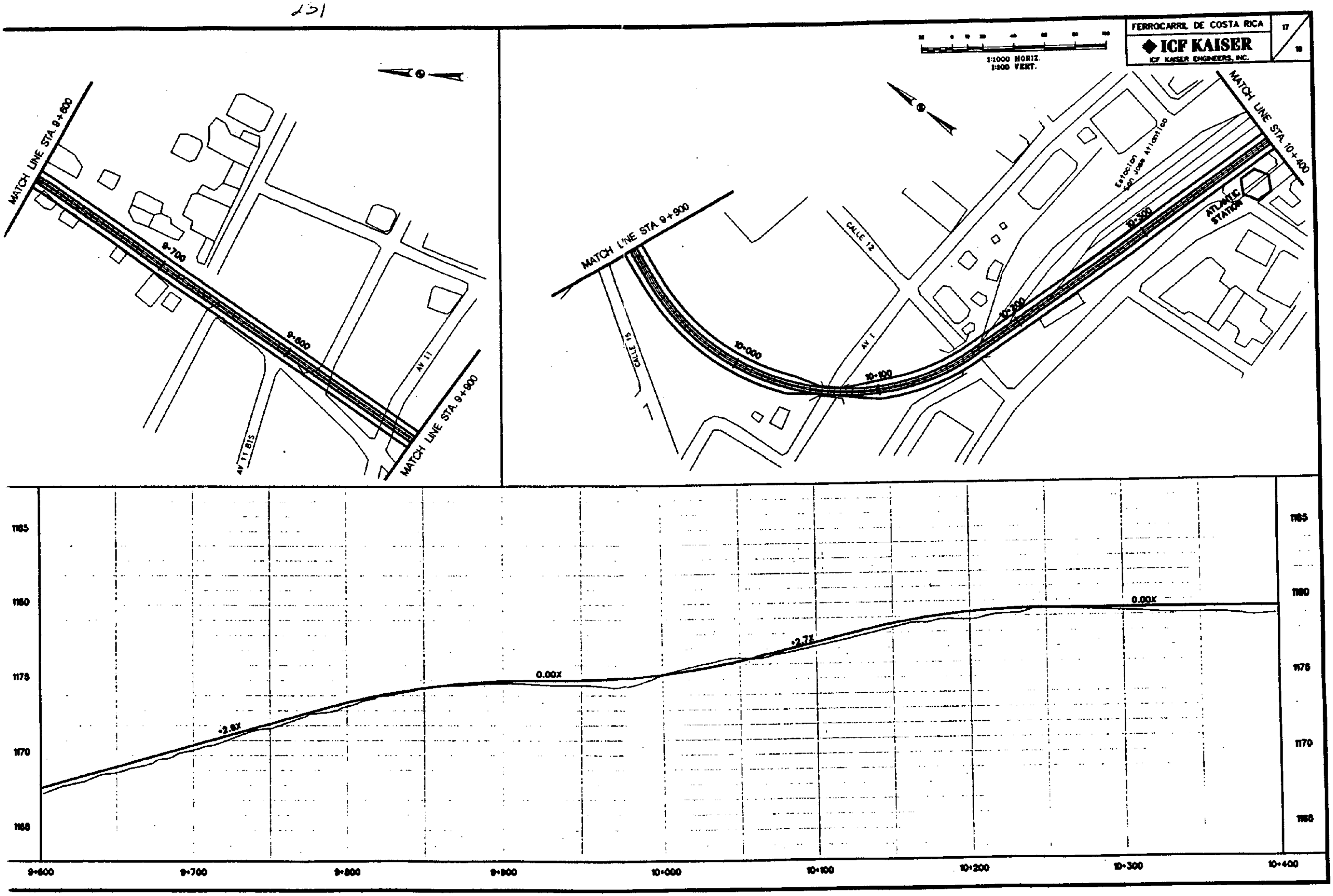
FERROCARRIL DE COSTA RICA
ICF KAISER
ICF KAISER ENGINEERS, INC.
14
16
1:1000 HORIZ.
1:100 VERT.
MATCH LINE STA. 7+200
MATCH LINE STA. 8+000
7+300
7+400
7+500
7+600
7+700
7+800
7+900
CALLE PANTANO
HIGHWAY 5
0.00%
-3.0%
-3.0%
+2.95%
+1.6%
1150
1145
1140
1135
1130
1125
1120
7+200
8+000

