JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

GUATEMALA MUNICIPALITY
THE REPUBLIC OF GUATEMALA

THE FEASIBILITY STUDY ON THE PROJECT OF URBAN TRANSPORTATION IN THE METROPOLITAN AREA OF GUATEMALA

FINAL REPORT

MARCH 1997

YACHIYO ENGINEERING CO., LTD.
CHODAI CO., LTD.

Applied Foreign Exchange Rates in
this report are:

US$1.00 = Quetzal 6.14 = yen 105.00
(As of January 1996)

Preface

In response to the request of the Government of the Republic of Guatemala, the Government of Japan decided to conduct the Feasibility Study on the Project of Urban Transportation in the Metropolitan Area of Guatemala of the Republic of Guatemala and entrusted the study to Japan International Cooperation Agency (JICA).

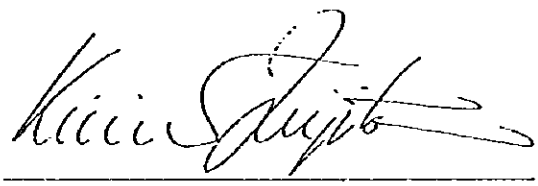
JICA sent a study team to Guatemala four times between September 1995 and December 1996. The study team was headed by Mr. Takeshi Yoshida and composed of members of Yachiyo Engineering Co., Ltd. and Chodai Co., Ltd..

The team held discussions with the officials concerned of the Government of Guatemala, and conducted field surveys in the study area. After the team returned to Japan, further studies were made and the present report was prepared.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Republic of Guatemala for their close cooperation extended to the team.

March, 1997



Kimio Fujita
President
Japan International Cooperation Agency

March 1997

Mr. Kimio Fujita
President
Japan International Cooperation Agency
Tokyo, Japan

Dear Sir,

Letter of Transmittal

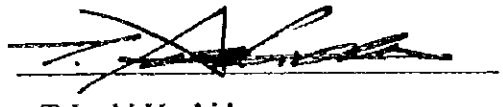
We are pleased to submit to you the report of the Feasibility Study on the Project of Urban Transportation in the Metropolitan Area of Guatemala. The report includes the advice and suggestions of the concerned authorities of the Government of Japan and your Agency, as well as the comments made by Guatemala Municipality and other authorities concerned in the Republic of Guatemala. The report consists of Executive Summary, Final Report and Drawings.

The report deals with the present and future conditions of urban transport in the Guatemala Metropolitan Area. The study aims to show the technical, economic and social feasibility of the nine transport facility projects which include toll highways, exclusive busways, bus terminals and a bus inspection and maintenance center, in order to resolve the serious traffic and transport problems.

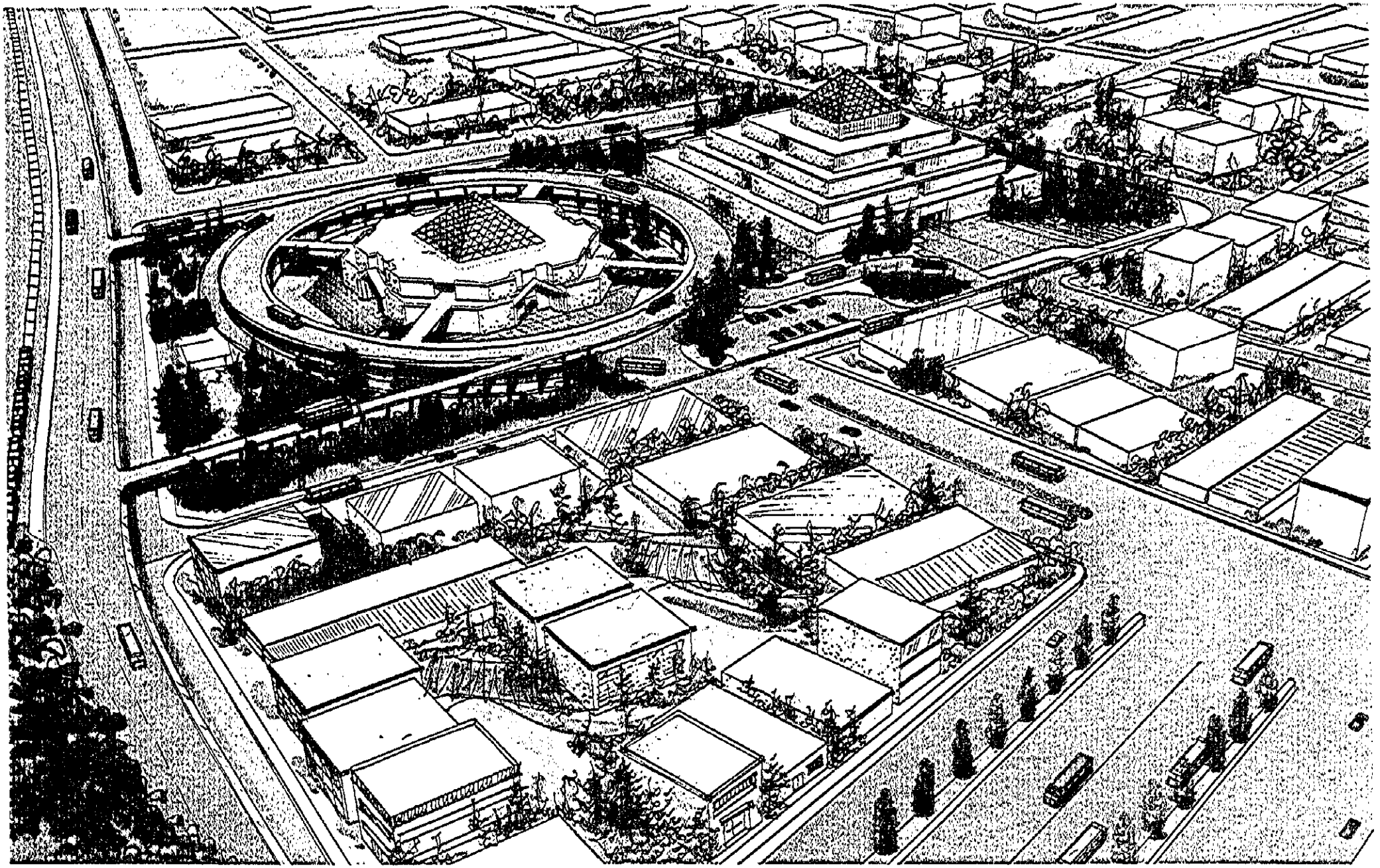
As a result of the evaluation of the projects from the various points of view, all of the projects are recommended to be implemented. Among them, Exclusive Busway FEGUA Route, Inter-regional Bus Terminals and Bus Inspection and Maintenance Center are strongly recommended to be constructed at an early stage.

We wish to take this opportunity to express our sincere gratitude to your Agency, Ministry of Foreign Affairs, Ministry of Transport and Ministry of Construction. We also wish to express our deep gratitude to Guatemala Municipality and the Governmental Agencies concerned in the Republic of Guatemala for the close cooperation and assistance extended to us during the Study. We hope this report will contribute to the development of the Republic of Guatemala.

Truly yours,



Takeshi Yoshida
Team Leader
The Feasibility Study
on the Project of Urban Transportation
in the Metropolitan Area of Guatemala



Perspective View of Urban Bus Center and Exclusive Busways

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1 INTRODUCTION AND BACKGROUND

I INTRODUCTION AND BACKGROUND

1. Introduction

1.1 Study Development

The Metropolitan Area of Guatemala has been suffering from traffic problems such as traffic congestion, pollution, low level of service of public transportation, etc. The government has made efforts to mitigate the problems by constructing new roads and grade intersections, and traffic control improvement. However, the overall conditions have not yet been improved due to the sharp increase in numbers of cars, urban development and incomplete network of roads, etc.

Although the bus system is the sole means of public transportation, relevant organizations and administrations should to be improved and strengthened to provide the people with reliable and comfortable service.

In these circumstances, among the short/medium term projects proposed in the Master Plan (M/P), six projects, being considered important, were selected as projects for the Feasibility Study (F/S). Emphasis is placed on public transportation and roads to meet the rapid and large scale development of the Western and Southern areas.

In response to the request of the Government of the Republic of Guatemala (hereinafter referred to as "Guatemala"), the Government of Japan decided to conduct a Feasibility Study on the Project of Urban Transportation in the Metropolitan Area of Guatemala (hereinafter referred to as "the Study"). Accordingly the Japan International Cooperation Agency (JICA), the official agency responsible for the implementation of technical cooperation programs of the Government of Japan, was entrusted to undertake the Study in cooperation with the authorities of Guatemala.

In March 1995, JICA dispatched a preparatory study team headed by Dr. Hisao Uchiyama to Guatemala for the reconnaissance study as well as for discussions on the scope of work for the forthcoming study. The Scope of Work for the Study and the Minutes of Meeting were agreed in April 1995 between the Guatemala Municipality and the JICA preparatory study team.

Based on this Scope of Work, JICA organized a study team headed by Mr. Takeshi Yoshida and the Study in Guatemala commenced with the submission of the Inception Report in September 1995.

1.2 Scope of the Study

(1) Objectives

The objectives of the Study are as follows:

1) to assess technical, economic and social feasibility of the urgent/short term projects listed below, which are expected to lead to the solution of existing traffic and transport problems in the metropolitan area of Guatemala (Figure 1.1).
   - New construction of East-West Corridor (Diagonal 3 - San Nicolas)
   - Improvement of Avenida Petapa (50 Calle - San Miguel Petapa)
   - Development of Exclusive Bus Ways
     a) Calzada San Juan and Avenida San Nicolas - Diagonal 3)
     b) FEGUA Central Station - Villa Nueva
   - Urban public transport passenger transfer center in the terminal area, Zone 4 (Urban Bus Center)
   - Inter-regional Bus Terminals
     a) North terminal
     b) West terminal
     c) South terminal
   - Bus Inspection and Maintenance Center (Bus Inspection Center)
2) to pursue technology transfer to the Guatemalan counterpart personnel in the course of the Study.

(2) Study Area

The Study Area covers Guatemala City and its peripheral area - Mixco, Villa Nueva, San Miguel Petapa, Santa Catarina Pinula, Villa Canales, Amatitlan, Fraijanes, San Jose Pinula, Chinautla. (Figure 1.2)

(3) Study Flow

The study flow is divided into three phases.

Phase 1 : Study on Present Conditions and Review of the Master Plan

Phase 2 : Formulation of Framework and Identification of F/S Projects

Phase 3 : Execution of Feasibility Study

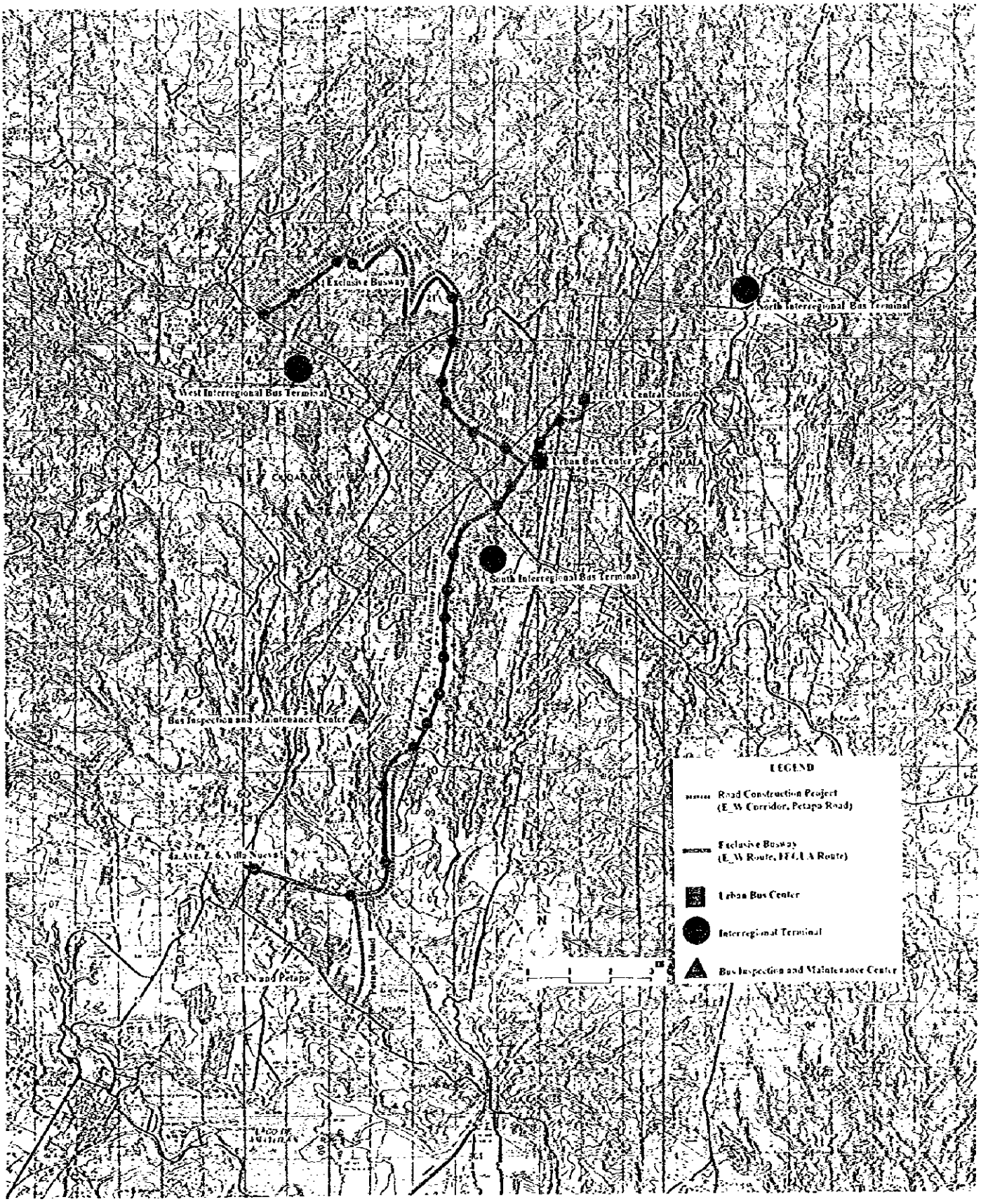


Figure 1.1 Projects for Feasibility Study

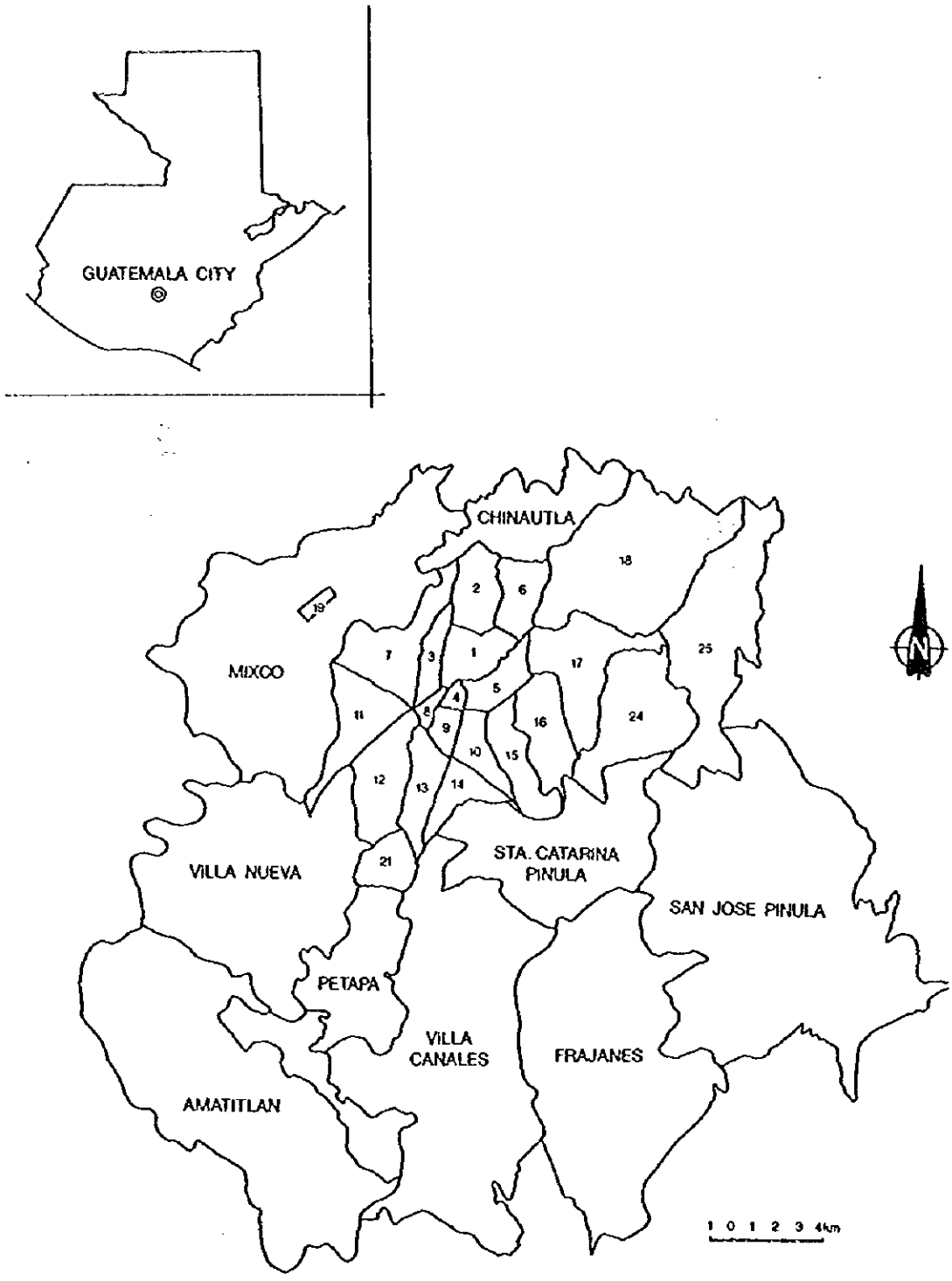


Figure 1.2 Study Area

1.3 Study Organization

The Study is to be carried out jointly by the JICA Study Team and Guatemala Municipality which is to act as the counterpart agency, and also act as the coordinating body in relation to other governmental and non-governmental organizations concerned.

A Steering Committee was organized for smooth implementation of the Study. JICA has set up the Advisory Committee in Japan to assist the Study Team by providing advice and suggestions from time to time.

