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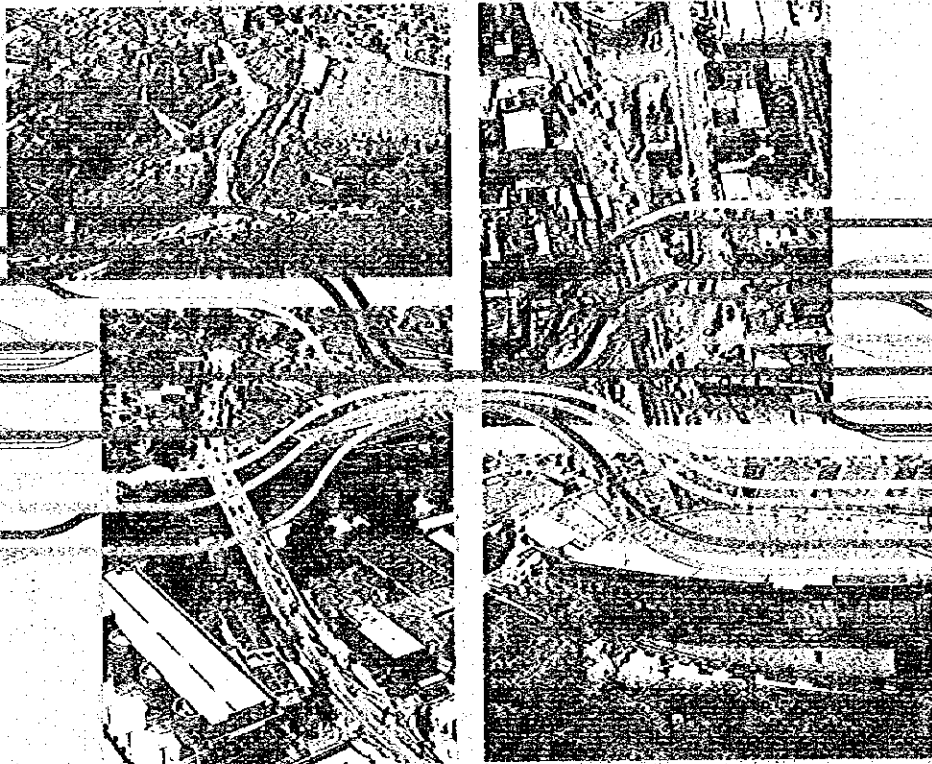
Japan International Cooperation Agency (JICA)

No. 22

Tegucigalpa Municipality of The Central District  
The Republic of Honduras

**THE TEGUCIGALPA  
URBAN TRANSPORT STUDY**

**FINAL REPORT  
MAIN TEXT  
VOLUME 2**



NOVEMBER 1996

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The following foreign exchange rate is applied in the study:

US\$ 1.00 = 11.70 Lempira (as of July 1996)

## PREFACE

In response to a request from the Government of the Republic of Honduras, the Government of Japan decided to conduct The Tegucigalpa Urban Transport Study and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Honduras a study team headed by Mr. Kazuro Yanagida, Oriental Consultants Co., Ltd., and composed of members from Oriental Consultants Co., Ltd. and Central Consultant Incorporated 3 times between June 1995 to September 1996.

The team held discussions with the officials concerned of the Government of Honduras, and conducted field surveys at 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 Honduras for their close cooperation extended to the team.

November, 1996



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Kimio Fujita  
President

Japan International Cooperation Agency

## LETTER OF TRANSMITTAL

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

We are pleased to submit to you the study report on the Tegucigalpa Urban Transport Study.

This study was conducted by Oriental Consultants Co., Ltd., in association with Central Consultant Co., Ltd., under a contract to JICA, during the period of May 1995 to November 1996. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Honduras and formulated the transportation master plan in Tegucigalpa.

We wish to take this opportunity to express our sincere gratitude to the officials concerned of JICA, Metroplan. We would also like to express our gratitude to the officials concerned of the Tegucigalpa Urban Transport Study, the JICA Honduran Office and the Embassy of Japan in Honduras for their cooperation and assistance throughout our field survey.