229

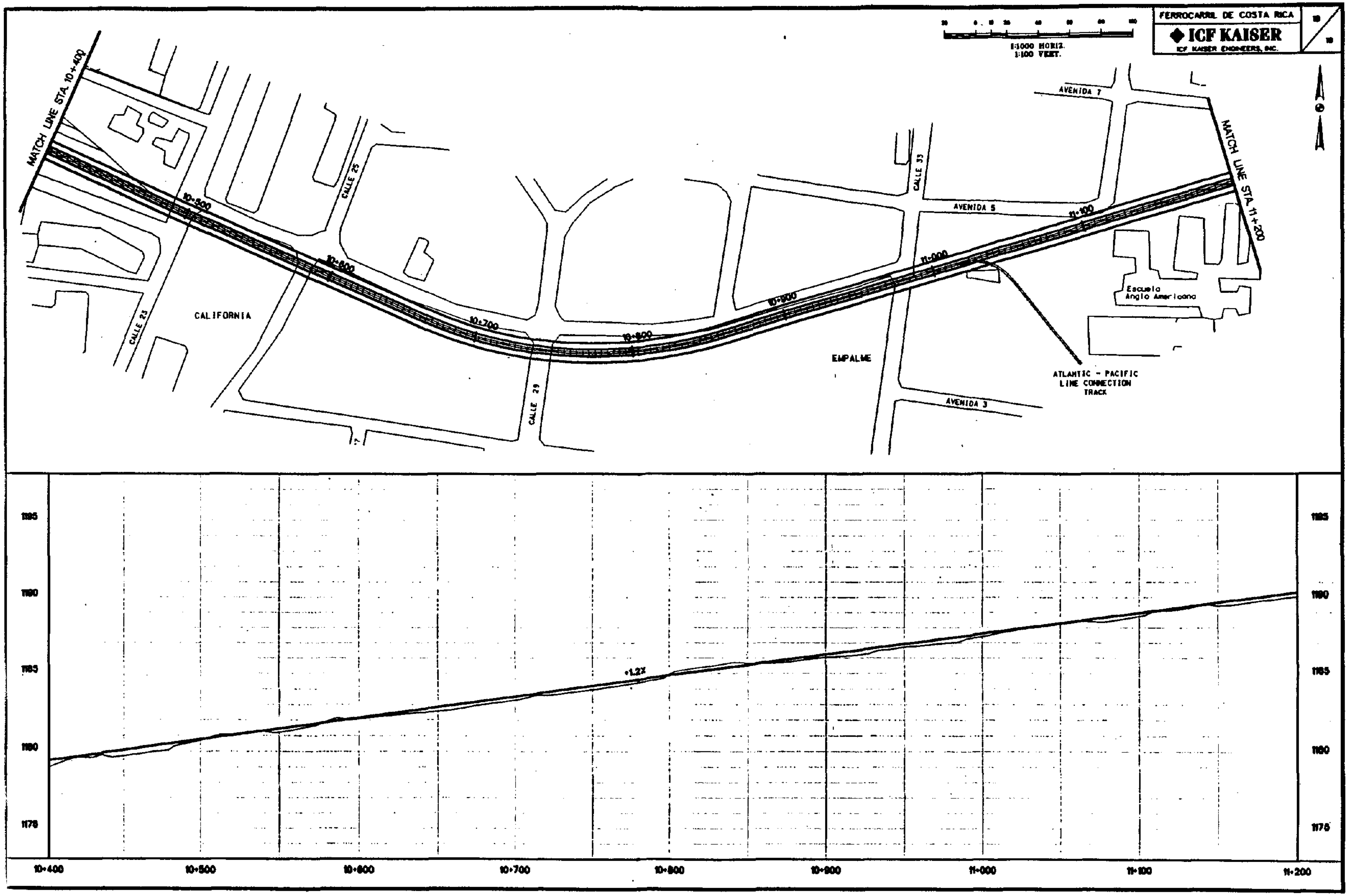

FERROCARRIL DE COSTA RICA
ICF KAISER
ICF KAISER ENGINEERS, INC.
1:1000 HORIZ.
1:100 VERT.
15
MATCH LINE STA. 8+000
MATCH LINE STA. 8+800
HIGHWAY 5
CALLE BAJO RODRIGUEZ
CALLE ESPINAL
HIGHWAY 100
HIGHWAY 32
Aserradero
PINOS
8+100
8+200
8+300
8+400
8+500
8+600
8+700
+1.6%
+3.5%
8+000
8+800


FERROCARRIL DE COSTA RICA
ICF KAISER
ICF KAISER ENGINEERS, INC.
1:1000 HORIZ.
1:100 VERT.
MATCH LINE STA 8+800
MATCH LINE STA. 9+800
STATION (SEE NOTE 2)
HIGHWAY 100
HIGHWAY 106
VOLIO
SAN FRANCISCO
8+900
9+000
9+100
9+200
9+300
9+400
9+500
+3.5%
-1.2%
+2.3%
1175
1170
1165
1160
1155
8+800
9+600

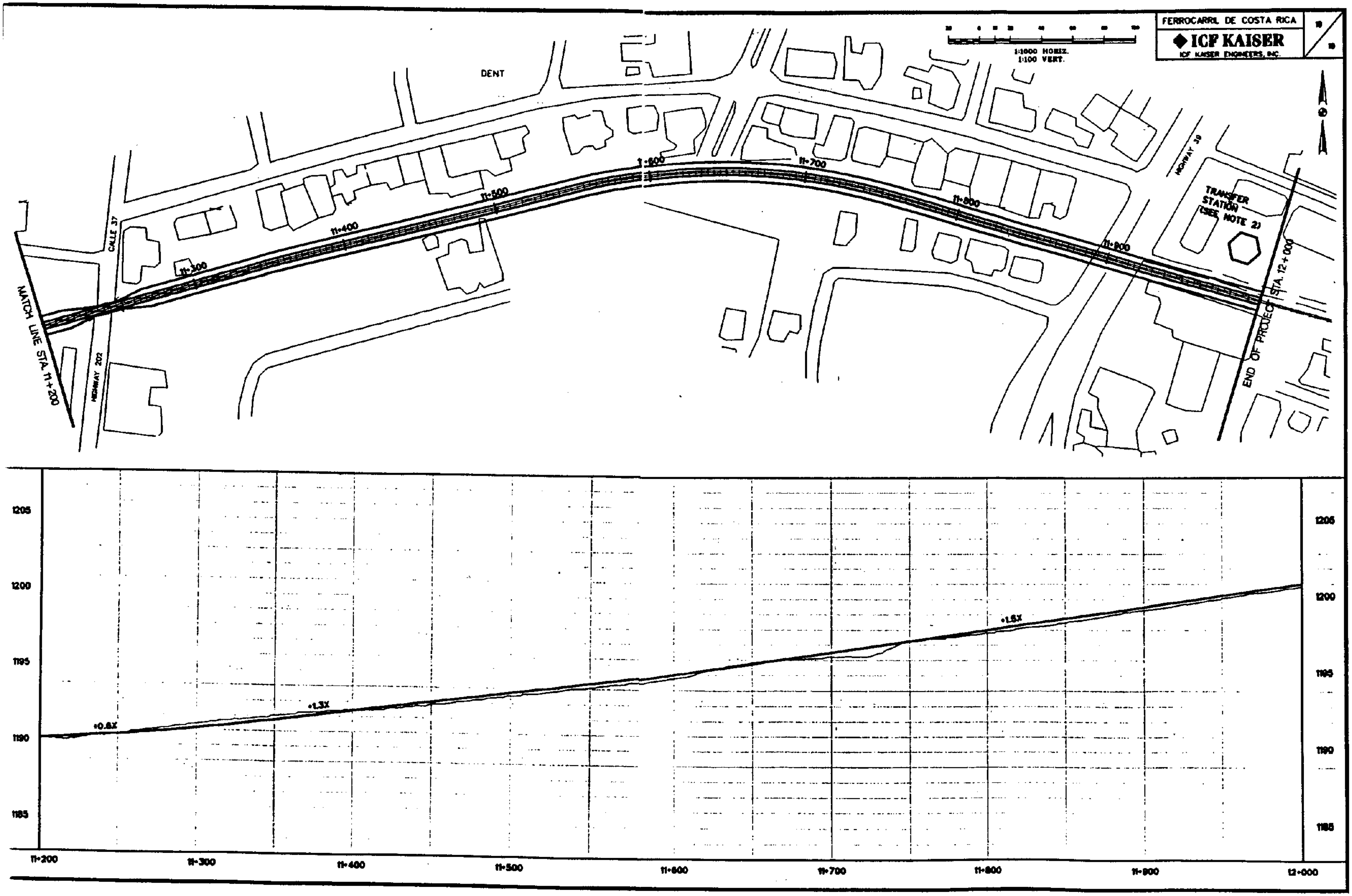
231



MATCH LINE STA 9+600
9+700
9+800
AV 11
AV 11 BIS
MATCH LINE STA 9+900
MATCH L'NE STA 9+900
CALLE 15
CALLE 12
AV 1
10+000
10+100
10+200
10+300
Estacion San Jose Atlantico
ATLANTIC STATION
MATCH LINE STA 10+400
1:1000 HORIZ.
1:100 VERT.
FERROCARRIL DE COSTA RICA
ICF KAISER
ICF KAISER ENGINEERS, INC.
17
18
1165
1170
1175
1180
1185
+2.8%
0.00%
+2.7%
0.00%
9+600
9+700
9+800
9+900
10+000
10+100
10+200
10+300
10+400