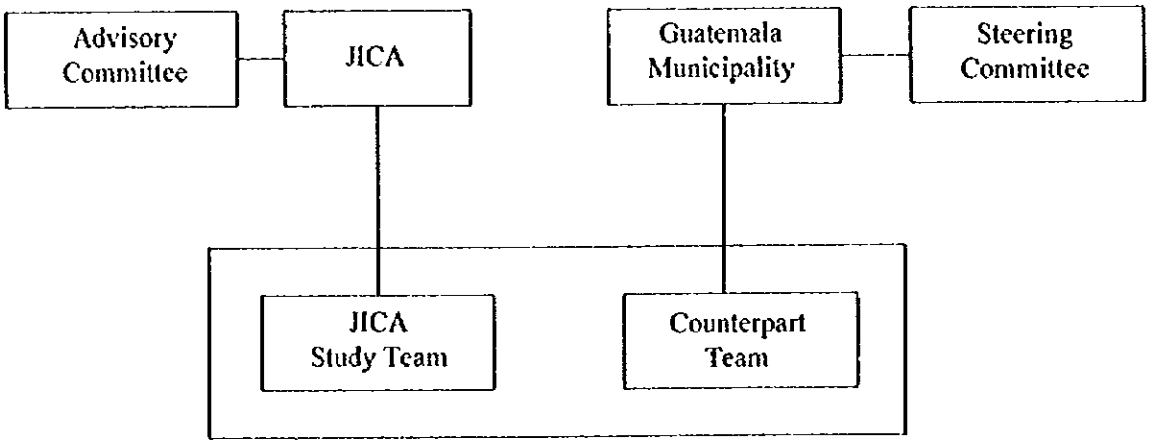


Figure 1.3 Study Organization

The JICA Advisory Committee comprises 3 members as follows:

- Dr. Hisao Uchiyama : Chairman :Science University of Tokyo
- Mr. Tooru Odamura : Road Network/Transport Facility Plan :Ministry of Construction
- Mr. Hiromi Tomita : Public Transportation Plan :Ministry of Transport

Mr. Keiichi Okitsu (predecessor : Mr. Mitsuyoshi Kawasaki) serves as the JICA coordinator.

The members of the Counterpart are as follows:

List of Counterpart Personnel

Ing. Edgar de Leon M.	Coordinator/Environment
Ing. Miguel de Leon	Institutional Aspects
Arq. Julio Castillo	Land Use
Lic. Ubaldo Perez Urizar	Socio-economy
Lic. Adalberto Castaneda	Socio-economy
Sr. Oliver Obregon	Transport Planning
Sr. Hugo Rodas	Investigation
Sr. Luis Morales	Drawing
Sr. Omar Pineda	Drawing
Lic. Roberto Mancilla	Socio-economy
Ing. Rafael Pilona	Master Plan of Urban Transportation

The members of the Steering Committee are as follows:

List of Steering Committee Members

Lic. Oscar Berger Perdomo	Mayor of Guatemala Municipality
Lic. Abraham Rivera	Mayor of Mixco Municipality
Sr. Jose Antonio De La Cruz	Mayor of Villa Nueva Municipality
Sr. Luis Corado	Mayor of San Miguel Petapa Municipality
Ing. Fernando Paiz	Ministry of Communications, Transport and Public Works (MCTO)
Arq. Edna Ramirez de Figueroa	Vice-Ministry of Housing (VIVIENDA)
Ing. Francisco Asturias	National Commission of Environment (CONAMA)
Lic. Jorge Monterroso	General Secretariat of Planning (SEGEPLAN)
Ing. Jose Garcia Barrios	General Bureau of Highway (CAMINOS)
Ing. Rafael Herrera	Guatemala Railway (FEGUA)
Arq. Jorge Mario Solares	Metropolis 2010, Guatemala Municipality
Sr. Pablo Merida	Public Transport, Guatemala Municipality
Lic. Sergio Leal	National Police

The members of the Study Team are as follows:

Members of the Study Team

Ing. Takeshi Yoshida	Team Leader/Transport Economics
Ing. Masayuki Ishiya	Urban Transport/Demand Forecast
Arq. Naoyuki Minami	Urban Development Plan/Land Use Plan
Ing. Toshihiro Hotta	Transportation Plan
Ing. Shinsuke Tsuruta	Public Transportation Plan
Ing. Kazuhiko Haruyama	Bus Maintenance Plan
Ing. Yosiaki Nishikatsu	Civil Design/Cost Estimate
Ing. Masahiro Mori	Structure Design/Cost Estimate
Arq. Yutaka Takahashi	Architecture Design/Cost Estimate
Ing. Kunihiko Harada	Environment Plan
Lic. Naoki Hara	Economic and Financial Analysis
Lic. Takao Yamane	Business Administration Analysis
Lic. Wataru Takada	Social Analysis
Ing. Shigeru Yoshijima	Traffic Survey
Ing. Hajime Goto	Land Survey
Ing. Lee Sang Gyoon	Administration

2. General Background

2.1 Geography

(1) Geography

The land of the Republic of Guatemala may be divided into four areas: Pacific Ocean area; Highland area; Caribbean area and Rain Forest area (Figure 2.1). Guatemala City is located in the Highland area.

The Highland area represents one-third area of the country with the Sierra Madre Mountains as its backbone. These mountains comprise volcanoes such as Tajumulco (4,220 m), Tacana (4,093 m), and are the highest mountains in Central America, extending along the Pacific coast from Mexico to El Salvador. The climate in the plateaus and basins in this area is mild because of the low latitude and the high altitude. The highland area is covered with a fertile volcanic soil, which encourages the production of vegetables and cereals, and therefore is most heavily populated. The capital, Guatemala City, and other major cities are located in this area.

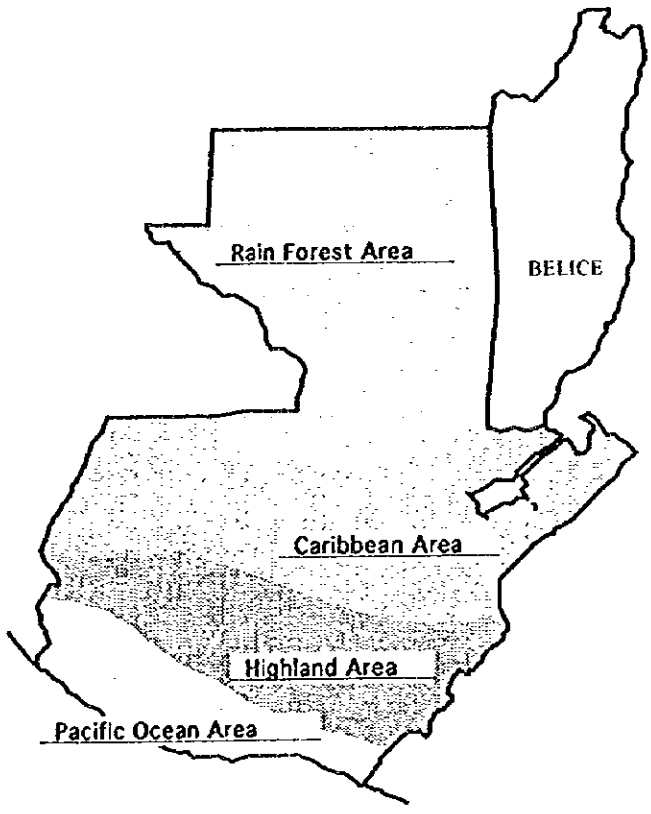


Figure 2.1 Geographical Division

(2) Topography and Geology

The mountains in Central America, as a whole, belong to the Circum-Pacific orogenic belt. Out of the northern and the southern cordillera included in the orogenic belt, the mountains of Guatemala are categorized as the northern cordillera from the geological point of view. The northern cordillera ranges from the root of the Yucatan Peninsula to the northern part of Nicaragua and it antedates the southern cordillera. Plateaus (1,000 m to 2,000 m in altitude) thickly covered with tertiary volcanic sediments extend from the southern part to the eastern part of the cordillera.

This cordillera, which traverses Guatemala from the east to the west starting from the southern part of Mexico, forms three lines of steep mountain ranges through the development of faults and folds. In Guatemala, there is a new quaternary volcanic line that stretches along the great tectonic line parallel to the Pacific coast and 33 volcanoes of various scale rise along the southern end of the plateau, depositing lava and volcanic ash in piedmont areas and peripheral basins (Figure 2.2).

Guatemala Metropolitan Area is located on a plateau with an altitude of 1,500 m in the basin of the Guatemala Valley which traverses the Sierra Madre. The basin is formed of different deposit with easily erodable volcanic sediments with a depth of 100 to 300 m. Therefore, rainfall erosion is very noticeable, and many deep-cut V-shaped valleys with depths of 50 m have been developed all around the Area. Cities and towns have been built on the platform-like land in the basin. The watershed runs from the north-west to the south-east. Rivers on the north side flow into the Caribbean and those on the south side into the Pacific. The valleys run like a labyrinth into the cities and towns from both the south and the north, thus cities and towns are fringed with steep, eroded valleys.

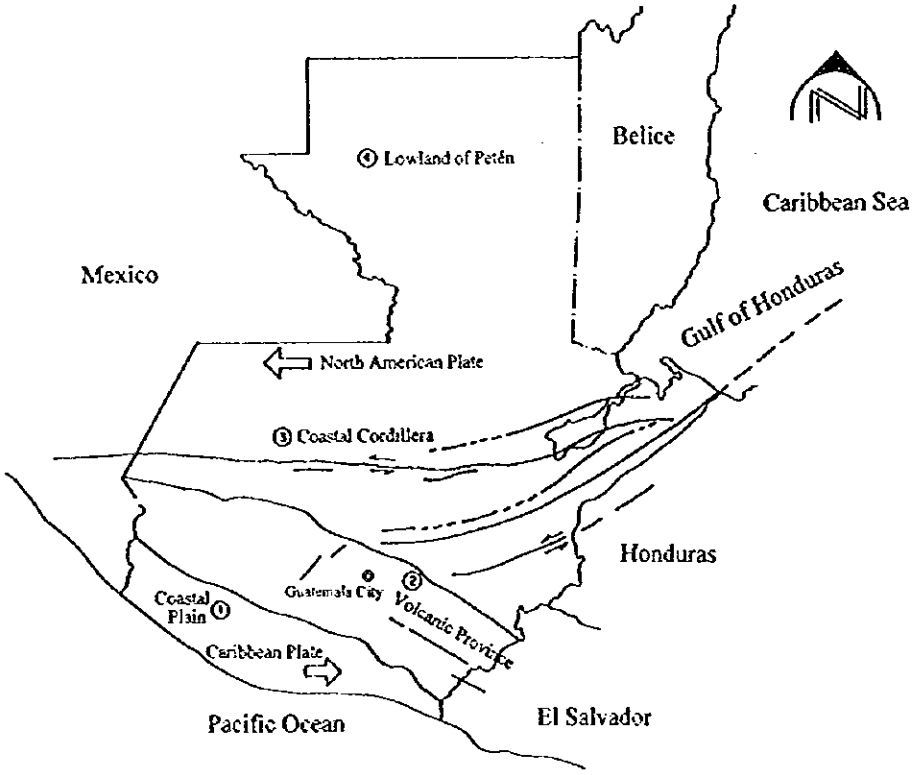
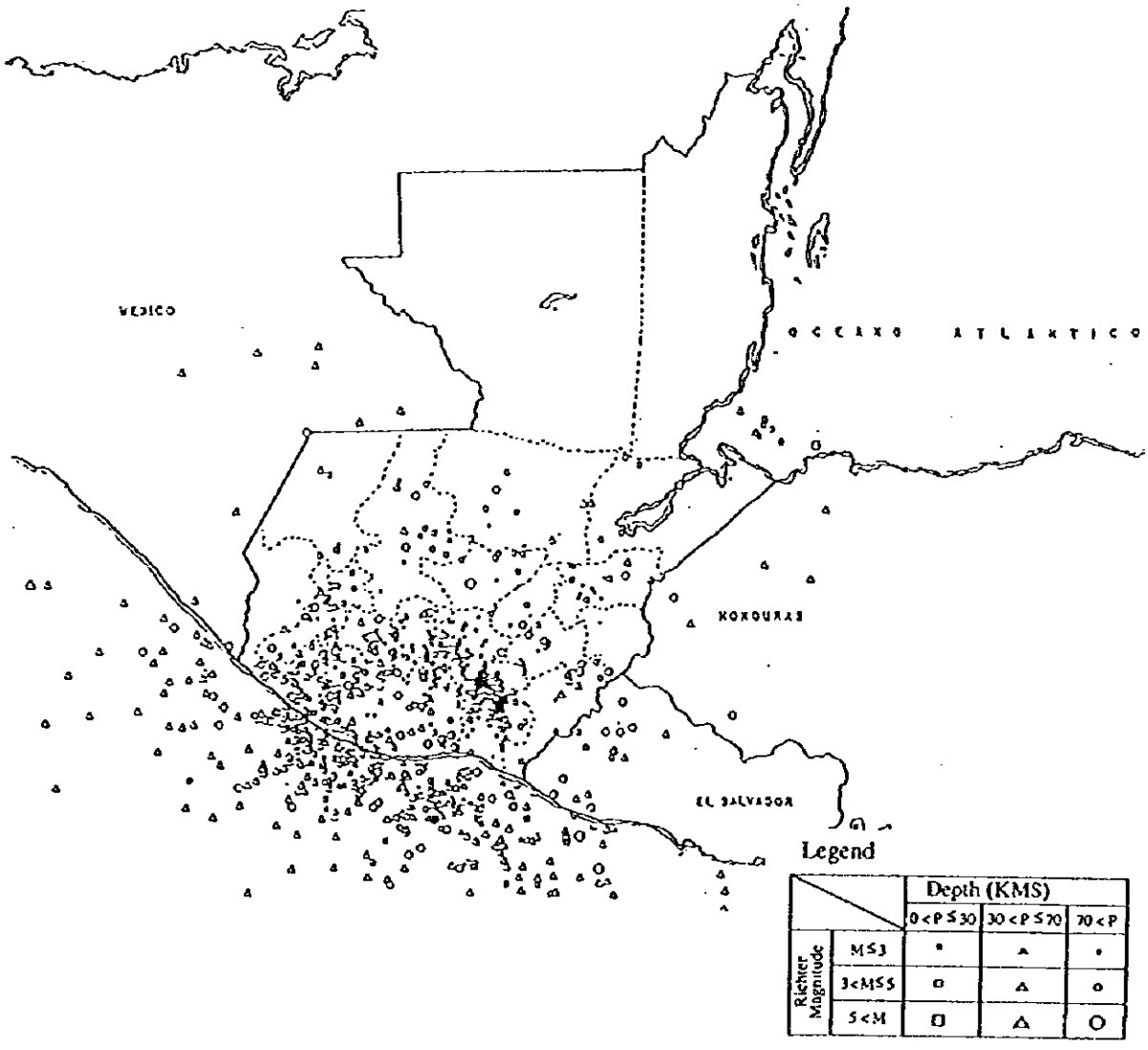


Figure 2.2 Location of Fault

(3) Earthquake

Guatemala, located at a convergence of the Pacific, American, Caribbean, Cocos and Nazca plates, is subject to frequent earthquakes. In 1717 and 1773, Antigua Guatemala City, the former capital of the country of those days, was completely destroyed by the earthquakes and the capital was moved to the present capital, Guatemala City. Quetzaltenango, the second largest city in the country, and Guatemala City were heavily damaged in 1902 and 1918, respectively. In recent years, a strong earthquake occurred in Guatemala City in February 1976, in which 30,000 lives were lost (Figure 2.3).



(Source: Department of Geophysics Systems)

Figure 2.3 Location of Hypocenter in 1981

2.2 Socio-Economy

2.2.1 Basic Social Indicators

Demographic information and other basic social indicators of the Republic of Guatemala are shown as follows:

Table 2.1 Basic Indicators of Guatemala

Indicators		Unit
Land Areas (1994)	108,889.0	Km^2
Population (1994)	10,322	thousand persons *1
Average Annual Growth Rate (1985-1994)	2.9	%
Density	94.8	persons/Km^2
Economically Active Population (EAP)	2,995	thousand persons *1
Economically Active Women in the total EAP	25.5	% *2
Urban Population as a % of the Total	38.5	%
Rural Population as a % of the Total	61.5	%
Indigenous Population	40.6	%
Unemployment Rate (1993)	5.5	%
Life Expectancy at Birth	64.8	years
Families in Poverty (1989)	75.5	%
Families in Extreme Poverty (1989)	54.0	%
Illiteracy Ratio (persons more than 15 years old)	39.0	%
Urban (1993)	31.9	%
Rural (1993)	74.4	%
Medical Doctors for 10,000 persons	8.3	doctors

(Source) General Secretariat of National Council of Economic Planning (SEGEPLAN), using data from Bank of Guatemala and National Institute of Statistics (INE)

(Note) *1 estimated data as in December 1994
*2 Socio-demographic Inquiry by INE, 1989

2.2.2 Population

While SEGEPLAN estimated the total population of the country in 1994 at 10,322 thousand, the preliminary data of the 1994 Census was released as follows:

Table 2.2 Population Data of the Census

	1981	1994	Annual Increase
Total of the Republic	6,054,227	8,322,051	2.48%
Guatemala Department	1,311,192	1,812,411	2.52%
- Municipality of Guatemala	789,883	822,587	0.31%
- Remaining Municipalities	521,309	989,824	5.06%

2.2.3 Characteristics of Social Conditions

The social condition of Guatemala has been characterized by the internal armed conflict which has affected various sectors of country for more than three decades. This seems to be caused by ethnic and cultural plurality in the country. The indigenous people, Mayan descendants, who live mostly in rural area, have been oppressed for several centuries and not integrated in equal terms into the national society. This situation have produced difference in classes and in areas. The Peace Process was based on recognition of this ethnic discrimination and all the accords are proposing to reform administrative and judicial mechanism of the country in order to eradicate such discrimination.

In the Metropolitan Area of Guatemala, according to the national census in 1994, the population of indigenous people occupies 7.2%, which is rather low in comparison with the national average of 42.8%. More than 50,000 indigenous people live in the City of Guatemala. They are domestic immigrants who came from rural area of the department of Guatemala or other departments looking for a job or refugees from the armed conflict in rural areas. Most of indigenous population in other cities than the Metropolitan Area are native people who live in rural areas and maintain the identity as indigenous.

2.2.4 Economic Activities

(1) Gross Domestic Product

The gross domestic product (GDP) of the Republic of Guatemala is given in Table 2.3. The economy of the country has shown a steady recovery since 1986 after a period of stagnation in the first half of the 1980's. The economy has continued a stronger recovery in the first half of the 1990's with growth rates around 4% per annum. Despite a political disturbance in 1993, the economy shows constant growth, led by the private consumption, particularly that induced with the investment.

The agricultural sector has shown only a slight growth due to shrinkage of areas planted with corn, beans, sorghum and cotton, and to the drop in the production of certain non-traditional products. The growth of the manufacturing sector was affected by lowering tariffs and the appreciation of the currency.

Table 2.3 Gross Domestic Product by Sector (current price, Q. million)

Sector	1991		1993		1995*e	
	amount	share (%)	amount	share (%)	amount	share (%)
Total	47,032.6	100.0%	63,562.7	100.0%	85,893.3	100.0%
- Agriculture	12,122.6	25.8%	15,774.0	24.8%		
- Mining, Quarrying	113.0	0.2%	221.7	0.3%		
- Manufacturing	7,011.6	14.9%	9,153.0	14.4%		
- Construction	922.4	2.0%	1,524.0	2.4%		
- Electricity, Energy	1,181.5	2.5%	1,793.0	2.8%	not available	
- Transport, Communication	3,818.0	8.1%	5,518.1	8.7%		
- Commerce	11,287.8	24.0%	15,368.6	24.2%		
- Banking, Insurance	2,019.8	4.3%	2,839.5	4.5%		
- Housing	2,356.4	5.0%	3,055.4	4.8%		
- Public Administration, Defense	3,348.3	7.1%	4,574.5	7.2%		
- Private Services	2,851.2	6.1%	3,740.9	5.9%		

(Source) Bank of Guatemala
(Note) *e; estimated figure

Table 2.4 Growth in Gross Domestic Product by Sector (constant prices of 1958)

	1991	1992	1993	1994*p	1995*e
Total	3.7%	4.8%	3.9%	4.0%	4.8%
- Agriculture	3.1%	3.0%	2.2%	2.4%	2.9%
- Mining, Quarrying	8.2%	30.4%	10.8%	4.5%	11.5%
- Manufacturing	2.4%	3.3%	2.9%	3.0%	3.2%
- Construction	1.5%	25.4%	-3.0%	-4.9%	8.0%
- Electricity, Energy	4.0%	13.6%	9.6%	5.7%	7.0%
- Transport, Communication	5.9%	7.5%	4.8%	5.3%	6.3%
- Commerce	4.2%	4.5%	4.1%	5.3%	6.6%
- Banking, Insurance	7.0%	6.4%	7.6%	8.0%	8.0%
- Housing	2.3%	2.5%	2.8%	2.3%	4.1%
- Public Administration, Defense	4.6%	5.6%	9.6%	6.3%	4.3%
- Private Services	2.4%	3.0%	3.2%	3.9%	4.1%

(Source) Bank of Guatemala
(Note) *p; preliminary figures, *e; estimated figures

Capital inflow has an impact on GDP growth, especially on the sectors that produce non-tradable goods and services. Consumption has been stimulated by a rise in the real wage, being made possible by a moderate inflation and a wage increase granted to public employees in late 1992. Private consumption shows a larger real increase than the real growth of the GDP. Domestic investment has shown a vital increase spurred by greater foreign private investment.