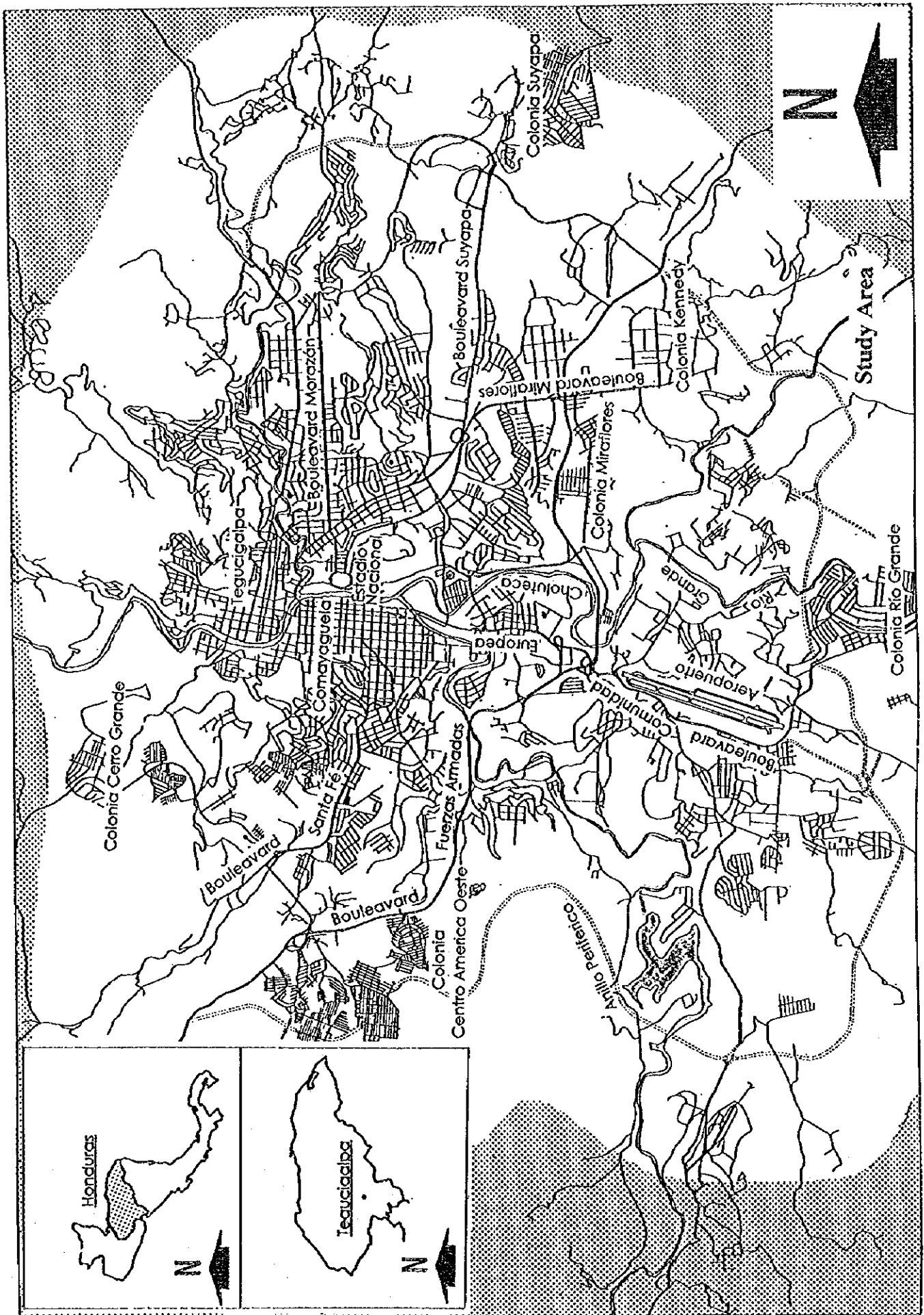
Finally, we hope that this report will contribute to further promotion of the project.

Very truly yours,  
November 1996



Kazuro YANAGIDA  
Project Manager,  
Study Team on the Tegucigalpa Urban  
Transport Study





## PROJECT SUMMARY

<b>1. COUNTRY</b>	The Republic of Honduras.
<b>2. NAME OF STUDY</b>	The Tegucigalpa Urban Transport Study.
<b>3. COUNTERPART AGENCY</b>	Tegucigalpa Municipality
<b>4. OBJECTIVE OF STUDY</b>	Formulate a Transportation Master Plan up to the year 2010

### 1. STUDY AREA : The Tegucigalpa Metropolitan Region (12,000ha)

#### 2. THE MASTER PLAN SUMMARY

##### ① Selection of Urgent Projects

5 urgent projects was selected installation of traffic signal and improvement of intersection, since "Term is very short", Cost is low" and "Effect is large".