FERROCARRIL DE COSTA RICA
ICF KAISER
ICF KAISER ENGINEERS, INC.
1:1000 HORIZ.
1:100 VERT.
MATCH LINE STA. 10+400
MATCH LINE STA. 11+200
CALLE 23
CALLE 25
CALLE 29
CALLE 33
AVENIDA 7
AVENIDA 5
AVENIDA 3
CALIFORNIA
EMPALME
Escuela Anglo Americana
ATLANTIC - PACIFIC LINE CONNECTION TRACK
10+500
10+600
10+700
10+800
10+900
11+000
11+100
+1.2%
1195
1190
1185
1180
1175
10+400
11+200

233


FERROCARRIL DE COSTA RICA
ICF KAISER
ICF KAISER ENGINEERS, INC.
1:1000 HORIZ.
1:100 VERT.
DENT
CALLE 37
HIGHWAY 202
HIGHWAY 39
MATCH LINE STA. 11+200
TRANSFER STATION (SEE NOTE 2)
END OF PROJECT STA. 12+000
11+300
11+400
11+500
11+600
11+700
11+800
11+900
+0.6%
+1.3%
+1.5%
1205
1200
1195
1190
1185
11+200
12+000

APPENDIX IX

LEGAL ISSUES

INFORME LEGAL SOBRE EL TRANSPORTE EN COSTA RICA

El artículo 121 de nuestra Constitución Política es la norma legal de base, a partir de la cual se emiten los diferentes cuerpos legislativos, dentro de los cuales debe operar el Transporte en nuestro país. Para el análisis propuesto es necesario plantearnos varias hipótesis tales como?

Es el sistema es impulsado por energía eléctrica, diesel limpio, gasolina o gas?
Se utilizan ruedas o llantas de hule o metal?
Se circula por carreteras, rieles, en un carril único, por servidumbres o derechos de vía, calles, avenidas o carreteras?
Los vehículos utilizados en el transporte público son buses impulsados por hidrocarburos, energía eléctrica, trolebuses, tranvías o trenes?

1. CONSTITUCIÓN POLÍTICA

"Atribuciones de la Asamblea Legislativa

Articulo 121.- Además de las otras atribuciones que le confiere esta Constitución, corresponde exclusivamente a la Asamblea Legislativa:

1) . . .

2) . . .

3) . . .

4) . . .

14) Decretar la enajenación o la aplicación a usos públicos de los bienes propios de la Nación. No podrán salir definitivamente del dominio del Estado:

a) Las fuerzas que puedan obtenerse de las aguas del dominio público en el territorio nacional;

b) Los yacimientos de carbón, las fuentes y depósitos de petróleo, y cualesquiera otras sustancias hidrocarburadas, así como los depósitos de minerales radiactivos existentes en el territorio nacional;

c) Los servicios inalámbricos.

Los bienes mencionados en los apartes a), b) y c) anteriores sólo podrán ser explotados por la administración pública o por particulares, de acuerdo con la ley o mediante concesión especial otorgada por tiempo limitado y con arreglo a condiciones y estipulaciones que establezca la Asamblea Legislativa.

Los ferrocarriles, muelles y aeropuertos nacionales éstos últimos mientras se encuentren en servicio no podrán ser enajenados, arrendados ni gravados, directa o indirectamente, ni salir en forma alguna del dominio y control del Estado. " (lo resaltado no es del texto)

Respecto al contenido de citado artículo Constitucional, respecto a la materia que nos ocupa, la Sala Constitucional de la Corte Suprema de Justicia, se pronunció en la siguiente forma:

1.1.- SALA CONSTITUCIONAL

Voto número 3789, de las 12 horas del 27 de noviembre de 1992, La Sala Constitucional realizó un análisis profundo respecto al inciso 14 del artículo 121 de la Constitución Política, me permito citar lo más importante así:

"...el artículo 121 inciso 14 contiene tres normas distintas, que deben ser claramente diferenciadas: a) La primera es una norma que habilita a la Asamblea Legislativa para decretar la enajenación o aplicación a usos públicos de los bienes propios de la nación. Por otra parte, esta norma es irrestricta en cuanto se refiere a todos los bienes propios de la nación, y , por otra, reserva a la ley la materia, invalidando actos administrativos de enajenación o aplicación a usos públicos no fundados en ley previa; b) la segunda, prescribe qué bienes no podrán salir definitivamente del dominio del Estado. Para esas categorías que están enunciadas en los incisos a), b) y c), la restricción es total y absoluta en cuanto a salir del dominio del Estado, pero, de inmediato, la norma modera su severidad advirtiendo que tales categorías de bienes pueden ser explotados por la administración pública o por particulares de acuerdo con la ley o mediante concesión especial; c) La tercera es una norma que se refiere específicamente a ciertos bienes (ferrocarriles, muelles, y aeropuertos nacionales en servicio) no incluidos en las tres categorías de la norma precedente. Si sobre estos bienes nada se dijera, los cubriría la norma de habilitación con que el inciso 14) comienza, como ya se ha visto. Pero la existencia de esta disposición específica implica un régimen jurídico propio para estos bienes, que limita el principio general de enajenación y aplicación a usos públicos de una manera rigurosa; tales bienes no podrán ser enajenados, arrendados ni gravados, directa o indirectamente, ni salir en forma alguna del dominio y control del Estado. La norma alude, en primer lugar a enajenación, arrendamiento o gravamen, pero la expresión "directa o indirectamente", en el contexto rígido de la disposición puede referirse el mismo a la situación en que el Estado procede por si o por medio de otras entidades jurídicas (en sentido subjetivo), o a los casos en que se emplean modalidades o medios que tengan consecuencias o efectos jurídicos equivalentes o similares, aunque per se no supongan teóricamente enajenación, arrendamiento o gravamen (sentido sustantivo). A continuación, este rigor se confirma con la expresión "ni salir en forma alguna del dominio y control del Estado", expresión esta a la que también hay que dar una amplia cobertura de hipótesis por la vocación de la norma."