Table 2.5 Supply and Final Demand (current prices, Q. million)

	1991		1993		1995*e	
	Q. million	% to GDP	Q. million	% to GDP	Q. million	% to GDP
SUPPLY						
GDP	47,302.3	100.0%	64,243.2	100.0%	85,893.2	100.0%
Import of Goods and Services	10,216.2	21.6%	16,765.1	26.1%	22,036.2	25.7%
Total Supply	57,518.5	121.6%	81,008.3	126.1%	107,929.4	125.7%
FINAL DEMAND						
Consumption	42,407.4	89.7%	58,315.9	90.8%	77,657.4	90.4%
Private	39,693.4	83.9%	54,164.5	84.3%	72,588.8	84.5%
Public	2,714.0	5.7%	4,151.4	6.5%	5,068.7	5.9%
Gross Fixed Capital Formation	5,760.2	12.2%	10,334.5	16.1%	12,251.5	14.3%
Private	4,736.3	10.0%	8,589.1	13.4%	10,154.3	11.8%
Public	1,023.9	2.2%	1,745.4	2.7%	2,097.2	2.4%
Variation in Value of the Stock	1,002.0	2.1%	745.1	1.2%	981.0	1.1%
Total of Internal Final Demand	49,169.5	103.9%	69,395.5	108.0%	90,889.9	105.8%
Export of Goods and Services	8,349.0	17.7%	11,612.8	18.1%	17,039.6	19.8%
Total Final Demand	57,518.5	121.6%	81,008.3	126.1%	107,929.4	125.7%

(Source) Bank of Guatemala
(Note) *e; estimated figure

Table 2.6 Growth in Supply and Final Demand (constant prices of 1958)

	1991	1992	1993	1994*p	1995*e
SUPPLY					
GDP	3.7%	4.8%	3.9%	4.0%	4.9%
Import of Goods and Services	7.2%	37.0%	4.2%	5.9%	11.0%
Total Supply	4.0%	7.9%	4.0%	4.2%	5.6%
FINAL DEMAND					
Consumption	3.6%	5.1%	4.5%	4.7%	5.1%
Private	3.8%	5.0%	4.1%	4.8%	5.2%
Public	1.7%	5.6%	8.0%	3.9%	4.5%
Gross Fixed Capital Formation	3.7%	29.8%	6.9%	-3.7%	7.6%
Private	6.9%	27.6%	11.4%	-3.5%	8.7%
Public	-3.4%	35.3%	-3.6%	-4.3%	4.7%
Variation in Value of the Stock	278.8%	28.9%	-52.9%	28.9%	-4.6%
Total of Internal Final Demand	5.5%	7.8%	3.1%	4.1%	5.2%
Export of Goods and Services	-4.9%	8.3%	9.6%	4.8%	8.1%
Total Final Demand	4.0%	7.9%	4.0%	4.2%	5.6%

(Source) Bank of Guatemala
(Note) *p; preliminary figures, *e; estimated figures

(2) Balance of Payments and Exchange Rate

Merchandise imports have remained at high levels in the last four years due to a large inflow of private capital. Imports of capital goods, such as machinery and equipment, have kept at high levels, while imports of raw materials and intermediates have shown a sharp contraction due to the slower growth of the manufacturing sector. Capital accounts have shown huge surpluses generated by the large amount of private capital flows.

Table 2.7 Balance of Payment (in US$ million)

	1990	1991	1992	1993	1994	1995
CURRENT OPERATION	-243.1	-214.2	-712.5	-709.5	-637.9	-512.9
Commodities	-216.6	-443.1	-1,044.3	-1,020.7	-996.5	-1,043.5
- Export (FOB, adjusted)	1,211.5	1,230.0	1,283.6	1,363.2	1,550.2	1,989.0
- Import (FOB, adjusted)	-1,428.0	-1,673.0	-2,327.9	-2,384.0	-2,546.7	-3,032.5
Services	-257.8	-30.9	-58.9	-52.1	-89.8	-22.3
- Transport	-204.4	-158.7	-183.7	-197.3	-216.2	-225.5
- Investment Income	-192.5	-171.1	-178.4	-151.4	-148.6	-159.4
- Tourism and Travel	18.4	45.0	83.0	87.4	54.3	71.2
- Insurance	-10.5	-9.0	-7.4	-22.8	-25.9	-23.4
- Government Services	22.5	8.5	2.6	-3.0	-4.2	15.7
- Miscellaneous Services	108.7	254.3	224.9	235.0	250.8	299.1
Transfer	231.2	259.7	390.6	363.3	448.4	552.8
- Donation	127.8	129.8	210.3	160.6	188.1	201.7
- Remittance	96.5	122.6	172.4	198.8	255.1	349.7
- Pension	3.0	2.6	1.2	0.0	0.4	-3.5
- Other Transfer	3.9	4.7	6.7	3.9	4.7	4.8
CAPITAL OPERATION	256.3	710.1	545.8	712.6	685.0	491.3
Private Capital	184.9	847.7	616.8	860.6	640.2	557.4
- Long Term	69.2	304.8	218.4	418.5	356.9	240.5
- Short Term	115.7	542.9	398.4	442.1	283.3	316.9
Official Capital and Banking	71.4	-137.6	-71.0	-148.0	44.8	-66.2
- Long Term	-2.1	-78.1	76.0	22.0	110.4	-34.6
- Short Term	73.5	-59.5	-147.0	-170.0	-65.6	-31.5
OTHER BALANCE	-82.5	63.0	114.1	110.0	-48.7	-135.2
TOTAL OPERATION	-69.4	558.9	-52.7	113.0	-1.5	-156.9
VARIATION IN RESERVE (- increase)	69.4	-558.9	52.7	-113.0	1.5	156.9

(Source) Bank of Guatemala

The value of Quetzals has kept stable or moderately going down in the exchange market, supported by controlled inflation in the recent five years.

Table 2.8 Exchange Rate (Quetzals per US Dollar)

	1990	1991	1992	1993	1994	1995
Buying	4.50	4.99	5.15	5.60	5.75	6.03
Selling	4.52	5.07	5.21	5.67	5.77	6.06

(Source) Bank of Guatemala
(Note) bank rate

(3) Inflation

While aggregate inflation has remained at moderate levels, prices of food have risen, resulting from the poor vitality of the agricultural sector.

Table 2.9 Consumer Price Indices in December of Each Year

(March-April of 1983=100)

	1990	1991	1992	1993	1994	1995
Total	419.9	462.0	527.7	589.1	657.4	714.0
Annual Increase	59.8%	10.0%	14.2%	11.6%	11.6%	8.6%

(Source) National Institute of Statistics (INE)
(Note) Indices in the Capital City

(4) Employment and Salaries

The agricultural sector still shares the highest portion in employment, although that portion has been decreasing. Because of higher growth in labor intensive sectors, such as construction, commerce and other service industries, unemployment has been brought down to 4.3% in 1995 from 14.0% in 1986. The Ministry of Labor and the SEGEPLAN have released interesting statistics on the labor market, called "equivalent unemployment" which is calculated as the number of employed persons minus the required labor force to achieve the GDP, assuming unchanged productivity. The "equivalent unemployment" rate in 1995 was as high as 31.5%, and the "total unemployment", that is "equivalent unemployment" plus unemployment rate, was 35.8%.

Table 2.10 Number of Employee

	1991		1993		1995	
	number	share	number	share	number	share
Total	786,903	100.0%	823,239	100.0%	855,596	100.0%
- Agriculture	237,488	30.2%	214,639	26.1%	224,329	26.2%
- Mining, Quarrying	2,849	0.4%	2,420	0.3%	2,494	0.3%
- Manufacturing	118,762	15.1%	136,677	16.6%	142,365	16.6%
- Construction	14,042	1.8%	26,395	3.2%	20,056	2.3%
- Electricity, Gas, Water	14,777	1.9%	11,142	1.4%	9,800	1.1%
- Commerce	99,504	12.6%	102,625	12.5%	119,985	14.0%
- Transport, Communication	23,194	2.9%	25,162	3.1%	27,450	3.2%
- Service	276,287	35.1%	304,179	38.7%	309,117	39.3%

(Source) Guatemalan Institute of Social Insurance
(Note) number of affiliated employees who pay fees to Guatemalan Institute of Social Insurance

Salaries have been increasing substantially faster than inflation. Since 1990, the increase in the real salary has reached 8.9% per annum. The salaries of the transportation and communication sectors are among the highest in the country, but the difference between those in the whole country and those in the Department of Guatemala is rather small compared to the difference in other sectors. The salaries in many sectors, however, have not recovered up to the level of 1980 by 1994.

Table 2.11 Average Salary (Nominal in 1995)

(Unit : Quetzal)

	Whole Country		Department of Guatemala	
	yearly	monthly	yearly	monthly
Total	11,193	933	14,207	1,184
- Agriculture	5,917	493	9,051	754
- Mining, Quarrying	13,116	1,093	17,005	1,417
- Manufacturing	13,656	1,138	14,270	1,189
- Construction	10,567	881	10,798	900
- Electricity, Gas, Water	18,923	1,577	21,363	1,780
- Commerce	16,909	1,409	17,787	1,482
- Transport, Communication	15,254	1,271	16,077	1,340
- Service	11,088	924	12,748	1,062

(Source) Guatemalan Institute of Social Insurance

Table 2.12 Change in Salary (Real)

1980 = 100

	1980	1985	1990	1992	1994
Total	100	87	65	82	91
- Agriculture	100	102	75	109	114
- Mining, Quarrying	100	69	30	33	36
- Manufacturing	100	93	58	67	68
- Construction	100	59	44	53	64
- Electricity, Gas, Water	100	92	66	77	108
- Commerce	100	79	50	58	65
- Transport, Communication	100	77	60	82	93
- Private Service	100	73	61	62	72
- Public Service	100	53	43	54	54

(Source) Guatemalan Institute of Social Insurance

(5) Financial Status of the Central Government

More than half of the revenue of the Central Government has been derived from indirect taxes. The ratio of direct taxes to indirect taxes was around 1:3.5 in 1995. Around 55% of the indirect taxes were imposed on external trade. The amount of the revenue by the Central Government has been strongly influenced by the policies of taxation on external trade, such as those of import duties or of value added tax on imports.

Table 2.13 Revenue of the Central Government

	1991		1993		1995	
	amount (Q.1000)	%	amount (Q.1000)	%	amount (Q.1000)	%
TOTAL REVENUE	4,312,716	100.0%	5,789,877	100.0%	7,319,489	100.0%
Current Revenue	4,282,051	99.3%	5,762,855	99.5%	7,309,465	99.9%
Tax	3,469,650	80.5%	5,026,542	86.8%	6,686,508	91.4%
Direct Tax	1,085,066	25.2%	1,225,572	21.2%	1,401,443	19.1%
Income Tax	1,040,833	24.1%	1,182,382	20.4%	1,369,343	18.7%
Property Tax	44,233	1.0%	43,190	0.7%	32,100	0.4%
Indirect Tax	2,384,584	55.3%	3,800,970	65.6%	5,285,066	72.2%
International Commerce	1,204,013	27.9%	2,118,640	36.6%	2,928,531	40.0%
Import Duty	662,087		1,133,957		1,560,407	
Export Duty	1,922		15		2	
IVA for Import	540,003		984,668		1,368,122	
Consumption Tax	852,088	19.8%	1,375,472	23.8%	1,922,750	26.3%
IVA	498,718		694,280		1,074,923	
Petroleum Distribution	173,771		451,462		582,436	
Others	179,599		229,730		330,470	
Others	328,484		306,857		433,785	
Non-Tax	812,401	18.8%	736,314	12.7%	622,956	8.5%
Capital Revenue	30,665	0.7%	27,022	0.5%	10,024	0.1%

(Source) Ministry of Public Finance

Capital expenditure by the Central Government has remained as low as about 20% of the total expenditure, while nearly the same portion is devoted to the public debt. The transportation sector has shared around 8% and nearly 80% of the total for that sector was devoted to capital expenditure in 1994.

Table 2.14 Expenditure of the Central Government

	1991		1993		1995	
	amount (Q.1000)	%	amount (Q.1000)	%	amount (Q.1000)	%
TOTAL EXPENDITURE	5,134,170	100.0%	7,787,129	100.0%	8,928,660	100.0%
Current Expenditure	2,824,132	55.0%	4,194,521	53.9%	4,716,228	52.8%
Capital Expenditure	730,526	14.2%	1,961,018	25.2%	2,246,587	25.2%
Public Debt	1,579,513	30.8%	1,631,591	21.0%	1,965,845	22.0%
[by Sector]						
Social Sector	**1,700,401**	**33.1%**	**2,895,137**	**37.2%**	**3,296,587**	**36.9%**
Health and Social Assistance	415,926	8.1%	623,474	8.0%	750,414	8.4%
Labor, Employment and Social Security	345,084	6.7%	515,846	6.6%	599,806	6.7%
Education, Science and Culture	731,336	14.2%	1,158,044	14.9%	1,411,936	15.8%
Housing and Urban Development	208,055	4.1%	597,773	7.7%	534,431	6.0%
Productive Sector	**167,883**	**3.3%**	**276,181**	**3.5%**	**303,505**	**3.4%**
Mineral and Hydrocarbon	2,007	0.0%	6,272	0.1%	2,535	0.0%
Agriculture	159,254	3.1%	253,173	3.3%	288,822	3.2%
Industry and Commerce	6,530	0.1%	16,661	0.2%	12,067	0.1%
Tourism	92	0.0%	74	0.0%	81	0.0%
Basic Sector	**491,643**	**9.6%**	**942,995**	**12.1%**	**920,999**	**10.3%**
Transport	393,508	7.7%	498,736	6.4%	783,155	8.8%
Current Expenditure	168,008		115,062		110,550	
Capital Expenditure	225,500		383,673		672,605	
Communication	36,196	0.7%	45,891	0.6%	49,126	0.6%
Energy	61,939	1.2%	398,369	5.1%	88,718	1.0%
Institutional Support Sector	**1,194,731**	**23.3%**	**2,041,225**	**26.2%**	**2,441,725**	**27.3%**
Administration and General Services	391,161	7.6%	900,496	11.6%	1,062,286	11.9%
Defense and Internal Security	661,392	12.9%	869,014	11.2%	1,132,010	12.7%
Finance	142,178	2.8%	271,716	3.5%	247,429	2.8%

(Source) Ministry of Public Finance

In the last two years, the Central Government faced deficits caused by reduced tax collection and decrease in foreign grants. Tax receipts, which fell from 8.3% of the GDP in 1992 to 6.8% in 1994, were affected by lowered tariffs and widespread evasion.

Even though the proportion of the current expenditure to the GDP has decreased, capital expenditure by the Central Government has also remained low because of the stagnant collection of revenues.

Table 2.15 Proportion of the Central Government Revenue and Expenditure to GDP

(percentage to the GDP)

	1990	1991	1992	1993	1994	1995
Current Revenue	8.15%	9.10%	10.62%	9.07%	7.74%	8.51%
Tax Revenue	6.88%	7.38%	8.33%	7.91%	6.78%	7.78%
Current Expenditure	7.34%	6.00%	6.78%	6.60%	5.97%	5.49%
Capital Expenditure	1.74%	1.55%	2.90%	3.09%	2.31%	2.62%
Deficits or Surplus	-3.36%	-1.75%	-1.79%	-3.14%	-2.61%	-1.87%

(6) Financial Condition of Guatemala Municipality

The share of tax revenue in total revenue of the Municipality remained less than half, although it has been considerably increasing. Before 1992, around half of the revenue was current transfer received from the central Government and most of them were transferred from the Central Government via the Municipality to the public transport sector, mainly to bus operating companies in the City. The transfer has been drastically reduced after 1993 and completely suspended in 1993 due to budgetary constraints of the government.

Table 21.6 Revenue of Guatemala Municipality

	1991		1993		1995	
	amount (Q.1000)	%	amount (Q.1000)	%	amount (Q.1000)	%
TOTAL REVENUE	188,889	100.0	189,070	100.0	254,654	100.0
Current Revenue	**156,864**	**83.0**	**123,839**	**65.5**	**135,527**	**53.2**
Tax Revenue	53,625	28.4	67,222	35.6	102,981	40.4
(Gasoline Consumption Tax)	1,597		524		1,433	
(Tax on Urban Bus Operation)	5,593		8,458		0	
(Tax on Vehicle Circulation)	4,696		6,335		2,801	
(Municipality Parking Meters)	184		233		72	
(Tax on Microbus Operation)	4,765		3,362		1	
Others	36,789		48,309		98,674	
Tax-Related Revenue	53	0.0	59	0.0	66	0.0
Non-Tax Revenue	13,674	7.2	25,040	13.2	28,111	11.0
Current Transfer Received	**89,512**	**47.4**	**31,517**	**16.7**	**4,369**	**1.7**
(Public Urban Transport)	72,000		9,000		0	
(Fortifying Urban Transport)	0		3,750		0	
Others	17,512		18,767		4,369	
Capital Revenue	**32,025**	**17.0**	**65,231**	**34.5**	**119,127**	**46.8**
Sale of Fixed Assets and Compensation	0		3,113		0	
Public Credit	5,644		4,661		45,704	
Capital Transfer Received	11,148		16,152		34,289	
Balance of Cash	15,233		41,305		39,134	

(Source) Accounting Section of the Municipality

The share of transport sector in the expenditure by the Municipality has changed according to the change of the transfer from the Central Government mentioned above. The share of the sector decreased to as little as 1.5% in 1994 and slightly recovered to 4.4% in 1995 because of a little increase in current expenditure for the sector.