##### ② Formulation of Transportation Master Plan

Master plan was formulated based on following concepts:

- Formulation of the city as a capital city
- Proper reallocation of commercial and business facilities
- Creation of a comfortable life environment for cities
- Formulation of a center of history, culture and education

Formulated transportation master plan is mainly road transportation and was composed of new road construction and improvement of existing road and public transportation system.

#### 3. IMPLEMENTATION PROGRAM

24 master plan projects to be implemented are selected based on transportation master plan. The implement period of these projects were categorized into three groups, short term, mid term and long term, based on urgency, construction cost, easiness of fund procurement and benefit.

Short Term (1997-2000) : Strength of north-south transportation axis and east-west transportation axis. (4 Projects, US\$13,141,000)

Mid Team (2001-2005) : Introduction of bus exclusive way, bus exclusive lanes and bus terminals and improvement of related road projects. (12 Projects, US\$21,698,000)

Long Team (2006-2010) : Strength of radial roads connecting Anillo Periferico. (8 Projects, US\$39,639,000)

#### 4. ECONOMIC EVALUATION

Below table shows the results of economic evaluation for proposed master plan projects. All the projects are evaluated to be feasible judging.

PROJECT	EIRR(%)	NPV(1000Lps)	B/C	PROJECT	EIRR(%)	NPV(1000Lps)	B/C
Project 6-1	16.24	1,160,000	1.33	Project 11-2	22.71	4,330,000	1.98
Project 6-2	13.64	811,000	1.12	Project 12	27.70	5,670,000	2.61
Project 7	46.95	10,900,000	5.42	Project 13	46.05	10,900,000	5.67
Project 8	36.38	8,160,000	4.03	Project 14	31.20	5,610,000	3.04
Project 9	46.25	15,000,000	6.18	Project 15	24.91	8,050,000	2.21
Project 10	19.72	4,430,000	1.66	Project 16	16.80	1,710,000	1.37
Project 11-1	26.35	4,420,000	2.43				

#### 5. RECOMMENDATION

- (1) To realize of master plan.
- (2) To continue of Road Maintenance Work.
- (3) To make use of review data obtains during at study.
- (4) To conduct the further study.

## **OUTLINE OF THE STUDY**

The Republic of Honduras, The Tegucigalpa Urban Transport Study

- Study Period : May, 1995 - November, 1996

- Counterpart Agency : Tegucigalpa Municipality

### **1. Background**

Although the roads in the central area of the city are very narrow and interlaced due to the city structure dating from the colonial era, many vehicles gather and / or pass through it, and the ring and radial road networks in this study area do not sufficiently meet traffic demand. In addition, the public transport systems such as buses and taxis are also somewhat insufficient. As a result, traffic congestion occurs everywhere in the city, creating traffic problems. The sound development of regional economy is also hampered.

The Government of the Republic of Honduras (GRH) needs realistic plans to improve transportation problems. In support of this, GRH has requested the government of Japan for technical assistance in formulation of a master plan, investment program for the transportation network.

### **2. Objective**

The objective of the Study is mainly to formulate a Master Plan up to the year 2010 for the transportation network.

### **3. Study Area**

The study area with the area of approximately 12,000 ha is the Tegucigalpa Metropolitan region.

### **4. Traffic Survey**

The following traffic survey was conducted in order to obtain many basic data.

- Main Survey (Person Trip Survey, Cordon Line Survey, Screen Line Survey, Traffic Speed Survey)
- Supplementary Survey ( Traffic Count Survey, Public Transport Survey, Parking Survey, etc.)

### **5. Urgent Projects**

The urgent projects were selected from the measures related to the installment of traffic signals and the improvement of the configuration at congested intersections, since "Term" is very short, "Cost" is low and "Effect" is large. The places requiring an urgent project were selected 5 places as shown in Table 1 based on the intersection traffic analysis.

### **6. Outline of the Master Plan**

#### **6.1 Basic Concept**

The Master Plan for the study area was formulated the following concepts;

- (1) Formulation of the city as a capital city
- (2) Proper reallocation of commercial and business facilities
- (3) Creation of a comfortable life environment for citizens
- (4) Formulation of a center of history, culture and education

#### **6.2 Socioeconomic Framework, Land Use Plan and Future Urban Structure**

##### **1) Socioeconomic Framework**

The future socioeconomic framework of the study area was projected under the control total of the future population projection of the entire Honduras projected by SECPLAN. As a result, the

number of the future population in the study area was forecast to increase by about 1.3 times from 674,920 persons in 1995 to 872,083 persons in 2010.