COMENTARIO;

Por disposición Constitucional los ferrocarriles, deben de permanecer bajo el control y dominio público, es decir, forman parte de lo que en doctrina se denomina "dominio público necesario", por cuanto no pueden ser enajenados ni gravados, restricción esta que únicamente podría ser levantada si el inmueble resultara desafectado del uso público, de lo contrario, deben de permanecer necesariamente bajo la tutela o control del Estado. No debemos sin embargo olvidar que en el área metropolitana los ferrocarriles "no están en servicio" pareciera que el contenido constitucional no se está cumpliendo, pues la redacción del referido artículo entre otras cosas dice "mientras se encuentren en servicio".

2.- LEY REGULADORA DEL TRANSPORTE REMUNERADO DE PERSONAS EN VEHÍCULOS AUTOMOTORES, número 3503 de 10/05/65 y 3560 de 27/10/65

Artículo 1.- El transporte remunerado de personas en vehículos automotores colectivos, excepto los automóviles de servicios de taxi regulado en otra ley, que se lleva a cabo por calles, carreteras y caminos dentro del territorio nacional, es un servicio público regulado, controlado y vigilado por el Ministerio de Obras Públicas y Transportes. La prestación es delegada en particulares a quienes se autoriza expresamente, de acuerdo con las normas aquí establecidas.

RUTA: Trayecto que recorren, entre dos puntos llamados terminales, los vehículos de transporte remunerado de personas.

LÍNEA: Servicio de transporte que se presta en determinada ruta.

CONCESIÓN: Derecho que el Estado otorga, previo trámite de licitación pública, para explotar comercialmente una línea por medio de uno o varios vehículos colectivos, tales como autobuses, busetas, microbuses o similares.

TARIFA: Retribución económica fijada por el Ministerio de Obras Públicas y Transportes, como contraprestación por el servicio de Transporte.

ARESEP: Autoridad Reguladora de los Servicios Públicos.

Artículo 2.- Es competencia del Ministerio de Transportes el relativo al tránsito y transporte automotor de personas en el país. Este Ministerio podrá tomar a su cargo la prestación de estos servicios públicos ya sea en forma directa o mediante otras instituciones de Estado, o bien conceder derechos a empresarios particulares para explotarlos.

El Ministerio de Obras Públicas y Transportes ejercerá la vigilancia, el control y la regulación del tránsito y del Transporte automotor de personas. El control de los servicios de transporte público concesionados o autorizados, se ejercerá conjuntamente con la Autoridad Reguladora de los Servicios Públicos, para garantizar la aplicación correcta de los servicios y el pleno cumplimiento de las disposiciones contractuales correspondientes.

A fin de cumplir con esta obligación, el Ministerio podrá:

a.- Fijar itinerarios, horarios, condiciones y tarifas.

b.- Expedir los reglamentos que juzgue pertinentes sobre tránsito y transporte en el territorio costarricense.

c.- Adoptar las medidas para que se satisfagan, en forma eficiente, las necesidades del tránsito de vehículos y del transporte de personas.

d.- Realizar los estudios técnicos indispensables para la mayor eficiencia, continuidad y seguridad de los servicios públicos.

Artículo 3.- Para la prestación del servicio público a que esta ley se refiere, se requerirá la autorización del Ministerio de Transportes, sea cual fuere el tipo de vehículo a emplear y su sistema de propulsión.

La referida autorización podrá consistir en una concesión o en un permiso, el otorgamiento de los cuales estará sujeto a las necesidades de planeamiento del tránsito y de los transportes en el territorio de la República, de acuerdo con los estudios que al efecto lleven a cabo los Departamentos de Planificación y de Transporte Automotor del Ministerio de Transportes.

Será necesaria concesión:

a.- Para explotar las líneas que se establezcan en nuevas rutas de tránsito en el territorio de la República.

b.- Para explotar nuevas líneas en las rutas existentes; y

a.- Para continuar explotando las líneas de transporte en operación.

Se requerirá permiso:

d.- Para explotar el servicio de transporte automotor remunerado con vehículos de transporte colectivo que no tenga itinerario fijo y cuyos servicios se contraten por viaje, por tiempo o en ambas formas.(lo resaltado no es del texto)

CAPÍTULO VI

SEÑALAMIENTO, VARIACIÓN, ESTABLECIMIENTO Y ADJUDICACIÓN DE LÍNEAS, RUTAS Y ESTACIONES TERMINALES DE CADA CONCESIÓN

Artículo 8.- Corresponderá al Ministerio de Transportes el señalamiento para cada concesión de las rutas, estaciones terminales y sitios de parada de vehículos de servicio público.

Por causa de utilidad pública podrá el Ministerio de Transportes modificar los señalamientos a que se refiere este artículo y el concesionario quedará sujeto a esos cambios. En tales casos, el Ministerio podría revisar la concesión, si considera que las modificaciones alteran sensiblemente las condiciones en que fue otorgada.

Artículo 10.- La explotación de cada línea de servicio se adjudicará de preferencia a una sola persona, física o jurídica; pero, en este último caso, el capital de la sociedad no podrá estar representado por acciones ni certificados al portador.

Cuando lo exija una demanda extraordinaria del servicio, el Ministerio de Transportes podrá autorizar el establecimiento de nuevas líneas en rutas en las que haya otras líneas, de acuerdo con los estudios que realizará la Dirección General de Transporte Automotor.

Antes de establecer una nueva línea, se otorgará un plazo no menor de treinta días ni mayor de noventa al concesionario de la ruta en cuestión, para que aumente la capacidad del transporte o satisfagan los requisitos de higiene y eficiencia exigidas para prestar el servicio público.

Si el citado concesionarios no cumple con esa obligación en el plazo señalado, el Ministerio de Obras Públicas y Transportes con base en los estudios técnicos aprobados por la Autoridad Reguladora de los Servicios Públicos, licitará una nueva concesión, distribuirá las líneas en la forma mas adecuada, modificándolas si es preciso, sin crear una competencia ruinosa entre los concesionarios.