Table 2.17 Expenditure of Guatemala Municipality

	1991		1993		1995	
	amount (Q.1000)	%	amount (Q.1000)	%	amount (Q.1000)	%
TOTAL EXPENDITURE	165,903	100.0	152,075	100.0	221,130	100.0
Current	130,366	78.6	100,377	66.0	144,559	65.4
Current Expenditure	43,375	26.1	55,183	36.3	71,448	32.3
Current Transfer	86,992	52.4	45,194	29.7	73,111	33.1
Capital	35,537	21.4	51,698	34.0	76,571	34.6
Direct Investment	31,621	19.1	46,472	30.6	65,633	29.7
Reimbursement of Debt	3,916	2.4	5,225	3.4	10,938	4.9
[by Sector]						
General Services and Administration	17,057	11.6	36,567	25.0	78,625	53.7
Civil Defense and Security	1,968	1.3	1,775	1.2	1,955	1.3
Finance	9,137	6.2	11,108	7.6	15,552	10.6
Housing and Urban Development	38,862	26.5	56,147	38.3	82,473	56.3
Transport	75,538	51.6	14,826	10.1	6,437	4.4
Health and Social Assistance	6,376	4.4	7,928	5.4	9,233	6.3
Labor and Social Prevention	15,083	10.3	20,854	14.2	23,663	16.2
Science and Cultural Education	1,883	1.3	2,870	2.0	3,192	2.2

(Source) Budget Section of the Municipality

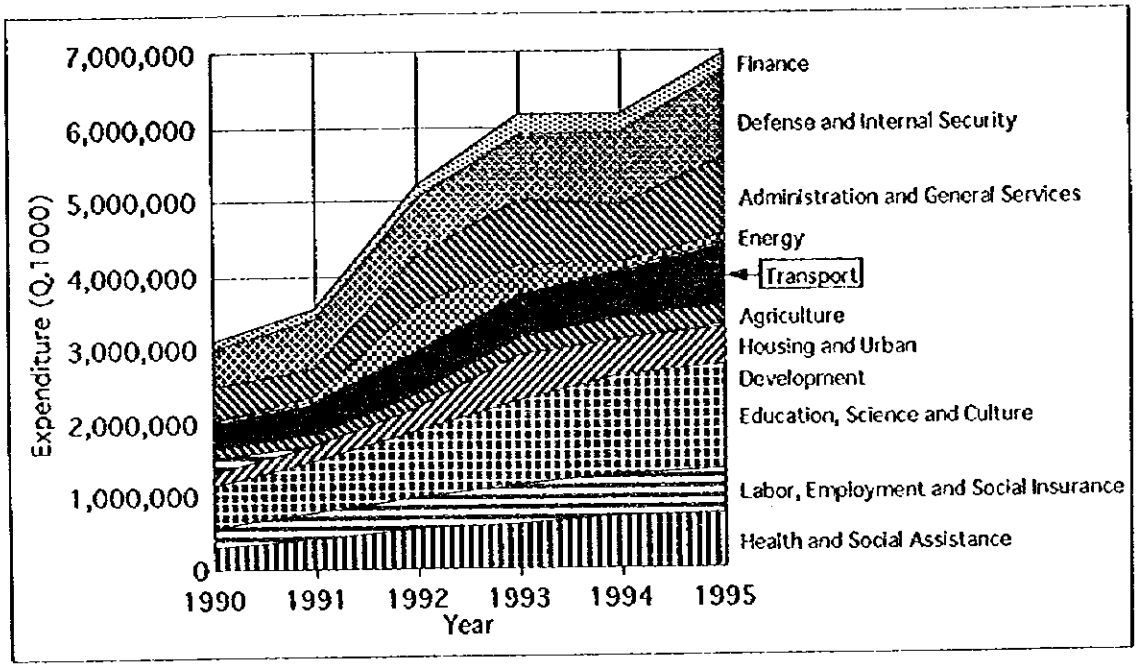


Figure 2.4 Expenditure of the Central Government by Sector

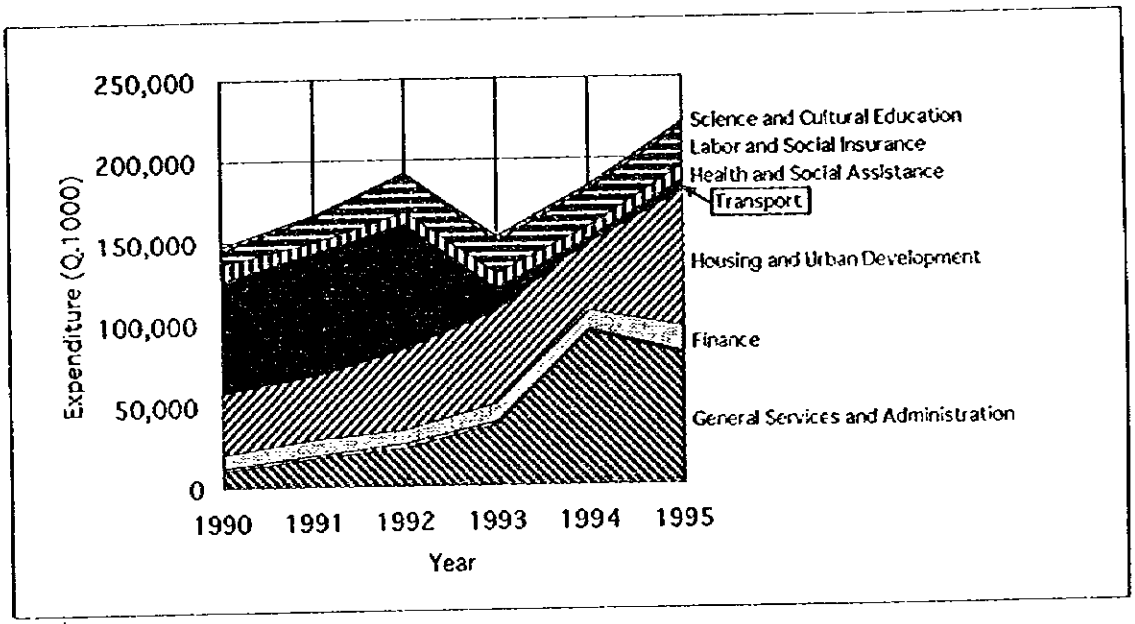


Figure 2.5 Expenditure of Guatemala Municipality by Sector

3. Outline of the Master Plan

3.1 Economic Framework

(1) Gross Regional Products

There will be a gradual increase in the growth of the economy, estimated at 3.5% - 4% during the 1990-1995 period. It is anticipated that it will increase at an average rate of 4% after 1995. The role of the Study Area will be fulfilled by driving the national economy through the secondary and tertiary sectors. Therefore, it is anticipated that the growth rate for the GRP will continue its increase from 4% in 1990 to 4.5% in 1995, and will reach to an average annual growth rate of 4.5% after 1995.

Table 3.1 Economic Development Estimation

Item	1990	2010	2010/1990
GRP (million quetzal)*1	1,827	4,355	2.38
GRP per capita (US dollar)*2	2,018	2,889	1.43

Note: *1 In 1958 constant prices
*2 In 1990 prices

(2) Population

Besides the increase in population of Guatemala Department, the Study Area population will rise from a 91.7% share of the Departments' population to 94.6% by the year 2010, in which year the population of the Department is estimated to reach 3 million, 1.67 times the current scale. The rate of population growth will gradually decline, but will still keep an average 2.6% annual growth over the next 20 year period.

Table 3.2 Future Population in the Study Area

Item	1990	2010	2010/1990
Population (thousand persons)	1,801	3,000	1.67
Share in Department (%)	91.7%	94.6%	

(3) Employment

An increase in labor productivity is necessary to raise the real income of employees. The future rate of annual increase in the labor force is estimated at 2.9% on average. Taking these factors into consideration, and assuming that the annual economic growth rate of 4.5% will be composed of an approximately 1% increase in labor productivity and 3.5% increase in employment, the number of persons employed by sector can be estimated.

Table 3.3 Future Employment by Sector

Sector	1990		2010		2010/1990
Primary	16	2.5%	12	1.0%	0.75
Secondary	150	23.5%	318	25.5%	2.12
Tertiary	471	73.9%	916	73.5%	1.94
Total	637	100.0%	1,246	100.0%	1.96

3.2 Land Use Plan

The future urban pattern of the Study Area is aimed at being the Polycentric/Corridor Pattern. New residential areas of 6,370 ha. are planned for an increasing population of 639 thousand which cannot be absorbed in the existing urban areas.

Table 3.4 Location of New Residential Area

Zone Group	Area		Average population density (persons/ha.)
	(ha.)	(%)	
Central Guatemala	417.3	6.6%	150.0
East Guatemala	1000	15.7%	120.0
Mixco	850	13.3%	92.9
Villa Nueva	1952.5	30.7%	94.5
Petapa	1000	15.7%	100.0
Sta. Catarina Pinula	1150	18.1%	80.4
Total	6369.8	100.0%	100.2

New industrial areas are located in habitable lands along the regional trunk roads. Of 1,400 ha. as a whole, a little more than one third, 500 ha., will be developed along CA9 in Villa Nueva/Amatitlan in order to contribute to increased job opportunities. Moreover, 250 ha. will be developed along CA9 in Zones 17 and 18; 300 ha. altogether along CA1 and Department Route 10; and 250 ha. along CA1 in Fraijanes. In Mixco, 50 ha. of industrial developments are planned along CA1 and 50 ha. along Calzada San Juan Sacatepequez.

The area of required land for future commercial/institutional cores is estimated at 550 ha., of which 160 ha. is considered to be formed by land use conversion from the residential or mixed to the commercial/institutional in the present urban areas. The new commercial/institutional cores of 390 ha. are located all around, especially in Sta. Catarina Pinula/Fraijanes, where high-income class residents are expected to increase and there is no commercial core. Several cores are located along CA1 and near the intersections with planned ring roads (about 90 ha. altogether), and in Traffic Zone 45 of Villa Nueva a new town center of about 40 ha. will be developed.

The summary of land use plan is shown in the following table.

Table 3.5 Summary of Land Use Plan

Zone Group	Urban are			Non urban are			
	Existing urban area	New urban area	Sub-total	Farmland	Forest	Sub-total	Habitable land total
Central Guatemala	7,466.1	457.3	7,923.4	155.0	329.0	484.0	8,407.4
East Guatemala	2,522.8	1,320.0	3,842.8	620.0	341.5	961.5	4,804.3
Mixco	4539.8	1,010.0	5,549.8	122.5	625.5	748.0	6,297.8
Villa Nueva	4632.5	2,532.5	7,165.0	1,297.5	302.5	1,600.0	8,765.0
Petapa	3437.5	1,350.0	4,787.5	2,920.0	440.0	3,360.0	8,147.5
Sta. Catarina Pinula	2655.0	1,490.0	4,145.0	5,607.5	225.0	5,832.5	9,977.5
Total	25,253.7	8,159.8	33,413.5	10,722.5	2,263.5	12,986.0	46,399.5

Unit: ha.

3.3 Traffic Demand

(1) Present Person Trip

The total numbers of person trips per day in the Study Area, obtained by the Person Trip Survey conducted in 1990, were 3,423,142 trips. Within those trips, 3,386,252 trips (98.9%) were made by residents in the Study Area, while the remaining 36,889 trips were made by outside residents.

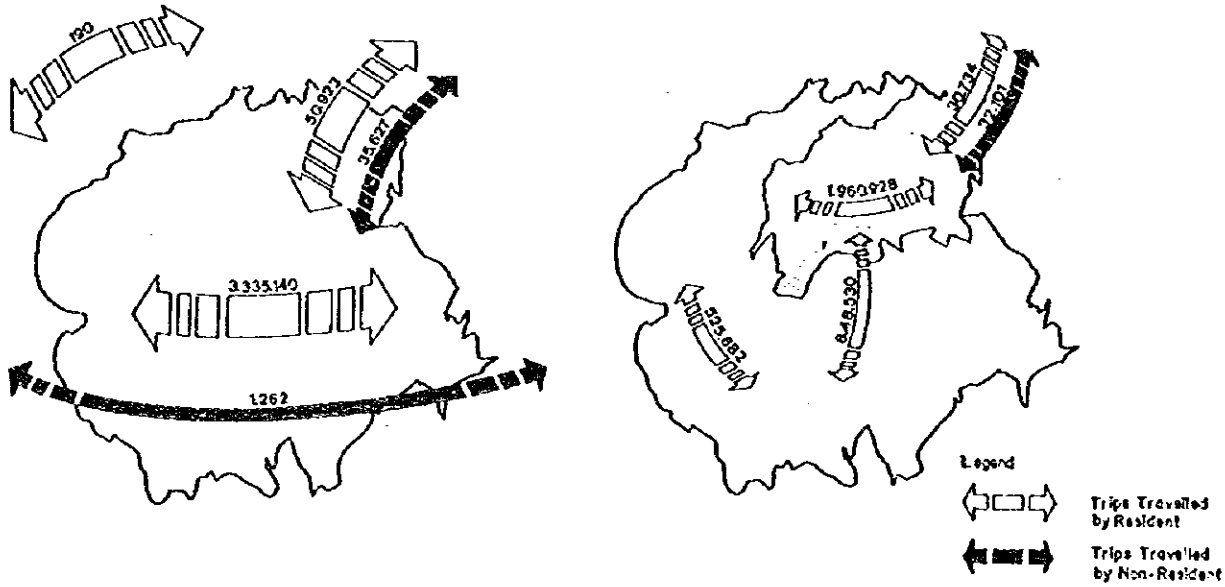


Figure 3.1 Outline of Person Trips

The composition of trip purpose were "to home" (47.7%), "to work" (22.5%), "to school" (14.6%), "others" (6.7%), "shopping" (4.5%), "business" (2.3%) and "to office" (1.5%). For the modal split, bus (large bus system) was the highest at 35.9%, followed by passenger car (18.7%), microbus (17.1%) and walking (16.3%).

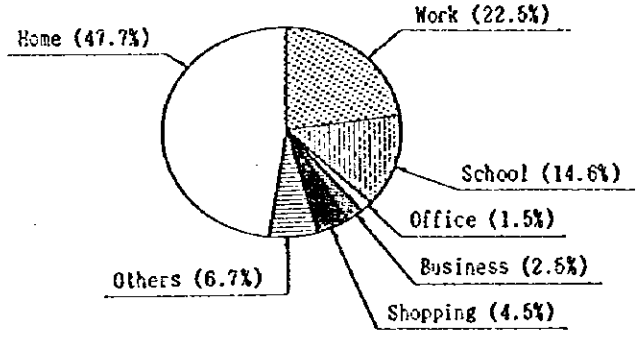


Figure 3.2 Trip Composition by Purpose

(2) Future Traffic Demand

The future traffic demand forecast model was developed by analyzing the quantitative relationship between person trip behavior such as Origin-Destination table, and the regional (zonal) socio-economic activities, which can be expected to remain stable in the future. The forecast model consists of the following four basic models so that the procedure is called the four step method.

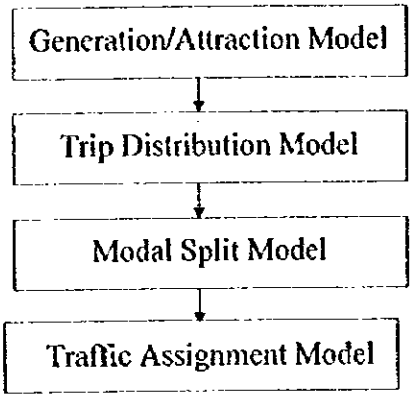


Figure 3.3 Traffic Demand Forecast Model

By the year 2010, the ratio of car owning households will increase to 46.6%, while the number of households will increase to 625,000. Besides, the number of vehicles is estimated at 2.6 times the present figure. The number of persons who belong to car owning households, estimated by using the model mentioned above, will be 1,219,567 in 2010. On the other hand, the number of non-car owning persons will be 1,444,433. The trip production made by car owners is calculated as 3,296,500 (53.9%) person trips in 2010, and that of non-car owners will be 2,819,600. The total of the both will be 6,116,100, 1.8 times the present number of person trips.

Table 3.6 Trip Production in 2010

Trip Purpose	Trip Production in 2010		
	Car owner	Non - car owner	Total
to work	764,700	622,600	1,387,300
to school	443,900	430,400	874,300
shopping	136,600	132,900	269,500
business	187,800	85,200	273,000
others	224,400	187,800	412,200
to home	1,539,100	1,360,700	2,899,800
Total	3,296,500	2,819,600	6,116,100
Population estimated to be over 4 years old in 2010	1,219,567	1,444,433	2,664,000

A large volume of person trips will be generated in the central district in the Municipality of Guatemala, especially in Zone 1, while the increase rate will be 0.99. Increase in trip generation in suburban areas, such as Mixco (2.09), Villa Nueva (2.94) and Zone 18 (1.70), will be obviously large. The number of person trips between the central Guatemala and Mixco will be the largest, and that between eastern Guatemala and central Guatemala will follow.

If the road service level is the same as the present ("Do-nothing" case), the number of private car trips will reach 2 million person trips (42% of the total number of person trips using vehicles). This number amounts to twice the present figure, thus massive congestion will occur if none of the road projects are realized. The percentages of private cars between Mixco and Central Guatemala, and Villa Nueva and Central Guatemala will be almost 50%. Therefore, it can be assumed that the traffic generated by private cars will make the roads congested in the both directions.

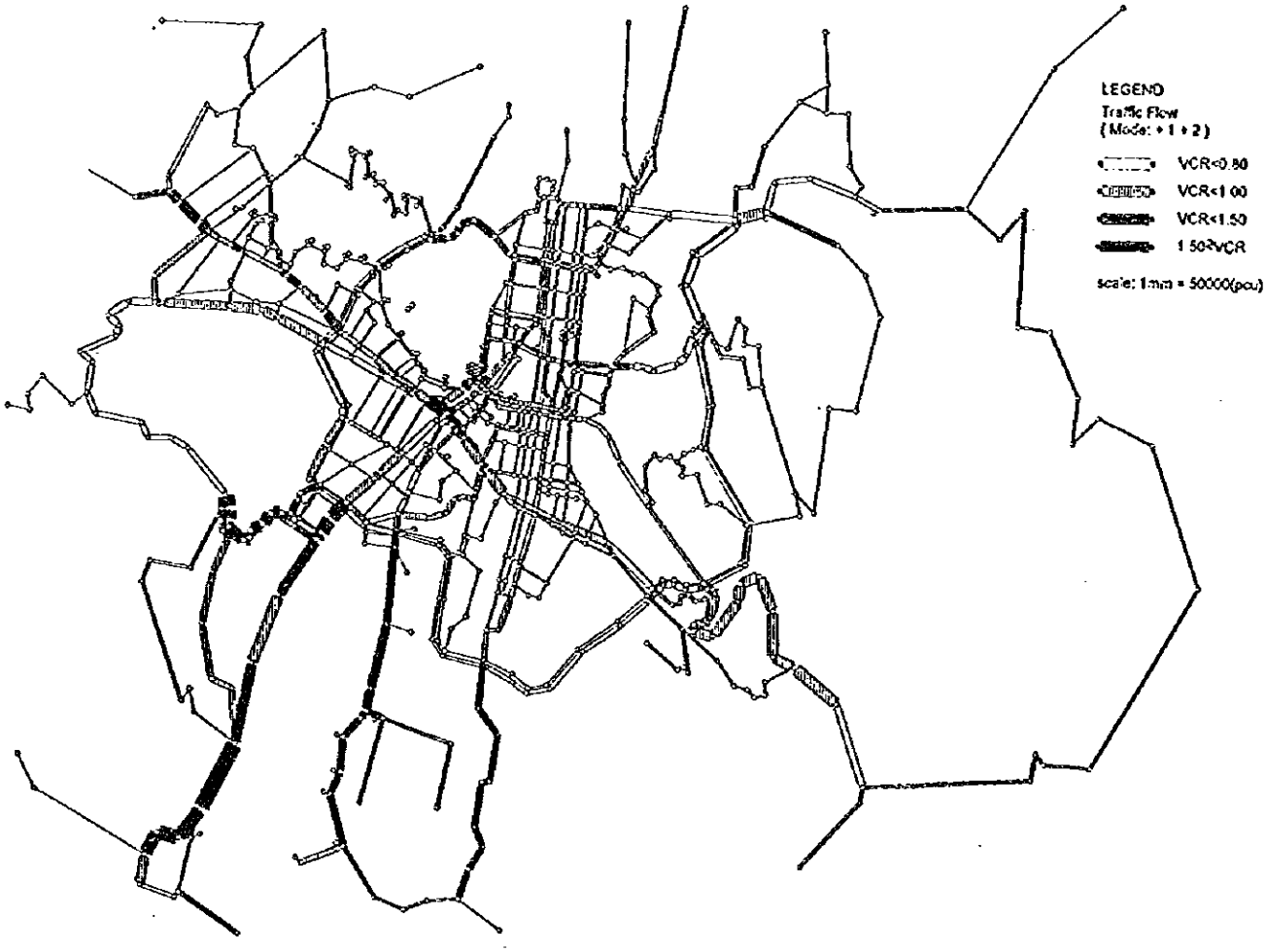


Figure 3.4 Traffic Assignment of "Do-nothing" Case

3.4 Master Plan Network

The Master Plan can be divided into two parts; a short term plan and a long term plan. The short term plan, whose the target year is 1995, was prepared by considering of the following factors.