CAPÍTULO XII

PERMISOS PARA EXPLOTAR EL SERVICIO DE TRANSPORTE AUTOMOTOR DE PERSONAS

Artículo 25.- Los permisos para explotar el transporte automotor de personas en vehículos colectivos, excepto los automóviles de servicios público que se contraten por viaje o por tiempo, serán expedidos por la Comisión Técnica de Transportes. Cada permiso podrá amparar uno o varios vehículos, de acuerdo con la naturaleza del servicio que se pretenda prestar y lo dispuesto en la presente ley y su reglamento. Los permisos serán revocables por incumplir las condiciones incluidas en ellos o por disposición justificada de la Comisión Técnica de Transporte Automotor

CAPÍTULO XIV

TARIFAS

Artículo 30.- La Comisión Técnica de Transportes fijará las tarifas aplicadas al servicio de Transporte automotor.
La Autoridad Reguladora de Servicios Públicos las aprobará, improbará o modificará. (lo resaltado no es del texto)

COMENTARIO

El transporte remunerado de personas dentro del territorio nacional en vehículos colectivos, sin importar el medio de propulsión o sistema de combustible utilizado, excepto los taxis y los ferrocarriles, es un servicio público regulado, controlado y vigilado por el MOPT.

Bajo este escenario que nos ocupa, si se decide implementar el uso de "Electric Trolley Buses" (ETB), "BusWay" (clean diesel), "Diesel Multiple", o buses eléctricos operando en calles avenidas o carreteras nacionales, esta ley sería de aplicación.

Si por el contrario la decisión fuera la de operar el "Light Rail Transport" (LRT), tren liviano, Tram o cualquier otra tecnología o variedad de ferrocarril, es estrictamente necesaria la utilización de la ley 5066 de 30 de agosto de 1972, conocida como ley de Ferrocarriles

3.- LOS FERROCARRILES

Debemos a esta altura del análisis recordar lo establecido en el citado artículo 121 inciso 14) de la Constitución Política:

"Los ferrocarriles, muelles y aeropuertos nacionales estos últimos mientras se encuentren en servicio no podrán ser enajenados, arrendados ni gravados, directa o indirectamente, ni salir en forma alguna del dominio y control del Estado."

Para mantener la continuidad del presente estudio, es necesario analizar la legislación de ferrocarriles veamos:

3.1- LEY GENERAL DE FERROCARRILES NÚMERO 5066

Artículo 4.- Los ferrocarriles construidos o que hayan pasado a poder del Estado no podrán ser enajenados, ni gravados, directa o indirectamente, ni salir en forma alguna del dominio y control del Estado, entendida esta prohibición a los ferrocarriles considerados como tales, conforme a la disposición contenida en el artículo 7.-

Artículo 7.- Para los efectos de la presente ley se entiende por ferrocarril la vía, el material fijo y rodante, los ramales o extensiones, los apartaderos, las terminales, las estaciones intermedias u todas aquellas edificaciones, instalaciones, muelles y otras anexidades que de manera directa o indirecta formen parte de una misma explotación. .

Artículo 10.- Corresponde al Poder Ejecutivo el otorgamiento de las concesiones para la construcción y explotación de ferrocarriles, sujeto a la aprobación de la Asamblea Legislativa.

Ninguna concesión de ferrocarril establecerá monopolio en favor de la empresa. Toda concesión de ferrocarril se enciende otorgada bajo la condición de que el Estado podrá rescatarla, conforme a los trámites que establece la presente ley.

CMENTARIO

Es claro que al alero de la Constitución Política se emitió la presente ley de ferrocarriles, donde se mantiene el principio de "dominio público necesario". Lo anterior quiere decir, que el otorgamiento de una concesión para la construcción y explotación de un ferrocarril debe ser estudiada y recomienda el Poder Ejecutivo, pero luego debe ser aprobada por la Asamblea Legislativa.

3.2.- LEY ORGANICA DEL INCOFER N. 7001, 1ro de Octubre de 1985.

Como un medio para lograr la modernización de los ferrocarriles en nuestro país se creó el Instituto Costarricense de Ferrocarriles, INCOFER, mediante su respectiva ley orgánica, veamos:

ARTICULO 1.- Créase el Instituto Costarricense de Ferrocarriles, denominado en la presente ley el Instituto, que será una institución de derecho público, con autonomía administrativa, personalidad jurídica, y patrimonio propio, y que se regirá por las disposiciones establecidas en esta ley y sus reglamentos, así como en las leyes que la complementen.

CAPITULO SEGUNDO

OBJETIVOS

ARTICULO 3.- Los objetivos principales del Instituto son:

a) Fortalecer la economía del país mediante la administración de un moderno sistema de transporte ferroviario para el servicio de pasajeros y de carga. Además podrá prestar servicios conexos con el citado sistema.

b) Rehabilitar, estructurar y modernizar, tanto en lo que se refiere a vías, instalaciones y equipo rodante, como a su administración y prestación de servicios en general, los actuales ferrocarriles nacionales del Atlántico y eléctrico al Pacífico, a fin de integrarlos en un ferrocarril interoceánico nacional para la prestación del servicio.

c) Estudiar, ejecutar y administrar toda nueva red ferroviaria que pueda integrarse a las actuales, a fin de habilitar zonas de producción del país. Los estudios comprenderán, además, la posibilidad de llevar a cabo una interconexión ferroviaria centroamericana.

Ch) Electrificar, reconstruir y rectificar toda su red ferroviaria existente, dentro de los tres años posteriores a la vigencia de esta ley. Para estos fines el instituto queda autorizado para contratar empréstitos directamente y constituir gravámenes y en cualquier forma legal, obtener recursos nacionales o extranjeros, sin que al efecto sea necesaria la autorización o aprobación de ningún organismo público y para lo cual el poder ejecutivo otorgará los avales necesarios. No obstante los empréstitos que se contraten para esta finalidad deberán ser sometidos, por conducto del poder ejecutivo a conocimiento y aprobación en la Asamblea Legislativa, la cual deberá aprobarlos dentro de los tres meses posteriores a su presentación. En defecto del pronunciamiento oportuno de la Asamblea Legislativa, se tendrá por aprobado el empréstito.

CAPTULO CUATRO

EL CONSEJO DIRECTIVO

ARTICULO 14).- Se requerirán cinco votos, por lo menos, para la validez de los siguientes acuerdos:

a)...
b)...
c)...

ch) Otorgamiento de concesiones a particulares, sean estos personas físicas o jurídicas.

ARTICULO 16).-

a)...
b)...
c)...

Dar permisos de uso, sujetos a canon, sobre determinados bienes inmuebles a terceros, siempre que su uso este destinado a las actividades propias de empresas portuarias, navieras, aduanales o de transporte, y siempre que otras instituciones del Estado o ministerio afines no requieran estos inmuebles.

CAPITULO UNDECIMO

PATRIMONIO

ARTICULO 36).- Formaran parte del patrimonio del Instituto:

Los terrenos, edificios, estructuras, equipos, material rodante y en general, todos los bienes muebles e inmuebles que estén o hayan estado destinados a actividades ferroviarias o conexas con estas como patios ferroviarios, bodegas, casas, y edificios que integraron o integren el patrimonio del instituto Autónomo del Ferrocarril Eléctrico al Pacifico, a los ferrocarriles del Atlántico o a cualquier otra institución pública que los tenga bajo su dominio o posesión por cualquier título. Estos bienes deberán ser traspasados en propiedad al Instituto, conforme con las previsiones establecidas en el transitorio 1 de esta ley.

. . .

c) . . .

. . .

COMENTARIO

Del contenido de los artículos antes citados es fácil deducir, que es posible, mediante los respectivos trámites legales correspondientes, el lograr la autorización, para que por el derecho de vía del ferrocarril puedan transitar conjutamente otros medios de transporte público de transportes. No se trata de excluir el ferrocarril, pero debe tomarse en cuenta, que actualmente no está operando, y que es posible una convivencia en la servidumbre o derecho de vía de otras formas de transporte público.

4.- LEY REGULADORA DE LOS SERVICIOS PÚBLICOS

Con el número 7593 se emitió la Ley Reguladora de los Servicios Públicos, transformando así el antiguo SNE, en una nueva institución conocida ahora como Autoridad Reguladora de los Servicios Públicos (ARESEP), otorgándole a esta institución una serie de competencias antes dispersas y redistribuyendo otras, veamos:

CAPITULO III
Funciones y atribuciones

Artículo 5°-Funciones

En los servicios públicos definidos en este artículo, la Autoridad Reguladora fijará precios y tarifas; además, velará por el cumplimiento de las normas de calidad, cantidad, confiabilidad, continuidad, oportunidad y prestación óptima, según el artículo 25 de esta ley. Los servicios públicos antes mencionados son:

a) Suministro de energía eléctrica en las etapas de generación, transmisión, distribución y comercialización.

Los servicios de telecomunicaciones cuya regulación esté autorizada por ley.

c) Suministro del servicio de acueducto y alcantarillado, incluyendo agua potable, recolección, tratamiento y evacuación de aguas negras, aguas residuales y pluviales.

d) Suministro de combustibles derivados de hidrocarburos, dentro de los que se incluyen: 1) los derivados del petróleo, asfaltos, gas y naftas destinados a abastecer la demanda nacional en planteles de distribución y 2) los derivados del petróleo, asfaltos, gas y naftas destinados al consumidor final. La Autoridad Reguladora deberá fijar las tarifas del transporte que se emplea para el abastecimiento nacional.

e) Riego y avenamiento, cuando el servicio se presta por medio de una empresa pública o por concesión o permiso.

f) Cualquier medio de transporte público remunerado de personas, salvo el aéreo.

g) Los servicios marítimos y aéreos en los puertos nacionales.

h) Transporte de carga por ferrocarril.

i) Recolección y tratamiento de desechos sólidos e industriales.

La autorización para prestar el servicio público será otorgada por los entes citados a continuación:

Inciso a): Ministerio del Ambiente y Energía.
Inciso c): Ministerio del Ambiente y Energía.
Inciso d.2: Ministerio del Ambiente y Energía.
Inciso e): Ministerio del Ambiente y Energía.
Inciso f): Ministerio de Obras Públicas y Transportes.
Inciso g): Ministerio de Obras Públicas y Transportes; Junta de Administración portuaria y de Desarrollo Económico de la Vertiente Atlántica e Instituto Costarricense de Puertos del Pacífico, respectivamente.
Inciso h): Ministerio de Obras Públicas y Transportes.
Inciso i): Las municipalidades.

Artículo 9°-Concesión o permiso

Para ser prestatario de los servicios públicos, a que se refiere esta ley, deberá obtenerse la respectiva concesión o el permiso del ente público competente en la materia, según lo dispuesto en el artículo S de esta ley. Se exceptúan de esta obligación las instituciones y empresas públicas que, por mandato legal, prestan cualquiera de estos servicios. Sin embargo, todos los prestatarios estarán sometidos a esta ley y sus reglamentos.

La Autoridad Reguladora continuará ejerciendo la competencia que la Ley No. 7200 y sus reformas, del 28 de setiembre de 1990, le otorgan al Servicio Nacional de Electricidad.

5.- LEY GENERAL DE CONCESIÓN DE OBRA PÚBLICA

Es la ley número 7404, ha sido muy discutida y hoy se encuentra en la Asamblea Legislativa un proyecto de ley bajo el expediente 12.528, en la Comisión Permanente de Asuntos Jurídicos, este proyecto pretende modernizar la ley para poner en concordancia con las nuevas tendencias de contratación, el proyecto cuenta ya con Dictamen afirmativo de mayoría.

CUADRO COMPARATIVO

LEY GENERAL DE CONCESIÓN DE OBRA PÚBLICA número 7404

Artículo 1.-

La concesión de obra pública es el instituto jurídico de derecho público mediante el cual el Estado encarga a una persona la ejecución de una obra y le transmite, temporalmente, los poderes jurídicos necesarios para que la explote, por medio del pago de una contraprestación o tarifa que abonarán los usuarios, con la autorización, control y vigilancia de la administración, pero por cuenta y riesgo del concesionario.

Artículo 2.-

La Administración concedente mantendrá el derecho de propiedad de la obra pública y la titularidad en la prestación del servicio público.

El concesionario tiene la obligación de cuidar, reparar y mantener la obra y todos los bienes de la concesión y la obligación de prestar el servicio público, de conformidad con esta Ley, su Reglamento y el contrato de concesión.

Artículo 3.-

El Poder Ejecutivo, los entes descentralizados y las municipalidades. Pueden otorgar concesiones para la construcción, reparación, ampliación, conservación y restauración de obras públicas y su correspondiente explotación, con base en las disposiciones de esta Ley.

Artículo 4.-

El Presidente de la República y el Ministro del ramo otorgarán las concesiones de obra pública que competan al Poder Ejecutivo, de conformidad con las disposiciones de esta Ley.

Si la obra pública se encuentra en el ámbito de competencia de un ente descentralizado, a solicitud de éste y con base en esta Ley, el Consejo de Gobierno podrá formular la directriz correspondiente para el trámite de la concesión.