- To develop the transport axis
- To balance the capacity with demand for transport
- To formulate a realistic system plan
- To utilize existing transport facilities

The long term plan was identified based on planning goals and policies as follows;

- Strengthening of transport axes
- Strengthening of public transport

The outline of the Master Plan Projects is shown in the following table.

Table 3.7 Outline of Projects on Transportation Master Plan

Project Name	Contents	
	Type	Size
1 Outer Ring Road (North)	New construction	L=16,700m (4 lane)
2 Outer Ring Road (South)	New construction	L=23,150m (4, 2 lane)
3 Middle Ring Road	New construction	L=20,400m (4 lane)
4 East-West Corridor	New construction	L=11,540m (4 lane)
5 Periferico Tramo	New construction	L=3,500m (4 lane)
6 Inner Ring Road	Widening	L=1,580m (4 lane)
7 CA-9 (South)	Widening	L=700m (6 lane)
8 CA-1 (East)	Widening	L=10,500m (6 lane)
9 Av. Hincapie	Widening	L=10,000m (4 lane)
10 Av. Petapa	Widening	L=6,000m (4 lane)
11 13 Av. Zone 7	Widening	L=2,050m (4 lane)
12 6 Av. Zone 2	Widening	L=1,120m (4 lane)
13 15 Av. Zone 6	Widening	L=2,300m (4 lane)
14 35 Av. Zone 11	Widening	L=10,090m (6 lane)
15 Boulevard Sur	Widening	L=1,400m (4 lane)
16 Intersection Improvement	Improvement	32 intersections
17 Bus Stop Development	New construction	Along priority routes
18 Bus Lane Development	Improvement	Along arterial roads
19 Busway Development	New construction	L=24,000m (2 lane)
20 Bus Center Zone 1	New construction	1 unit
21 Bus Center Zone 4	New construction	1 unit
22 Extra-urban Bus Terminal	New construction	3 units
23 Bus Inspection Center	New construction	1 unit
24 Effective Lane Usage	Improvement	6a, 7a Avenue
25 Traffic Control System	Improvement	221 intersections
26 Traffic Safety Park	New construction	1 unit
27 Pavement Marking	Improvement	Urban area
28 Parking Card System	Improvement	Urban area
29 Pedestrian Mall	Improvement	Central area
30 Car Parking	New construction	4 units
31 Sidewalk Development	Improvement	Central area

3.5 Public Transportation Plan

(1) Public Transportation System

As new categories of buses, extra-urban bus, key route bus, ordinary bus and feeder bus are proposed. The role of each bus category is as follows:

- Extra-urban bus

  serves non-commuter inter-regional trips.

- Key route bus

  serves routes along arterial roads connecting major OD pairs.

- Ordinary bus

  serves routes connecting minor OD pairs.

- Feeder bus

  The feeder service is a frequent service by small buses to feed passengers to key route buses.

(2) Public Transportation Skeleton

The public transportation skeleton consists of busways and bus lanes as shown in the following figure.

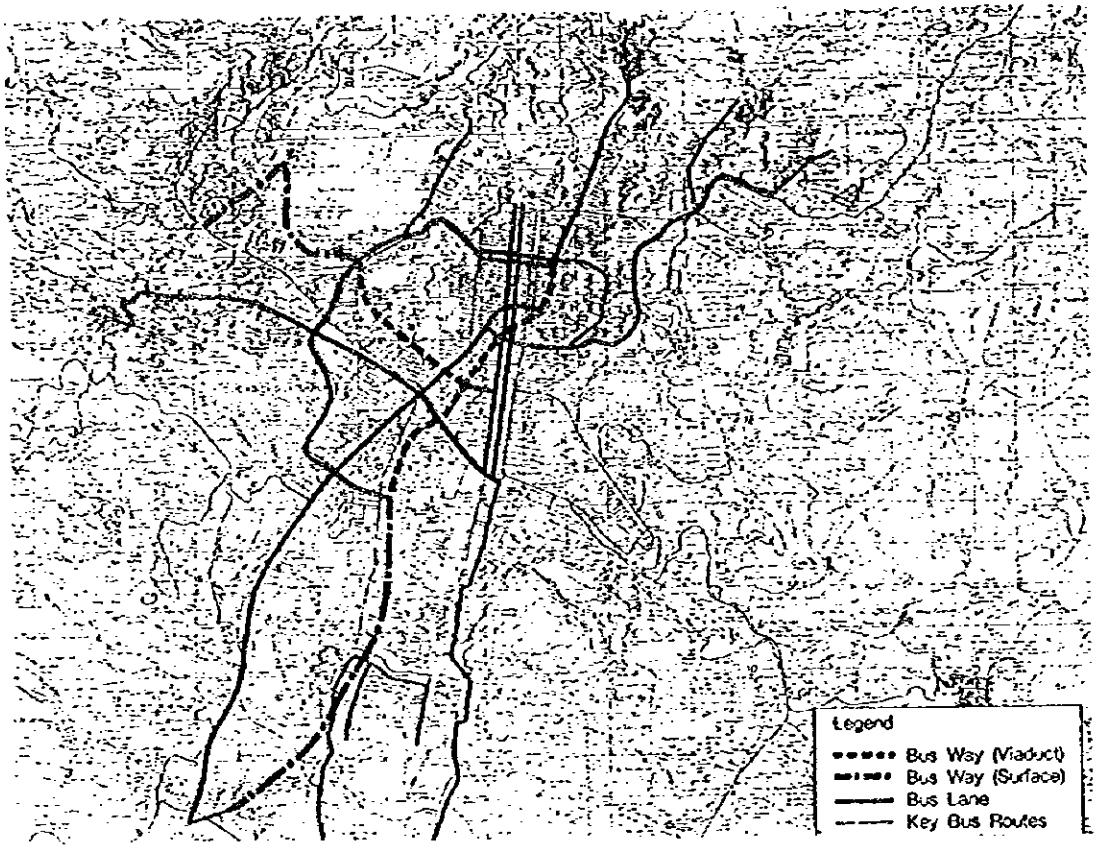


Figure 3.5 Busway and Bus Lane Network

3.6 Implementation Program

The implementation program was prepared according to the following phases.

Phase	I	1992 - 1993	Immediate Action Projects
Phase	II	1992 - 1995	Short Term Projects
Phase	III	1996 - 1999	Mid Term Projects
Phase	IV	2000 - 2009	Long term Projects

Table 3.8 Implementation Schedule

Unit : Q 1,000

Project Name	Project Cost	1990			2000	
		92	95	00	05	10
1 Outer Ring Road (North)	287,525					+++ ++ +++
2 Outer Ring Road (South)	163,339					+++ ++ +++
3 Middle Ring Road	469,999					
4 East-West Corridor	151,399	--- --- --- ---				
5 Periferico Tramo	25,519		--- ---			
6 Inner Ring Road	81,029					+++ +
7 CA-9 (South)	61,048					++ +++
8 CA-1 (East)	84,743					++ +++
9 Av. Hincapie	124,670					+++ +
10 Av. Petapa	59,361	--- --- ---				
11 13 Av. Zone 7	2,642					++ +++
12 6 Av. Zone 2	17,001					++ +++
13 15 Av. Zone 6	16,514		--- ---			
14 35 Av. Zone 11	35,784				+ +++ +++	
15 Boulevard Sur	11,729					+ +++
16 Intersection Improvement	105,817	--- --- --- ---		--- --- --- --- ---		
17 Bus Stop Development	3,306	--- ---				
18 Bus Lane Development	3,794	--- ---				
19 Busway Development	493,950		== == ==	== == == == ==	== == == == ==	
20 Bus Center Zone 1	9,620				+ +++ +++	
21 Bus Center Zone 4	12,000			= == == == =		
22 Extra-urban Bus Terminal	42,842			= == == == =		
23 Bus Inspection Center	21,700		---	---		
24 Effective Lane Usage	4,841	--- ---				
25 Traffic Control System	11,301	--- --- --- ---		--- --- --- -- ---		
26 Traffic Safety Park	5,940			== =		
27 Pavement Marking	1,548	---				
28 Parking Card System	500	--- --- --- ---				
29 Pedestrian Mall	2,843		--- ---			
30 Car Parking	72,200				+++ + +++ +++	
31 Sidewalk Development	2,673				+++ + +++ +++	
Total	2,387,177	394,990		508,560	1,483,627	

Note: ---- : Short term projects
===: Middle term projects
+++: Long term projects

II PLANNING CONDITION

II PLANNING CONDITION

4. Physical Conditions

4.1 Land Survey

(1) Aerial Photography

Aerial photography surveys at scales of 1:10,000 and 1:4,000 were carried out. The former was used for the 1:2,000 topographic mapping and also for the 1:2,000 uncontrolled photomosaics. While the latter was used for the 1:500 topographic mapping.

The actual aerial photography operations were subcontracted to a local company. Although the weather conditions in October and November of the year were exceptionally unsuitable for the aerial photography operations and several times reflight were inevitable, the following aerial photographs were finally taken and the results were accepted.

(2) Uncontrolled Photomosaics

The uncontrolled photomosaics at approximate scale of 1:2,000 covering 24 km^2 of the East West Corridor, southern part of Petapa Road and the Exclusive Busways were prepared. The areas were covered with photomosaics of 33 sheets of 40 cm x 50 cm size. Names of sreets, towns and districts were collected form the existing topographic maps and superimposed on the photo images.

(3) Topographic Mapping

1) Ground Control Survey

Vertical and horizontal ground control points to restitute stereo models for the photogrametric mapping were established by the Differential GPS survey. Two main ground control survey routes were selected as one for the northern area and another for the southern area. The survey started at an existing ground control point, observed the satellites signals simultaneously with two units of the GPS receivers at every new ground control point, and closed to the starting point so that the accuracy of the observation were checked by the value of misclosures. Observation were carried out at several existing bench marks, and existing data and observed data were compared to know the accuracy of the GPS survey. The horizontal and vertical coordinates of the ground controls were established by the GPS survey.

2) Photogrammetric Plotting and Drawing

The topographic maps at scales of 1:2,000 and 1:500 were prepared from the 1:10,000 and 1:4,000 aerial photographs, respectively. The residuals in the vertical and horizontal controls after restitution of the stereo models were well remained within 0.5 m in elevation and 0.3 mm in planimmetric positions on the scaled maps.

Plotted map manuscripts were compiled with data and information collected in the fields. The compiled pencil manuscripts were overlaid with polyester bases and traced with black ink to complete the original 1:2,000 and 1:500 topographic maps. The plotted manuscripts were also verified in the fields.

4.2 Soil Condition

(1) Geological Conditions

Due to volcanic activity, the geological formation of the Study Area is characterized by pyroclastic deposits, tuff, pumiceous tuff and pumice layers. The Study Area is surrounded by the Montagua faults with its secondary faults on one side, and the Villalobos river, the peripheral road and San Nicolas boulevard on the other side. The area is seismically active.

The Guatemalan geological layers of tuffaceous ash, pumiceous tuff and similar materials formed by volcanic activity are characterized by low specific weights which make then easily prone to erosion under rainfall. That is why the Study Area stratigraphy can be classified into alluvial deposits and pyroclastic deposits.

Alluvial deposits can be observed in the topographic depressions formed by the alluvial valley of the Villabolos river, Vella Neuva, the Naranjo river and Cascade of the Democracia Park. Sedimentary deposits of fluvial and lacustrian materials with a depth of 20 m lie under the Villalobos river. To a depth of 15 m from the upper layer, the soil is composed of silty clay, sandy silt, silty sand, and fine to medium sand.

The pyroclastic deposit layer in the valley, upstream of the river is underlain and interbedded by sandy mud, slimy sand, rounded fragments of pumice stone, andesite and basalt. Gravel and fine sand with silt and small alluvial deposits are found in the river valley and ravines of the Naranjo river and the Democracia Park. Along the Guatemalan terrace formation, pyroclastic deposit of ash flow, formed by fine ash, pumice stone and tuffs, pumice rock fragments interbedded with clayey silt is wide spread.

The upper surface of the area enclosed by the Villalobos river and the Villa Nueva is formed of pumice stone and pumice ash having a large thickness. The Guatemalan terrace is further characterized by pumiceous, tuffaceous ash and clayey silt interbedded with fine pumiceous ash. The hill on which the National Theater is located and Naranjo hill are formed of andesytic type soil mixed with tuffaceous ash by the lava material. The terraces of the East West Corridor are mainly formed of clayey silt and compressed silty sand with tuffaceous and pumaceous ash on the surface.

(2) Soil Condition

1) Soil Characteristic in the Project Area

Engineering soil survey is performed for the recognition of soil characteristics, both in plan and profile of the soil, which may be encountered for their possible use as construction materials for earth work, pavement type and bridge foundation before the final selection of each project site. Based on the results of the soil survey and the following laboratory test, the soil of the project area was classified.

a) Clayey Silt

This type of soil is distributed at upper layer in the whole area of Guatemala City. N values of the stratum range from 5 to 30, and the soil mixes with sand and fragments. This stratum does not have sufficient bearing force for bridge construction. Specific gravity of soil is about 2.5. Natural moisture content of soil is 25 to 50%, and the liquid limit is 50%. For this reason, the natural moisture content may be beyond the liquid limit in some places, where soil is physically unstable.

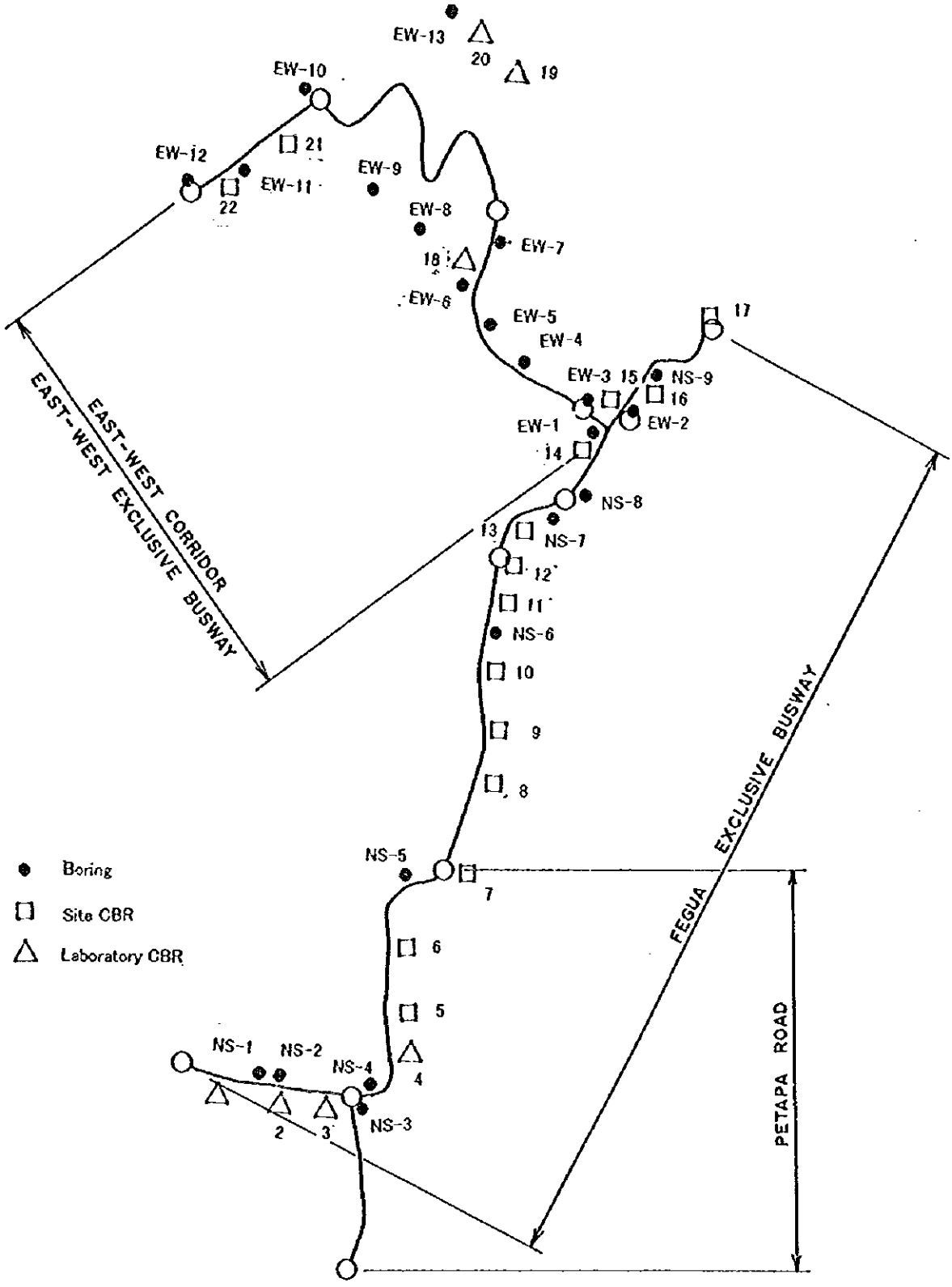


Figure 4.1 Location of Geological Survey

b) Sandy Silt

This type of soil is distributed in under layer of clayey silt. N values of the stratum are more than 15. Specific gravity of soil is about 2.6. Natural moisture content of soil is 15 to 50%, and liquid limit is 35%. For this reason, the natural moisture content may be beyond the liquid limit in places, where soil is physically unstable.

c) Pumeiceous ash and Pumice

This type of soil is distributed alternately in clayey silt or sandy silt which includes pumice stone. N values of stratum is expected to be 15 to 50. Specific gravity of this soil is about 2.2 to 2.5. This stratum of more than 10 m depth may have sufficient bearing force for bridge structure.

d) Fine to medium sands

N values of the soil layer of more than 10 m depth are expect to be more than 30 and may have sufficient bearing force for bridge structure.

e) Clean Gravel

This type of gravel is found in river valley beds. N values are more than 30 and may have sufficient bearing layer for bridge structure.

f) Tuffaceous Ash

This type of soil stratum is consist of basaltic pyroclas deposit. N values of this stratum of more than 10 m depth from the surface are 30 or more and may have sufficient bearing layer for bridge structure.

2) General Condition of Soil in the Project Areas

a) East West Corridor and the Exclusive Busway

There is clayey soil in upper layer between San Juan (STA 0+0) to Periferico road (STA 77+00). N value and natural moisture content of the clayey soil are 15 and 25%, respectively. Construction of a long span bridge to cross the Naranjo Valley requires a layer whose N value is more than 50 for its foundation. There are many large scaled bridges to be constructed over the valley between Periferico road (STA 77+00) to Mercado (STA122+50). Some protection is necessary to prevent advancing erosion of steep slope in the valley, and the bridge foundations have to be placed on the good bearing layer whose N value is 50 or more. The road to cross Avenida Bolivar is designed as a depressed road. Cutting soil of the depressed road construction contains clayey silt and sandy silt which is sufficient to use for subgrade materials.

b) Petapa Road, and Exclusive Busway-FEGUA Route

Most part of the section of the Petapa Road between Petapa (STA0+00) and El Frutal (STA 27+00) located in the Villalobos valley which is alternately formed of deposit of sandy silt, clayey silt and clean gravel. Liquefaction of sandy silt should be studied in consideration of earthquakes.

There is clayey silt in upper layer and sandy silt in lower layer under the basway section between Villa Nueva (0+00) and El Frutal (STA27+00). The soil of those layers can be used as subgrade materials. The FEGUA Route section between El Frutal (STA27+00) and Pamplona (STA72+80) has inclined ground to connect the heights to the lowland of the Villalobos river.

Upper layer of the Villalobos river bed is consist of sandy silt which has bad grading curve conditions for liquefaction in case of earthquake. The section between Pamplona (STA72+80) and FEGUA railway is relatively flat. The busway route is to be parallel to the FUEGUA railway. Upper layer alternately contains deposit with clayey silt and sandy silt which has no problem for the usage as subgrade materials.

4.3 Hydrological Conditions

(1) Climate

Guatemala City is situated on a highland whose altitude is 1,500 m above the sea level. The annual mean temperature is 18℃, 24 to 27℃ in the daytime and 15 to 21℃ in the night time, and the lowest temperature seldom falls below 10℃. Guatemala City has generally a mild climate through out the year and there are two seasons, rainy months from May to October and dry ones from November to April.

Throughout the year, tropical easterly winds predominate. In the rainy season, however, westerly winds against easterlies or weak tropical hurricanes cause rainfalls. Even in the dry season, cool northerly gales induce rainfall from time to time.

The annual average rainfall in Guatemala City is 1,100 mm; plentiful in June, August and September with monthly rainfall of 250 to 300 mm (Figure 4.2). The storm in the rainy season is a squall type that lasts 1 to 2 hours and the rain-intensity is rather high. The number of rainy days varies from year to year, but the number of rainy days per month in the four months from June to September exceeds 20 days. According to the 10 year records during the period from 1985 to 1994, the maximum monthly rainfall reached 458 mm. The number of rainy days per month during the five-month period from November to March is less than 8 days with scanty rainfall (Figure 4.3).

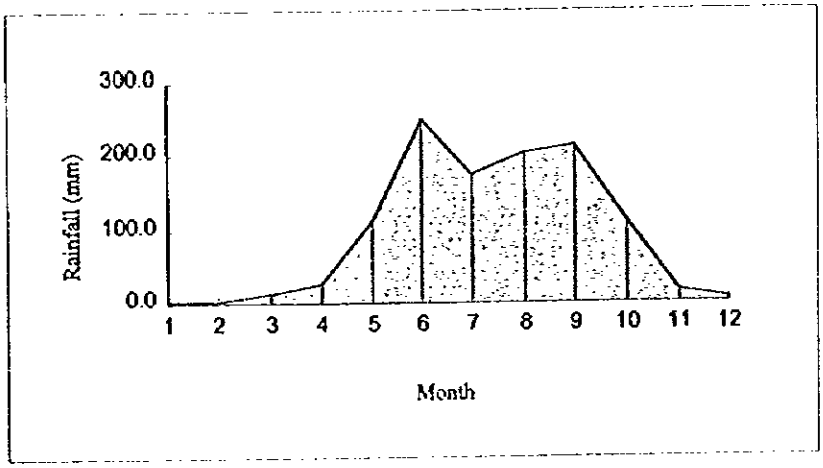


Figure 4.2 Monthly Rainfall (mm) (average of 1985 to 1994)
(Source : Departomento de Systemas Atomosfericos)

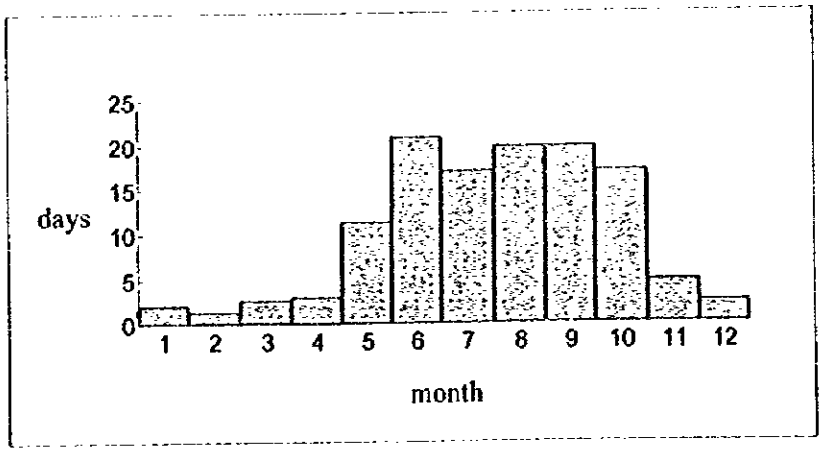


Figure 4.3 Number of Monthly Rainy Days (average of 1985 to 1994)
(Source : Departomento de Systemas Atomosfericos)

(2) Probability of Precipitation Intensity

EMPAGUA is responsible for the drainage of the rain water within Guatemala City. EMPAGUA drains the rain water into the Caribbean Sea and the Pacific Ocean. The rain fall intensity for 2, 5, 10, 20 and 30 year durations are estimated by the Talbot method based on the recorded data in the Study Area. The Talbot equation is a function of the number of hours of rainfall and rainfall intensity. In this equation, as the water catchment area increases and the number of hours of rainfall increases, the average intensity of rainfall decreases. As estimated with the Talbot equation, the rainfall intensity in the Pacific area is 1.3 to 1.45 times larger than that in the Atlantic area. In order to design the drainage system alongside the road, EMPAGUA estimates rainfall amount with 10 year probability. The number of hours of rainfall is estimated by the time from the start of rainfall to the time for rain water to reach to the water channel, and the time for the water to flow in the channel within the Study Area. The time of the rain water down flow is estimated by the slope of the land and the soil impermeability.

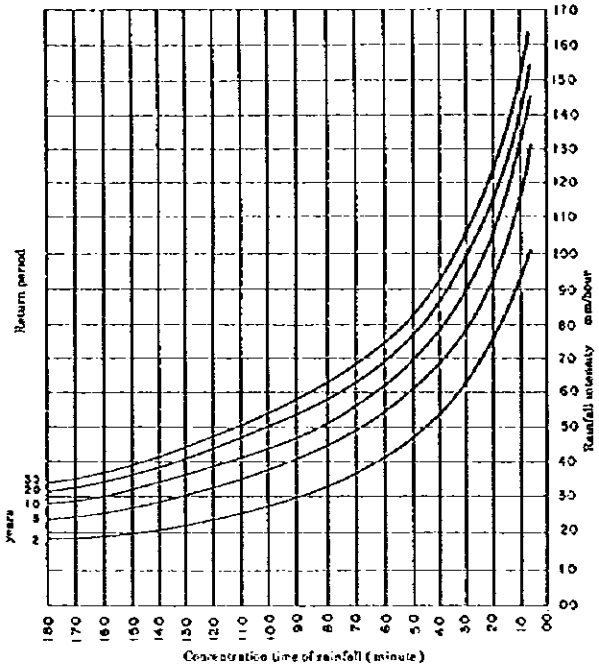
$$t = t1 + L/60v$$

where t: number of rainfall hours
t1: time for rain water to reach to water channel from the start of the rain fall
L: water channel length
V: velocity of water flow in the channel

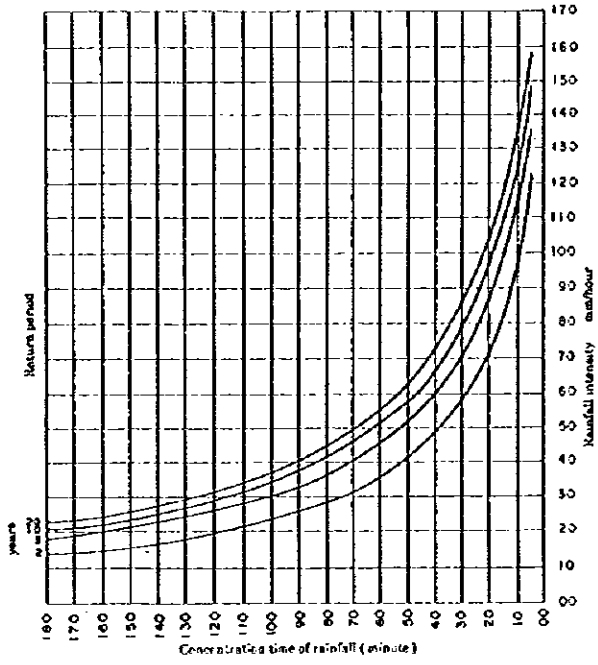
Furthermore the run-off coefficient is affected by the surface conditions. This study takes into consideration the following run-off coefficients shown in Table 4.1 by area classification.

Table 4.1 Proposed Run-off Coefficient

Area classification	Coefficient
Park and green area	0.2
Hilly area	0.3
Residential area	0.5
Pavement	0.8



PACIFIC Zone



ATLANTIC Zone

Figure 4.4 Rainfall Intensity and Rainfall Hours (Minute)

4.4 Land Use

(1) Existing Cinditions

The development in Zone 1 was almost saturated and the Zone 9 and 10 is still developing as the central business district. The major urban development axes are west and south along Calzada Roosevelt (CA1 west) and Calzada Aguilar Batres (CA9 south). The above development will be continued. Factories and industrial facilities are also located along the Calzada Roosevelt (CA1 west), Calzada Aguilar Batres (CA9 south) and Avenida Petapa.

Recent characteristics of the urban development is described as follows:

Large shopping centers and complex with plenty parking space were constructed on CA1 in Zone 10 and 7, such as El Proceres and Mega-centro. Also the opposite side of Mega-centro, a large-scale complex of shops, offices and hotel, etc., is under construction in Zone 11, in the vicinity of which huge commercial development plan exists. Thus the area along Carzada Roosevelt inside Periferico, in particular the zone around the crossing of Carzada Roosevelt and Periferico is developing as concentrated commercial and business zone.

(2) Land Use Plan in the Master Plan

The direction of the land use plan in the Master Plan is as follows:

1) According to the proposed Corridor - Poly-centric Pattern, commercial and business sub-centers will be formed in the suburban towns.
2) Major industrial development axis will also be south.
3) In general, the low income people live in the suburban area in north (Zone 6, 18), west (Mixco, Zone 19) and south (Villa Nueva). In particular the poor inhabit in Villalobos and Mesquitar (Villa Nueva) and Lo de Fuentes (Mixco). The Exclusive Busway, East-West Corridor and Improvement Petapa Road will contribute to their activities.

(3) Major Changes

Major changes from the Mater Plan in the land use projection is as follows:

- Naranjo area, which was forest and vacant zone at the time of Master Plan formulation, will be changed to residential area with a commercial core in the center, according to the existing development plan. The forest in the steep slopes and valleys and hills should be preserved. Small industries may be distributed near the future outer ring road.
- The commercial area west of the crossing of Carzada Roosevelt and Periferico will be extended according to the existing development plan and potential.
- CENMA will play a public role of logistics and distribution of cargo, and will form commercial zone in the surrounding area.
- The commercial area of San Miguel Petapa will be extended to the east along the National Road 2N in accordance with the modification of the route of Petapa Road Improvement.
- The areas centered with the Inter-regional Bus Terminals will form a commercial zone. Especially the existing shopping center and extension plan in Atlantida in Zone 18 should develop as a commercial center.

5. Traffic Conditions

5.1 Road Condition

5.1.1 Road Network in the Study Area

The trunk roads in Guatemala City consist of seven radial roads despite restrictions on their development caused by steep V-shaped valleys called "barranco". The border between the developed sections and the valleys form steep cliffs of a depth of 50 to 120 m. Therefore, Periferico Road is only the ring road in the city which runs in a semicircle with a radius of 4 km in the west side of the city.

(1) Northward

In the northern area of the city, CA9, which has Belice bridge to the north-east, is the only major road available restricted by the deep valleys in the due north. CA9 is a four-lane road, which connects Guatemala City with the areas north to the city (65,200 veh./day).

(2) Westward

There are two roads to connect to Mixco: one is CA1 with six lanes and the other is Calzada San Juan Sacatepequez with four lanes running adjacent to CA1 (CA1 : 86,000 veh./day; Calzada San Juan Sacatepequez 58,400 veh./day).

(3) Southward

Three roads connect the city to the southern districts: four-lane Petapa Road to Villa Nueva, Petapa and their neighborhood; and four-lane Avenida Hincapie to Villa Canales and its vicinity. CA9 road goes up to Puerto Quetzal on the Pacific coast connecting to CA2 in Escuintla. Avenida Hincapie was improved in 1994, so Villa Canales, a satellite city south of the capital, has been connected to the capital much more smoothly (CA1 : 70,200 veh./day; Petapa road : 54,500 veh/day).

(4) Eastward

CA1 that leads to Santa Catarina Pinula, a satellite city east of Guatemala City, and further to San Jose Pinula, Cuilapa and El Salvador is a four-lane road (82,000 veh./day).

(5) Ring Road

Restricted by geographical configuration, especially by the deeply eroded valleys, the only ring road built in the city is Periferico, which runs west of the city forming a semicircle. Periferico, a six-lane road, directly links to CA9, runs along the outer edge of central district, and crosses, Calzada San Juan Sacatepequez (CA1) and Calzada Aguilar Batres (CA9).

5.1.2 Calzada San Juan Sacatepéquez

Calzada San Juan Sacatepéquez, starting from the down town, is the only trunk road that goes to the northwest part of the Metropolitan Area.

Geographical conditions along the road is complicated because the road crosses the boundary between the Municipality of Mixco and the Municipality of Guatemala. On the north-east side, the road traverses Zone 19 and runs through a large part of Zone 7.

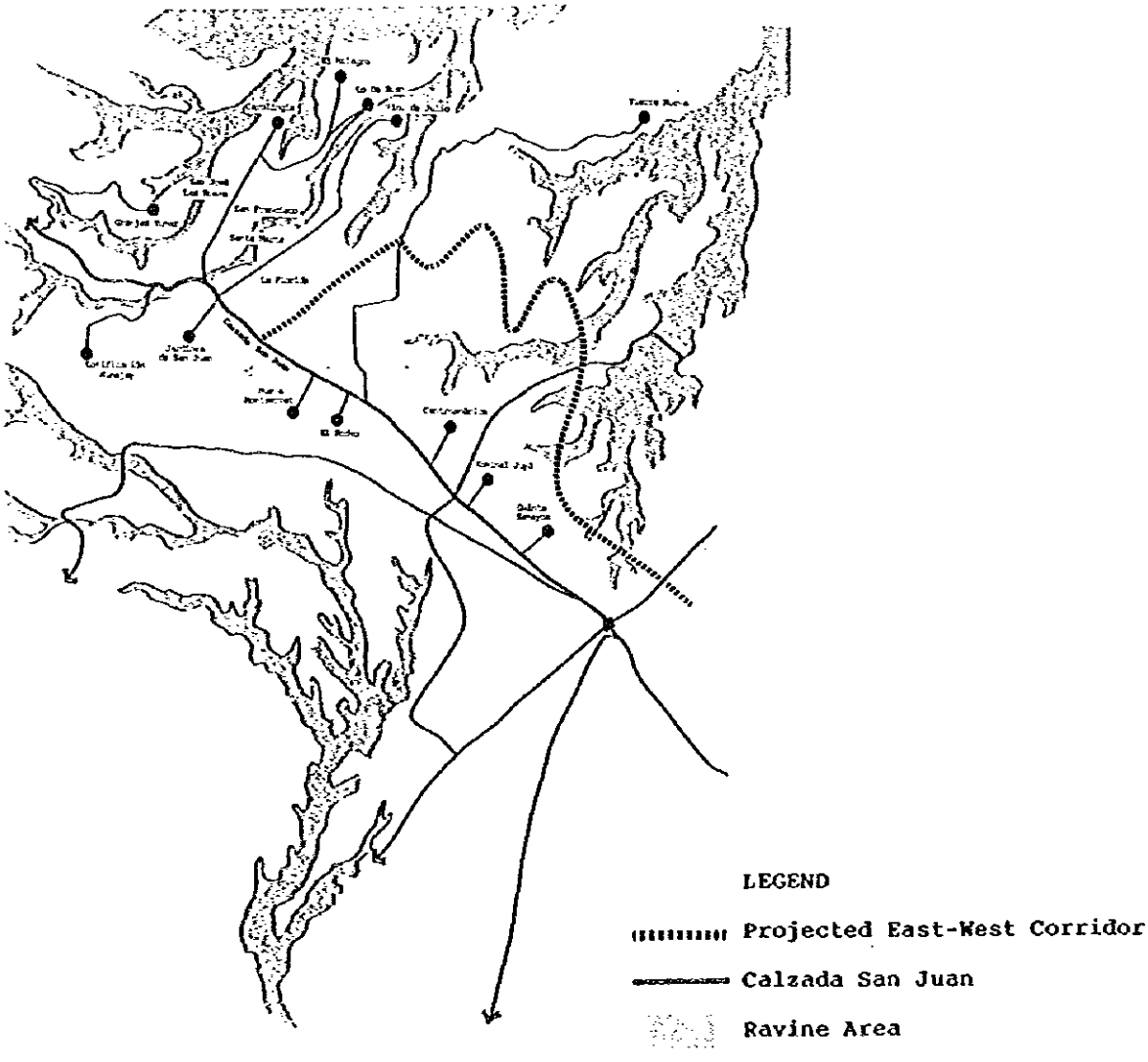


Figure 5.1 Location Map of Calzada Sun Juan Sacatepequez

A sharp peak of congestion occurs on the road every day. The reasons of this traffic congestion are a traffic volume in saturation and the formation of the road, that is to say, the width of the shoulder is not designed and the driving lanes are inevitably reduced by roadside parking, which accelerates the traffic congestion.

(1) Road Side Condition

Commercial activity is the predominant use of the land along this road, but nearby this area a residential development has been implemented. In addition to serve as interconnection to Central American Routes, CA9 and CA1, from the cities of San Pedro and San Juan Sacatepéquez, it is used as main access to residential areas that have been developed at the north-east side of the City (see Figure 5.1).

It serves for residential development at the north-east part of Colonia El Milagro. Adding to the residential areas mentioned above, it has to be considered that it also connects to the ones located between Calzada San Juan and Calzada Roosevelt (CA1 West).

5.1.3 Petapa Road

CA9 (South) is one of the trunk roads that connect the downtown to the southern part of the Metropolitan Area. There are two other roads to connect the downtown to the south part, which are Boca Del Monte Road and Petapa Road.

Boca Del Monte Road goes through Petapa area and residential areas, such as Villa Canales, Los Alamos, Boca Del Monte towards the downtown, having 2 lanes in total. On the way, it goes down almost to the riverbed along the steep slope, because of crossing over the Pinula River, and scrambles on from one valley to another. The road longitudinal gradient near this point is very steep, or 10%, and slow speed vehicles, such as buses, cause traffic congestion.