Las municipalidades por votación no menor de las dos terceras partes de la totalidad de sus miembros, pueden otorgar obras en concesión, para prestar servicios públicos propios, en interés de sus comunidades, cuando no puedan suministrarlos directa y eficientemente. No obstante, la Contraloría General de la República, a la que se le enviará todo acuerdo municipal que autorice el trámite de una concesión, puede objetarlo por razones de legalidad.
Siempre se tomará en consideración el impacto ambiental del proyecto y para ello debe obtenerse el criterio del Ministerio de Recursos Naturales, Energía y Minas, que supervisará la construcción de la obra y la prestación del servicio, en lo relativo al ambiente.

Toda concesión se otorgará condicionada a la aprobación de un estudio o evaluación del impacto ambiental de sus actividades, por parte del Ministerio de recursos Naturales, Energía y Minas. El oferente seleccionado deberá presentarlo dentro de los cuatro meses posteriores a que se le notifique la resolución en que así se prevenga.

El Ministerio de Recursos Naturales, Energía y Minas dispondrá de un plazo de dos meses, contados a partir de la presentación del mencionado estudio para evaluarlo. Si lo aprueba, la adjudicación se tendrá por definitiva; pero si el estudio está incompleto o es deficiente, el Ministerio le concederá al interesado un plazo hasta de dos meses para corregirlo. Si el estudio no se completa o no se corrige a satisfacción del Ministerio o si no se vuelve a presentar, la adjudicación se tendrá como inexistente para todos los efectos legales.

Artículo 5.-

No puede darse en concesión una obra pública, cuando su otorgamiento pueda significar una limitación a derechos fundamentales referentes al libre tránsito, a la salud y a la educación salvo que, además de la obra en concesión, existan otras por medio de las cuales el Estado preste esos servicios.

Tampoco pueden darse en concesión, las obras que sean fundamentales para el resguardo de la soberanía o de la seguridad de la Nación o que afecten la libertad, tranquilidad o seguridad de los habitantes, ni los bienes mediante los cuales el Estado o los entes públicos brinden servicios en condición de exclusividad o monopolio.

Artículo 6.-

Los Ferrocarriles, muelles y aeropuertos nacionales, estos últimos mientras se encuentren en servicio, no pueden ser enajenados, arrendados ni gravados, directa o indirectamente, ni salir, de ninguna forma del dominio y control del Estado.

Las concesiones que se otorguen para construir y explotar nuevas instalaciones de ferrocarriles, muelles y aeropuertos deben ser tramitadas de acuerdo con esta Ley y aprobadas por la Asamblea Legislativa, dentro del plazo que corresponda conforme a su Reglamento de Orden, Dirección y Disciplina Interior.

Pueden darse en concesión, los servicios públicos complementarios o no esenciales, situados en ferrocarriles, muelles y aeropuertos.

Artículo 9.-

El plazo de la concesión no puede ser mayor de veinticinco años y se inicia el día en que la administración reciba la obra pública a plena satisfacción.

Entratándose de proyectos de ferrocarriles, aeropuertos y muelles, por la complejidad de la obra y el tiempo que se requiere para la recuperación de la inversión, la concesión será de hasta cincuenta años.

Artículo 12.-

Toda concesión otorgada al amparo de esta Ley se sujetará al procedimiento de licitación pública.

REFORMAS A LA LEY GENERAL DE CONCESIÓN DE OBRA PÚBLICA número 7404, expediente 12.528

Artículo 1.-

Mediante la concesión de obra pública, el Estado encarga a una persona la ejecución, modificación, reparación, conservación, ampliación, mejora o mantenimiento de una obra nueva o preexistente, otorgándole la concesión para la explotación temporal a que se encuentra destinada, por medio de una contraprestación o tarifa que abonarán los usuarios. En todo momento la concesión se entenderá por cuenta y riesgo del concesionario, a quien el Estado podrá cobrarle un canon como retribución por la explotación de la obra o servicio.

En aquellos casos en que la explotación de la obra deba darse a través de un servicio público consustancial a la misma, se deberán observar siempre los principios de continuidad, regularidad, uniformidad, generalidad y obligatoriedad.

En estos supuestos, el Estado continuará ejerciendo, además de la titularidad de los bienes y servicios, el control y la fiscalización directa y permanente por medio de la Administración concedente, la Autoridad Reguladora de los Servicios Públicos, la Contraloría General de la República y cualquier otro órgano especializado, en sus respectivos ámbitos de competencia.

Artículo 2.-

Igual.-

Artículo 3.-

Para lo no previsto en la presente Ley y en su Reglamento, se aplicará supletoriamente, la Ley de Contratación Administrativa.

Artículo 4.-

En todo proceso de concesión de obra pública siempre se tomará en consideración el impacto ambiental del proyecto y para ello debe obtenerse el criterio del Ministerio de Ambiente y Energía, que supervisará la construcción de la obra y la prestación del servicio, en lo relativo al ambiente.

Continua hablando del ambiente. . . .

Artículo 5.-

El Presidente de la República y el ministro del ramo otorgarán las concesiones de obra pública que competan al Poder Ejecutivo, de conformidad con las disposiciones de esta ley.

También corresponderá al Poder Ejecutivo el otorgamiento de las concesiones para la construcción y explotación de ferrocarriles, muelles y aeropuertos, de conformidad con lo que dispone la presente ley.

Si la obra pública se encuentra en el ámbito de competencia de un ente descentralizado, a solicitud de éste y con base en la presente ley, el Consejo de Gobiemo podrá formular la directriz correspondiente al trámite de la concesión.

Las municipalidades, por votación no menor de las dos terceras partes de la totalidad de sus miembros, pueden otorgar obras en concesión, aún cuando a través de ellas se presten servicios públicos propios, en interés de sus comunidades, cuando no puedan suministrarlos directa y efectivamente.

Todo acuerdo municipal que autorice el trámite de una concesión se le enviará en consulta vinculante a la Contraloría General de la República, quien podrá objetarlo mediante acto razonado por razones de legalidad. Si la Contraloría General no resuelve lo pertinente en el plazo de un mes, operará el silencio positivo en favor de la municipalidad consultante.

Artículo 6.-

Los ferrocarriles, muelles y aeropuertos nacionales, tanto nuevos como existentes, pueden ser otorgados en concesión, de conformidad con esta Ley y su Reglamento.

Artículo 9.-

El plazo de la concesión no puede ser mayor de veinticinco años. Tratándose de obra nueva, se inicia el día en que la administración la reciba a plena satisfacción. En los casos de obra preexistente, la administración establecerá la fecha de inicio de la concesión, según la naturaleza de los trabajos por realizar.

Cuando la concesión se refiera a proyectos relacionados con ferrocarriles, aeropuertos y muelles, la concesión podrá ser de hasta por cincuenta años, considerando la complejidad de la obra y el tiempo que se requiere para recuperación de la inversión.

El plazo de la concesión se determinará, dentro de los límites establecidos en la presente ley, de acuerdo con el tiempo que prudencialmente se requiere para la recuperación de la inversión, a criterio de la administración concedente.

En cualquiera de los casos de los párrafos anteriores la administración deberá dejar constancia en el expediente respectivo, mediante acto razonado, de los fundamentos y razones que ha tenido para fijar el plazo de la concesión.

Artículo 12.-

Toda concesión otorgada al amparo de esta ley se sujetará a los principios generales de la contratación administrativa y al procedimiento de licitación pública regulado por la Ley de Contratación Administrativa.

6.- LEY DE LA CONTATACIÓN ADMINISTRATIVA

Esta ley es bastante nueva, y permite la innovación e materia de nuevos procedimientos de contratación, siempre que resulten acordes a la satisfacción del fin público.

"Artículo 3.- Régimen Jurídico

La actividad de contratación administrativa se somete a las normas y los principios del Ordenamiento Jurídico Administrativo.

Cuando lo justifique la satisfacción del fin público, la Administración podrá utilizar, instrumentalmente, cualquier figura contractual que nos e regule en el ordenamiento jurídico administrativo. En todos los casos, se respetarán los principios, los requisitos y los procedimientos ordinarios establecidos en esta ley, en particular en lo relativo a la formación de la voluntad administrativa.

Las disposiciones de esta Ley se interpretarán y se aplicarán, en concordancia con las facultades de fiscalización superior de la hacienda pública que le corresponden a la Contraloría General de la República, de conformidad con su ley Orgánica y la Constitución Política."

COMENTARIO

Esta ley es bastante nueva y permite la utilización de figuras contractuales aun no comprendidas en nuestro Ordenamiento Jurídico, siempre y cuando lo que se persiga es la satisfacción del Fin Público, se puede dar entrada aquí a nuevas formas de contratación como el Leasing, los BOT, BLT etc.

6.1 DISCUCIÓN DEL PROYECTO EN LA ASAMBLEA LEGISLATIVA

El citado artículo (3.-) fue muy comentado en la COMISION PERMANENTE DE ASUNTOS JURÍDICOS DE LA ASAMBLEA LEGISLATIVA PERIODO EXTRAORDINARIO ACTAS - 54 y 55, en la materia que nos interesa dicen:

> En Costa Rica la orientación ha sido hacia la recepción del "modelo monista" en materia de contratación administrativa, en contraposición con el "modelo dualista". Este modelo acepta la posibilidad de que cierto tipo de actividad la desarrolle el Estado bajo su capacidad de derecho privado. En este caso, estamos sentando en un artículo específico de la ley, la tesis contraria, que es el "modelo monista", que consiste en que toda forma de actividad de contratación administrativa, está sujeta al derecho público. No existirá en este caso, más que el ejercicio de competencias administrativas que conducen a la satisfacción del bien público.

Mas adelante señala:

> La idea es la siguiente: Pese a que decimos que el régimen de la contratación administrativa es de derecho público y en vista de la imposibilidad conceptual de hacer separaciones tajantes entre los distintos sectores del ordenamiento, se contempla la posibilidad de la utilización de otras figuras, aunque se encuentren fuera del ordenamiento jurídico administrativo, esto es conocido en doctrina o por algunos autores, como la utilización instrumental de institutos del derecho privado por parte de órganos de la administración pública. En este caso, dejamos abierta la posibilidad para utilizar figuras que existen o que lleguen a existir, fuera de lo que tradicionalmente se conoce como ordenamiento jurídico administrativo, siempre y cuando se respeten los principios de la ley y se forme la voluntad administrativa de acuerdo con el ordenamiento propio del derecho público. (lo resaltado no es del acta citada)

CONCLUSIONES

El proyecto que nos ocupa en estos momentos, está referido a dos vertientes principales:

Utilización de los derechos de vía o las servidumbres utilizadas para colocar los rieles o vías de los ferrocarriles actuales, propiedad o patrimonio de INCOFER para implementar en ellas, las nuevas tecnologías de transporte remunerado de personas, tales como:

LRT / TRAM / ELÉCTRICO/ CON VÍA EXCLUSIVA
DMV / DIESEL
ETB / ELECTRICO / LLANTAS DE HULE / VIA EXCLUSIVA
BUSES / CUALQUIER COMBUSTIBLE / VIA EXCLUSIVA

Utilización de las diferentes rutas ubicadas en las calles y carreteras, para usar nuevas tecnologías de transporte remunerado de personas:

TRAM
ETB
BUSES

La propuesta número 1.- puede ser desarrollada haciendo uso del comentado artículo 3.- de la ley 7494 de La Contratación Administrativa, en la modalidad de una Alianza Estratégica "joint-venture", donde INCOFER, contando con :

derecho de vía
concesión de transporte de personas y
clientes o usuarios

Mediante el procedimiento de concurso o Licitación Pública, puede buscar el cocontratante que pueda aportar:

reparación de la vía
equipo rodante y
administración del sistema, mediante el cobro del servicio al usuario compartiendo tal suma con INCOFER.

Previo a iniciar el procedimiento de selección del contratista, INCOFER debe gestionar ante el Poder Ejecutivo, de acuerdo a lo establecido en el Capítulo III de la Ley General de Ferrocarriles número 5066, el respectivo permiso para utilizar las servidumbres, con una nueva tecnología de transporte de personas.

Finalmente de acuerdo a lo establecido en el artículo 5 en concordancia con el 9.- de la Ley 7593, conocida como Ley Reguladora de los Servicios Públicos, el permiso debe ser aprobado por el respectivo Ministerio.

La propuesta 2.- no requiere de mayor comentario pues lo que debe hacerse para el uso de TRAM, ETB y Buses, es negociar la modernización de las actuales unidades de transporte con lo operadores actuales cuando se refieran a las rutas que ellos explotan.

Las rutas nuevas deben licitarse, mediante los procedimientos de la Ley de Contratación Administrativa, o esperar las modificaciones a la ley de Concesión de obra Pública la cual es más amplia y específica en estas materias.

Como comentario final es necesario decir que la coexistencia de diferentes medios de transporte en los derechos de vía de INOFER, no sólo es jurídicamente posible, sino que mas bien permite hacer un uso mas adecuado de tales vías, incremente además la eficiencia del transporte como servicio público.