Petapa Road has 4 lanes from the downtown to Ciudad Real, but from Ciudad Real to Petapa, 2 lanes in total. The section from Trebol intersection to Ciudad Real has an intermittent descending gradient of 2-3%, but by crossing over the Villalobos River (1,200m above sea level) from Ciudad Real (1,400 above sea level), this section has a descending longitudinal gradient of 6% in the average (12% at maximum). A road widening is now being executed, but the longitudinal gradient of the actual road will not be improved.

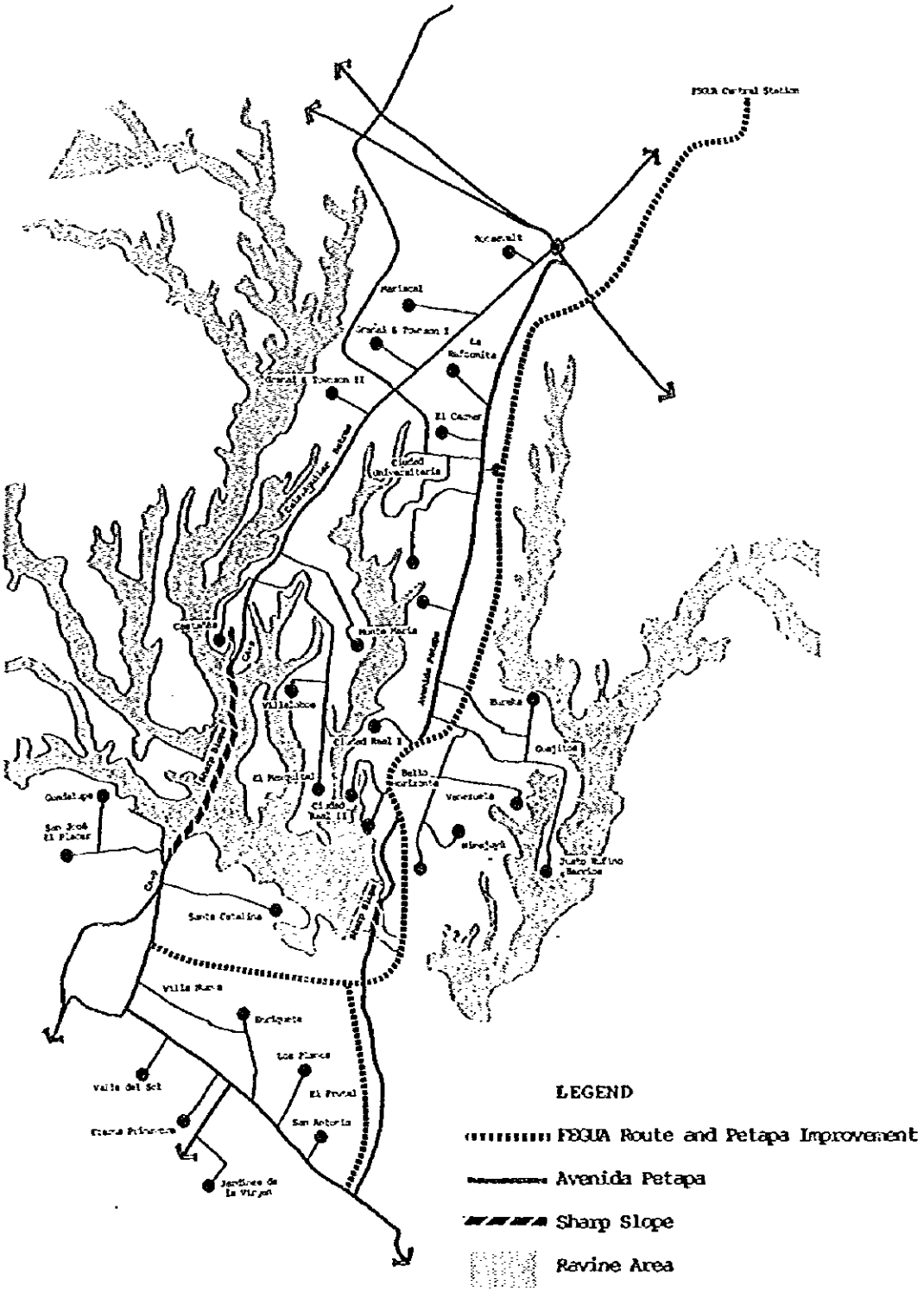


Figure 5.2 Location Map of Avenida Petapa

5.2 Traffic Condition

5.2.1 Traffic Volume Survey

(1) Screen Line Survey

The summarized number of vehicles counted at each point is shown in Table 5.1. The traffic volume which crosses the screen line in a day is almost 550,000 vehicles. The noteworthy points are as follows.

- Puente Belice; 65,000 veh.
- 7a Avenida; 49,000 veh.
- 6a Avenida; 66,000 veh.
- Boulevard Liberacion; 117,000 veh.

Table 5.1 Summary of Traffic Volume Counted crossing Screen Line

Station No.	Type of Vehicle								Total	Rate	
	Passenger Car	Pick-up	Small Truck	Truck	Micro-bus	Bus	Motor-cycle	Others		Trucks	Buses
1	27,666	13,911	3,670	5,207	3,588	5,703	4,729	691	65,165	13.6%	14.3%
2	16,965	4,897	804	841	1,174	561	1,344	482	27,068	6.1%	6.4%
3	13,073	4,150	649	379	1,414	1,594	2,557	834	24,650	4.2%	12.2%
4	23,059	4,907	505	202	694	286	3,314	168	33,135	2.1%	3.0%
5	29,461	6,519	628	395	1,042	7,904	2,794	689	49,432	2.1%	18.1%
6	38,367	9,037	1,165	345	3,122	8,276	4,983	989	66,284	2.3%	17.2%
7	13,651	5,043	414	490	1,571	143	1,577	181	23,070	3.9%	7.4%
8	2,421	1,224	323	52	381	75	474	144	5,094	7.4%	9.0%
9	799	1,429	165	231	13	17	159	281	3,094	12.8%	1.0%
10	983	1,568	192	186	268	160	331	440	4,128	9.2%	10.4%
11	3,924	3,280	239	380	508	1,067	1,027	372	10,797	5.7%	14.6%
12	5,786	2,299	304	27	423	678	733	65	10,315	3.2%	10.7%
13	3,252	1,046	157	14	187	58	578	81	5,373	3.2%	4.6%
14	73,133	20,896	3,428	1,043	4,609	7,303	5,635	809	116,856	3.8%	10.2%
15	16,217	4,624	675	716	556	1,175	1,641	285	25,889	5.4%	6.7%
16	3,010	2,970	627	643	489	877	653	1,559	10,828	11.7%	12.6%
17	1,140	982	49	175	13	190	289	986	3,824	5.9%	5.3%
18	4,690	1,316	156	294	370	125	310	150	7,411	6.1%	6.7%
19	3,746	1,607	194	192	619	292	1,075	276	8,001	4.8%	11.4%
20	1,374	526	68	44	92	232	297	126	2,759	4.1%	11.7%
21	15,293	4,826	1,081	431	852	1,374	1,357	406	25,620	5.9%	8.7%
22	409	256	63	74	44	136	126	86	1,194	11.5%	15.1%
23	8,239	2,984	518	327	1,117	1,013	960	416	15,574	5.4%	13.7%
24	1,833	1,394	293	533	119	935	538	218	5,863	14.1%	18.0%
Total	308,491	101,691	16,367	13,221	23,265	40,174	37,481	10,734	551,424	5.4%	11.5%
Rate	55.9%	18.4%	3.0%	2.4%	4.2%	7.3%	6.8%	1.9%	100.0%		

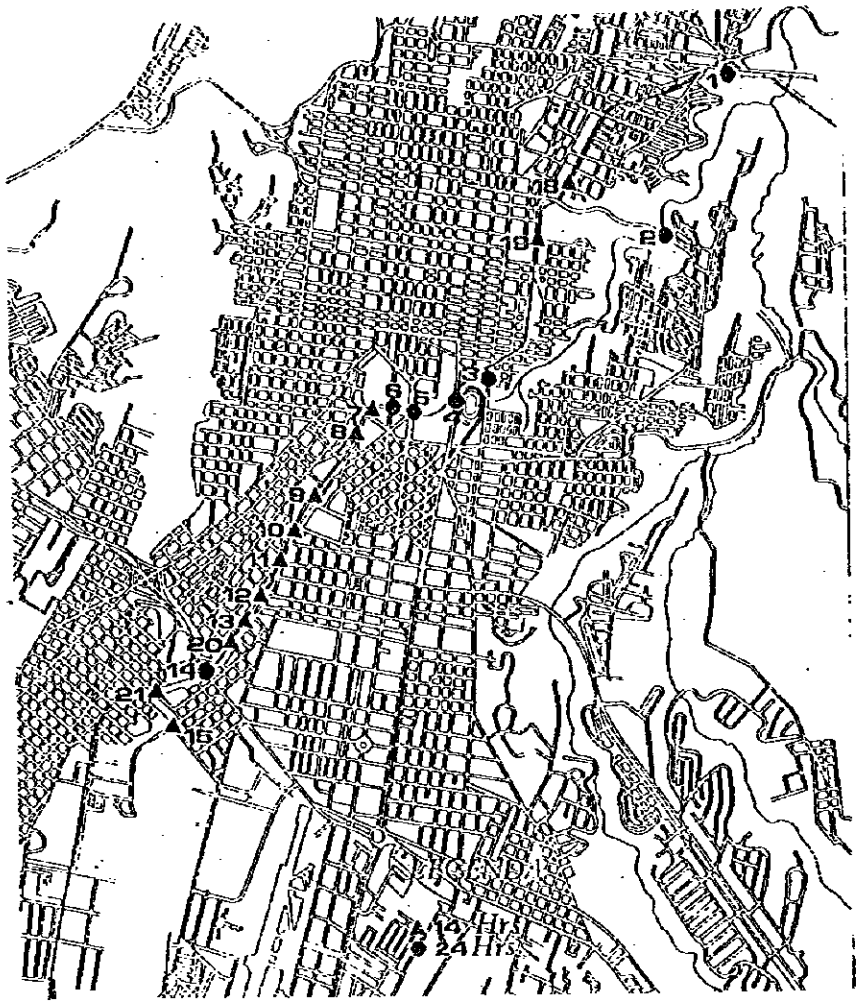


Figure 5.3 Survey Points of Screen Line

(2) Traffic Count Survey on Principal Arterial Roads

Table 5.2 indicates the summarized number of vehicles counted at each point on a principal arterial road. Large traffic volume as more than 70,000 vehicles was counted at four points, namely Anillo Periferico (Station 1), Calzada Roosevelt (Station 3), Calzada Aguilar Batres (Station 4) and Calzada Aguilar Batres (Station 15).

Table 5.2 Summary of Traffic Volume on Principal Arterial Road

Station No.	Type of Vehicles								Total	Rate	
	Passenger Car	Pick-up	Small Truck	Truck	Micro-bus	Bus	Motor-cycle	Others		Trucks	Buses
1	49,362	14,492	3,910	4,550	4,813	5,315	3,665	395	86,503	9.0%	11.7%
2	25,641	12,496	3,383	1,515	4,348	7,442	2,611	985	58,423	11.6%	20.2%
3	52,236	16,611	2,325	3,400	3,435	4,511	3,014	597	86,132	5.4%	9.2%
4	35,150	14,898	5,285	2,802	2,381	5,616	4,068	729	70,933	14.9%	11.3%
5	18,306	4,242	300	175	554	1,629	1,206	377	26,794	2.2%	8.1%
6	26,103	9,931	3,555	3,115	3,666	3,663	3,332	1,157	54,528	13.0%	13.4%
7	7,705	3,669	427	426	660	1,149	1,723	372	16,138	5.3%	11.2%
8	3,150	1,197	221	1,062	150	1,009	388	119	7,304	6.1%	15.9%
9	32,653	7,159	316	625	1,349	753	778	282	43,924	1.4%	4.8%
10	27,491	6,198	886	252	1,337	695	970	236	38,075	4.7%	5.3%
11	7,804	3,257	766	209	847	816	962	418	15,090	10.2%	11.0%
12	10,767	7,285	553	1,044	1,532	4,385	2,021	1,455	29,054	3.8%	20.4%
13	18,269	7,585	1,132	701	2,173	6,842	2,421	600	39,736	5.7%	22.7%
14	17,754	4,619	419	708	528	677	822	118	25,689	3.3%	4.7%
15	27,869	11,930	5,471	5,510	6,995	8,701	3,085	669	70,245	15.6%	22.3%

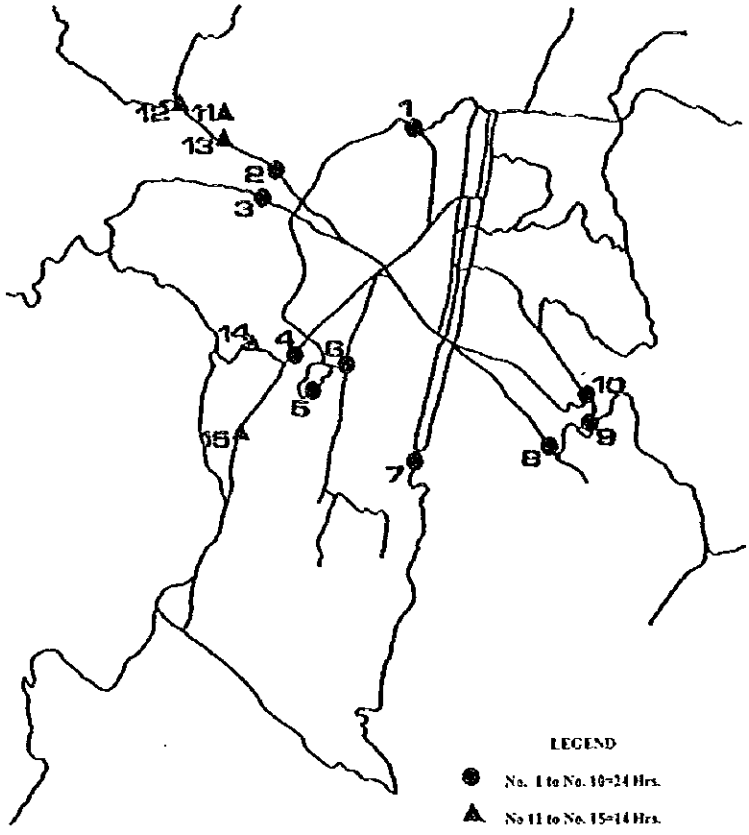


Figure 5.4 Survey Points for Traffic Count

5.2.2 Travel Speed Survey

The summary of the travel speed observations is shown in Table 5.3. The following points are obvious from examination of this table.

- The difference between travel speed in both directions is large at the morning peak hour on all routes except Calzada Roosevelt.
- Travel speed in the up direction is less than 20 km/h at morning peak hour on every route except Calzada Roosevelt.
- On the Calzada Roosevelt route, the travel speed in both directions is almost 20 km/h at the evening peak hour.

Table 5.3 Result of Travel Speed Survey

No.	Name of Street	Survey Date	Distance (km)	Up/down	Morning		Daytime		Evening		Remark
					Start Time	Average Travel Speed	Start Time	Average Travel Speed	Start Time	Average Travel Speed	km/h observed in the M/P
1	San Juan Sacatepequez	3/11/95	10.806	Up	7:30	10.8	12:00	27.3	19:15	25.7	Less than 20
				Down	8:35	30.7	11:30	24.8	17:30	10.7	
2	Calzada Roosevelt	31/10/95	12.188	Up	7:00	31.4	11:45	36.2	17:40	19.9	20 - 30
				Down	7:25	38.5	12:05	33.3	17:00	19.9	
3	Calzada Aguilar Batres	31/10/95	14.950	Up	7:30	19.9	12:00	22.6	17:55	24.2	20 - 30
				Down	3:50	41.1	11:30	37.4	17:15	25.1	
4	Avenida Petapa	3/11/95	18.838	Up	7:30	18.8	13:00	21.8	16:00	22.5	30 - 40
			18.363	Down	8:30	26.5	12:00	19.8	17:00	19.9	

(Note) Figures of the average travel speed (km/h) in peak hours observed in M/P study are shown under Remark.

5.3 Traffic Demand

5.3.1 Presupposition of Demand Forecast

(1) Progress of the Master Plan Network

The possibility of realization of the Master Plan was examined based on the progress of the implementation plan applied by the Municipality authorities. As a consequence of the examination, the following road projects supposed to be completed in the target year.

- Middle ring road (Periferico intermedio)
- Periferico Tramo
- Inner ring road (Periferico interno)
- Avenida Hincapie
- 13 Avenida, Zone 7
- 6 Avenida, Zone 2
- 15 Avenida, Zone 6
- 35 Calle, Zone 11
- Boulevard sur
- CA9
- CA1

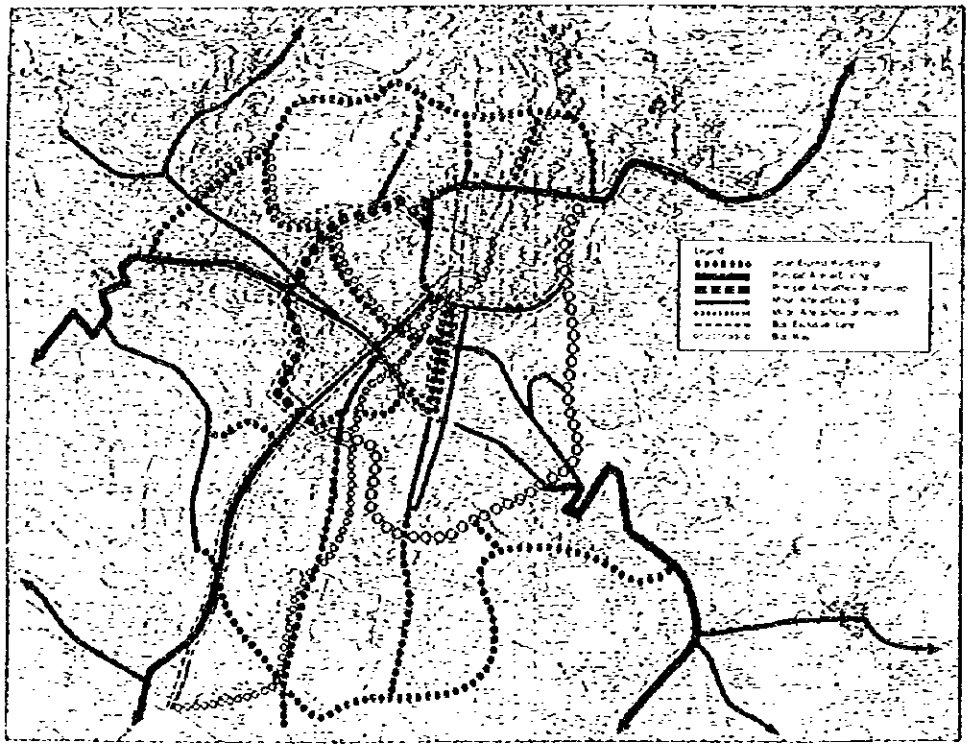


Figure 5.5 Master Plan Network in 2010

(2) Revision of Population

The target population of 3,000,000 in 2010 of the Master Plan was verified by studying economic growth, future land use on the basis of the framework of SEGEPLAN. On the other hand, the distribution of population by zone was revised in consideration of the following points. The revised population is shown in Table 5.4.

- Urbanization from 1990 up to 1996
- Balance with the National Transportation Plan
- Result of Census data in 1994.

Table 5.4 Revised Population Projection

Zone/ Municipality	Estimated Population 1995		Revised Population 2010		Adjustment	Annual Growth Rate 1995 - 2010
	population	share (%)	population	share (%)		
Zone 1	61,711	2.96%	43,740	1.46%		-2.27%
Zone 2	24,878	1.19%	31,185	1.04%		1.52%
Zone 3	53,797	2.58%	57,950	1.93%		0.50%
Zone 4	3,951	0.19%	1,900	0.06%		-4.76%
Zone 5	86,131	4.14%	83,600	2.79%		-0.20%
Zone 6	98,446	4.73%	94,554	3.15%		-0.27%
Zone 7	162,767	7.82%	188,836	6.29%		1.00%
Zone 8	17,433	0.84%	12,980	0.43%		-1.95%
Zone 9	2,873	0.14%	2,380	0.08%		-1.25%
Zone 10	12,530	0.60%	11,525	0.38%	-5,000	-0.56%
Zone 11	51,405	2.47%	84,675	2.82%	-16,375	3.38%
Zone 12	53,583	2.57%	70,120	2.34%	-16,375	1.81%
Zone 13	29,198	1.40%	29,892	1.00%		0.16%
Zone 14	19,673	0.94%	24,450	0.82%		1.46%
Zone 15	16,416	0.79%	22,120	0.74%		2.01%
Zone 16	19,573	0.94%	50,030	1.67%		6.46%
Zone 17	22,557	1.08%	83,600	2.79%	-15,300	9.13%
Zone 18	178,574	8.58%	216,213	7.21%	-31,632	1.28%
Zone 19	32,632	1.57%	25,250	0.84%		-1.70%
Zone 21	68,876	3.31%	74,000	2.47%	32,750	0.48%
Zone 24	13,490	0.65%	55,700	1.86%		9.92%
Zone 25	15,328	0.74%	22,300	0.74%	15,300	2.53%
Guatemala Municipality	1,045,820	50.23%	1,287,000	42.90%		1.39%
Santa Catarina Pinula	52,487	2.52%	138,800	4.63%		6.70%
San Jose Pinula	31,331	1.50%	43,400	1.45%		2.20%
Chinautla	80,252	3.85%	90,195	3.01%	36,632	0.78%
Mixco	388,126	18.64%	486,655	16.22%		1.52%
Fraijanes	22,593	1.09%	46,300	1.54%		4.90%
Amatitlan	70,239	3.37%	95,875	3.20%		2.10%
Villa Nueva	251,392	12.07%	468,825	15.63%		4.24%
Villa Canales	83,730	4.02%	202,200	6.74%		6.05%
Petapa	56,029	2.69%	140,750	4.69%		6.33%
Other Municipalities	1,036,180	49.77%	1,713,000	57.10%		3.41%
Study Area Total	2,082,000	100.00%	3,000,000	100.00%		2.47%

5.3.2 Estimation of Future OD Tables

(1) Estimation Method

The procedure of the future OD tables estimation is shown in the following figure. The models developed in the Master Plan Study was applied in principal. The models estimate OD tables by car ownership so that the estimation process can be divided into that for car owners and for non-car owners.

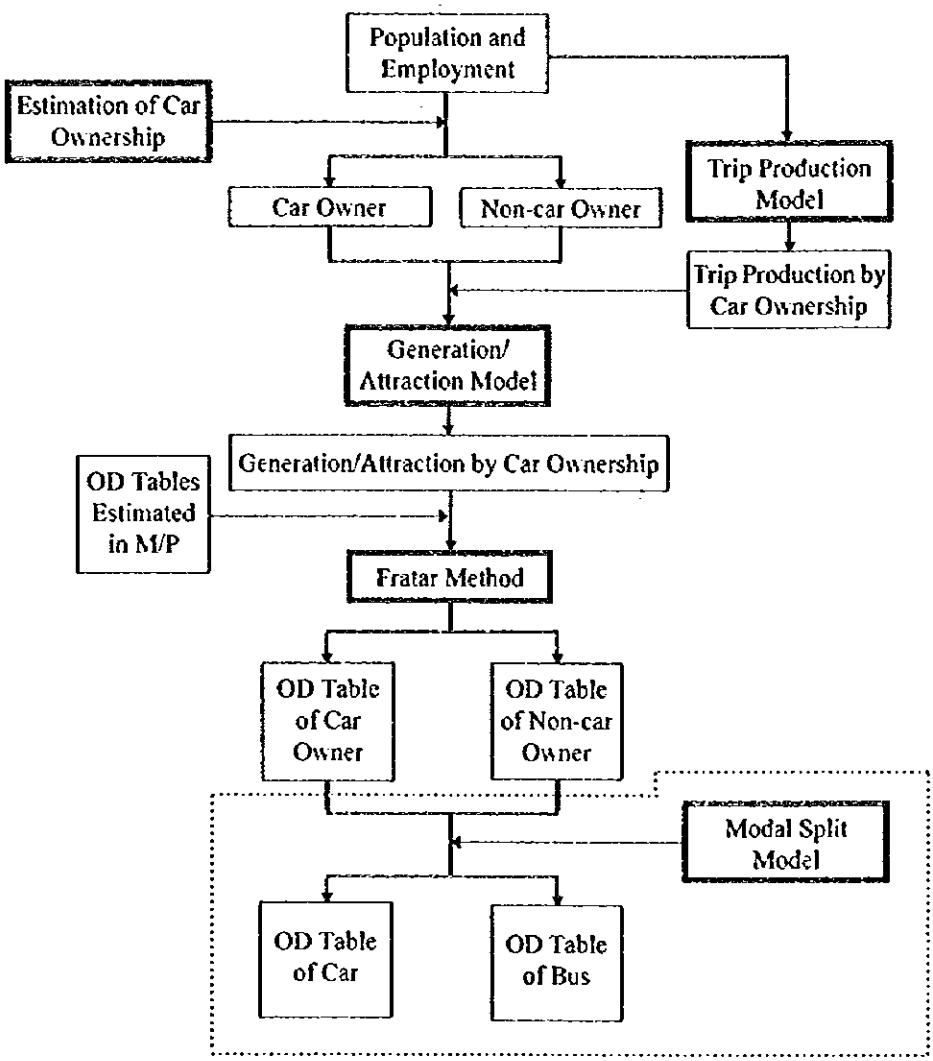


Figure 5.6 Process of Future OD Estimation

In the beginning, a model which estimates the number of car owned in the Study Area, was examined because car ownership supposed to be drastically changed from the situation at the time of in the Master Plan Study. Trip production, generation and attraction by zone were recalculated next by using the models. The OD table by purpose and car ownership were calculated based on the OD table estimated in the Master Plan Study by Fratar method. The modal split model developed in the Master Plan Study was used in order to estimated the OD table by mode and car ownership. The result of the estimation is described in the following sections.

(2) Car Ownership

The number of registered vehicles in the Republic of Guatemala has rapidly increased since 1990 when the Master Plan Study was conducted. A model which estimates the number of registered vehicles, therefore, was reconstructed reflecting the tendency since 1990 as follows:

$$V = 26.38 \times t - 52160$$

where, V; a number of vehicles in the country
t; year

The number of vehicles in the whole country can be estimated at 873,500 in 2010 by using the above mentioned equation. The number of private cars in the Study Area is estimated at 459 thousands based on the present proportional rate (about 75% of the number in a country). The number of households by car ownership should be calculated as shown in Table 5.5. Consequently, the car owning household rate is 55%, while that in 1990 is 30.9%.

Table 5.5 Estimated Number of Vehicles

Index	Area	1990	2010
Population	Study Area	1,800,900	3,000,000
No. of Vehicles	Whole Country	288,400	873,500
	Study Area	196,500	611,500
No. of Private Cars	Study Area	158,000	458,900
No. of Household	Study Area	359,600	625,000
Car Owner		111,000	344,000
No Car Owner		248,600	281,000
Car Owning Rate	Study Area	30.9%	55.0%

(3) Trip Production

The number of trips produced in the Study Area was calculated multiplying the number of persons by the trip production rate. Table 5.6 is the result of the trip production calculation in 2010. The total number of trips by car owners is estimated at 3,965,000 and that by no car owning persons is 2,337,000. The total number of both trips is 6,302,000.

Table 5.6 Estimated Trip Production in 2010

Purpose	Trip Production Rate by Car Ownership		2010		
	Car Own	No Car	Car Own	No Car	Total
to Work	0.627	0.431	919,500	516,400	1,435,900
to School	0.364	0.298	534,400	356,500	890,900
Shopping	0.112	0.092	164,700	109,600	274,300
Business	0.154	0.059	226,300	70,400	296,700
Others	0.184	0.130	269,700	155,800	425,500
to Home	1.262	0.942	1,850,300	1,128,400	2,978,700
Total	2.704	1.951	3,964,900	2,337,100	6,302,000
	Population in 2010 by Car Ownership		Car Own	No Car	Total
			1,466,300	1,197,800	2,664,100

(4) OD Tables

The trip generation and attraction were estimated by inputting the above mentioned population and employment to the generation/attraction model developed in the Master Plan Study. Therefore, the review of the population can be reflected in the trip generation and attraction. The number of trips both generation and attraction are controlled to adjust the total number of trips in the above table.

The OD tables were obtained by applying Fratar method to adjust the generation and attraction of OD tables estimated in the Master Plan Study. The OD tables by purpose were distributed to the OD tables by mode with modal split model developed in the Master Plan study.

(5) Subdivision of Zones

The zoning system of the OD tables should be subdivided in order to examine project roads in detail. Many zones, whose trips were supposed to have influence in traffic on the project roads, were examined and the following four zones were determined to be subdivided. These four zones are too large to analyze traffic on the project roads such as East West Corridor and Exclusive Busway-FEGUA Route. Therefore, these zones are divided into two or three zones. The subdivision rate was determined considering the proportion of habitable area.

In the table, Pt means the present person trips and Ft means the future person trips. For example, Traffic Zone 38 is divided into three subdivisions. A divided Zone 38-1 is urbanized area and the others are newly developed area. The volume of present person trips is assumed to generate and attract from/to urbanized area and increased volume in the future is assumed to generate and attract from/to newly developed area. The proportions of between the two divided subdivisions to be newly developed were calculated by habitable area, such as 0.49 and 0.51, as shown in the below table.

Table 5.7 Subdivision of Target Zones

Area	Traffic Zone	Divided Zone	Method to assign the person trips	Land use
Naranjo	38	38-1	Pt	Urbanized
		38-2	(Ft-Pt)*0.49	To be developed
		38-3	(Ft-Pt)*0.51	To be developed
Mixco	39	39-1	Pt	Urbanized
		39-2	Ft-Pt	To be developed
Villa Nueva	47	47-1	Pt	Urbanized
		47-2	(Ft-Pt)*0.54	To be developed
		47-3	(Ft-Pt)*0.46	To be developed
Petapa	49	49-1	Ft*0.64	To be developed
		49-2	Ft*0.36	To be developed

5.3.3 Traffic Assignment

(1) Assignment Method

The traffic assignment simulation is repeatedly executed to assign the divided OD trips on the shortest time route several times. The shortest time route is searched for on the road network from origin node to all destination nodes. The divided OD trips which generate from i zone will be assigned on the shortest route previously discovered. Every time the divided OD trips of all OD pairs are assigned on the shortest route, the travel speed on each road section will be recalculated by using the QV curve which the road section has. Therefore, the traffic demand on each road can be obtained according to the above mentioned manner as a consequent.

The traffic assignment simulation will be separately done for bus traffic and car. Therefore, two types of networks should be prepared. First, travel time and travel distance are calculated on the each networks. A bus OD table and a car OD table are estimated by inputting the travel distance and travel time to the modal split model. Second, the bus OD table is assigned on the bus network. The car OD table is assigned on the car network on which the bus OD table has been assigned in order to obtain the traffic volume assigned.

The traffic volume of public transportation estimated by the above mentioned manner is potential demand. Therefore, the traffic demand based on a bus route system plan should be considered in case of evaluation for a public transportation system such as bus exclusive lanes and a bus transfer center. Accordingly, the following manner was applied. A bus route system was considered according to the public transportation demand calculated by the assignment model. The bus route system should have a route and capacity of vehicle. Passengers of public transport can select the shortest time route from origin zone to destination zone within two times transfer. The frequency of bus operation on each route can be derived from the highest number of passengers. The process of traffic assignment is illustrated in the following figure.

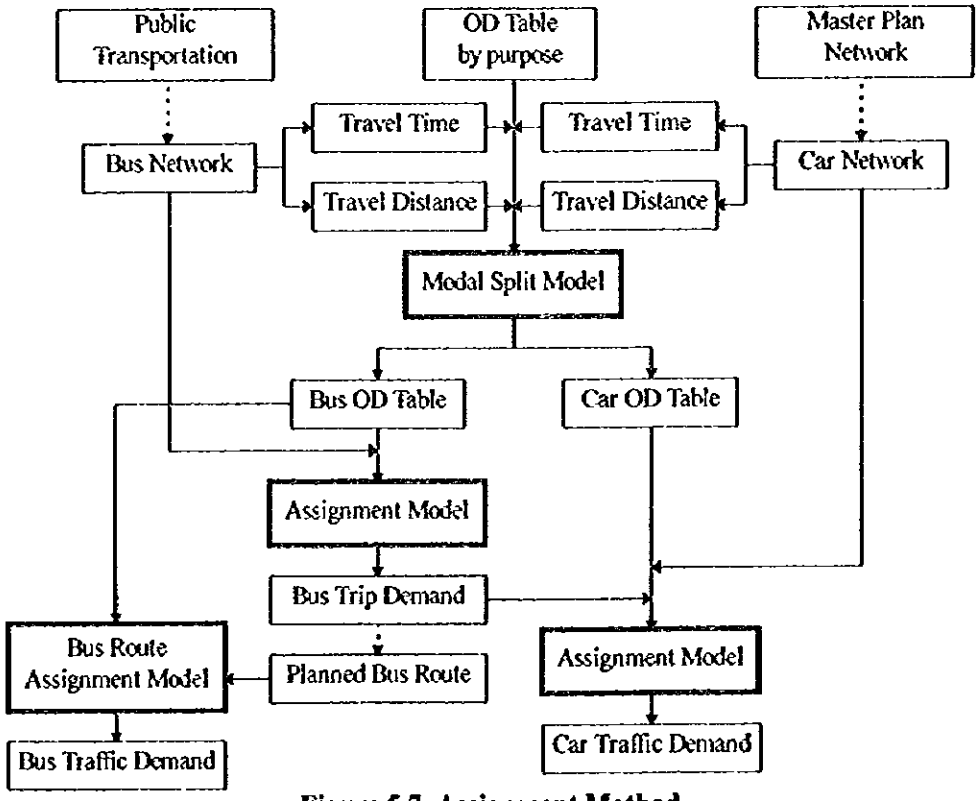


Figure 5.7 Assignment Method

(2) Assigned Traffic Demand

The traffic assignment should be done for each project concerning to the road network in order to evaluate alternatives from the traffic aspect. The result of the calculation is described in each section. Cases of assignment discussed in this section are the project case and the without project case. The project case includes all project and the without project case does not include any project. A network for the without project case consists of a present network and prearranged projects as mentioned in the former section.

The summary of indices is described in the following table. PCU kilometer of buses in the project case will be 7% higher than that in the without project case. As a consequence, total PCU kilometer of the project case will increase. On the other hand, PCU hour will be reduced by 10% for buses and 4% for cars. The time saving benefit derives from this improvement. The realization of the projects will decrease vehicle capacity ratio by 0.02 in the whole Study Area so that the load of network would be expected to be reduced. Moreover, the average speed of buses is to be improved by 14%.

Table 5.8 Summary of Indices by Case

Item	With Project		Without project	
	Bus	Car	Bus	Car
PCU*km	2,468,100	11,541,200	2,306,600	11,641,400
PCU*hour	143,400	328,100	159,000	340,700
V/C ratio	0.31	0.41	0.33	0.43
Average speed	16.8	34.2	14.8	33.0

The estimated traffic flow is illustrated in Figure 5.7 and 5.8.

In the southern part of the Study Area, CA1 will be congested in the without project case. Much traffic will be assigned on both CA1 and San Juan Sacatepequez which connect Mixco City to the center of Guatemala City. In the project case, this traffic flow will be dispersed into East West Corridor and San Juan Sacatepequez. The traffic which is concentrated to the eastern part of Periferico will also be reduced. Traffic from Mixco City can directly access to Zone 4. Most of the traffic assigned in the without project case will pass Petapa Road and Exclusive Busway-FEGUA Route. As a consequence, the load of CA9 will be reduced in the project case.

Figure 5.8 Traffic Volume Assigned of Without Project Case

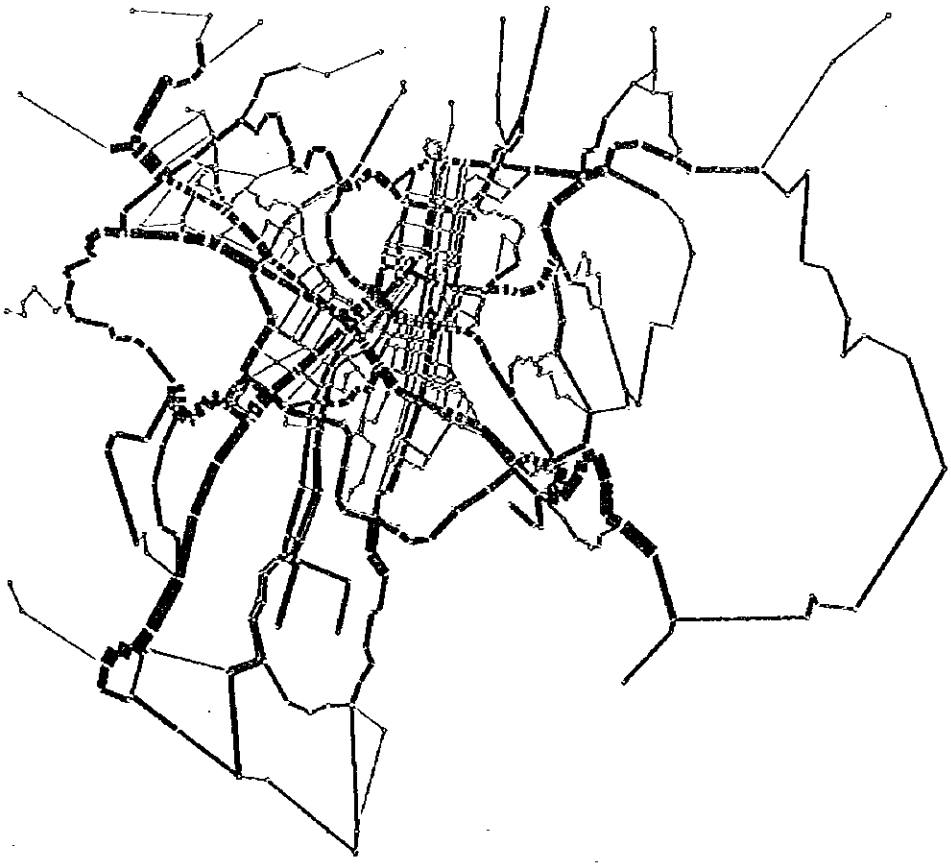


Figure 5.9 Traffic Volume Assigned of Project Case