## **2) Future Land Use and Future Urban Structure**

Future land use was determined by the future allocation of population and workers, considering the direction of urban development and the extension of the housing area in the inhabitable land, and the urban structure. On the other hand, the future urban structure was determined based on "Linear and Multiple Nuclei Pattern" together with the future land use, the location of urban facilities and the distribution of future population and workers, the future trunk transportation network.

## **6.3 Formulation of Master Plan**

### **1) Formulation of Master Plan**

The future socioeconomic framework and urban structure was determined in line with the basic concept for the master plan, and the traffic demand was estimated based on above results. The master plan was formulated based on traffic demand.

### **2) Selection of the Master Plan Projects**

Various projects were planned based on transport policy and future traffic demand. These planned projects were divided into the following three categories from the critical impacts on the traffic situation;

- (1) To introduce regulations prohibiting vehicle inflow into "Centro" (Regulation)**
- (2) To construct a toll road connecting "Centro" with Anillo Periferico using the river basin of the Cholteca River (Toll Road)**
- (3) To implement other projects, in consideration of the realization of the liner multi-nuclei urban structural pattern (Other Projects)**

The four alternatives were selected based on the combination of above three categories. From the results of examination on aspects of possibility and economy, 24 desirable master plan projects were adopted. Master plan projects were categorized into three groups below based on considering their urgency, construction cost, easiness of fund procurement, benefit, etc. as shown in Table-1.

- (1) Short Term : Project packages to strengthen the north-south transportation axis and the east-west transportation axis**
- (2) Mid Term : Project packages which introduce bus exclusive ways, bus exclusive lanes, bus terminals and improvement of related road project.**
- (3) Long Term : Projects to strengthen the radial roads connecting Anillo Periferico**

## **6.4 Public Transportation Plan**

The restructure plan of bus route system including hierarchic structure of bus (Key Route, Ordinary Route, Inter-Urban Route) and the detailed bus route network plan including the suitable fare system is proposed to examine to decrease traffic congestion by related organizations.

## **6.5 Traffic Management Plan**

Based on the existing traffic conditions and anticipated problems in the future, the traffic management plan was examined as follows;

- (1) While general information signs are not lacking, many more regulatory and directional signs are recommended to be installed not only on major roads but also smaller roads with high traffic.**
- (2) In "Centro", it is necessary not only to strengthen regulations against illegal parking but also**

Table 1 Estimated Project Costs and Implementation Program

Term	Category	Pft. No.	Project Description	Project Total Cost (Leq)(m) (US\$1,000)	1997	1998	1999	2000	2001	2002	2003	2004	2005	2005	2007	2008	2009	2010				
Urgent	Improvement of Intersection	1	Configuration Improvement and Traffic Signal Installation at Intersection of Subida al Estadio Nacional and the Circular Road of the National Stadium.	28	78																	
		2	Configuration Improvement at Intersection of Av. Cobana and Blvd. Santa Fe.	10	10																	
		3	Configuration Improvement at Intersection in Front of Institute Hondureño de Seguridad Social on Blvd. Comunidad Europea	318	33																	
		4	Traffic Signal Installation at Intersection of Blvd. Jose Cecilio del Valle and Calle Colón	44	44																	
		5	Approach Road Construction in Grade Separation of Blvd. Miraflores and Blvd. Fuerza Armada	165	116	50																
Short-term	Improvement & Construction of Roads	7	Road Improvement of Estadio Nacional - Blvd Morazan up to the Intersection of Juan Manuel Galvez	600	2,662	2,662																
		8	Road Improvement of Calle Nickson - Calle 12 of the Central Area of Conasaguala - a new Bridge in the South of Puente de Juan Ramón Making up to Blvd. Jose Cecilio del Valle.	2,520	650	1,624	974															
		9	Road Improvement of Calle Iala - Jose Cecilio del Valle	2,100	3,500		1,050	1,400	1,050													
		(8)	Bridge to calle 12		incl. 8																	
Mid-term	Improvement of Roads	11-1	Bridge to Av. 6	1,000	3,731																	
		6-2	Inner Ring Road Construction Surrounding the Central Area of Tegucigalpa (South Section)	1,300	9,520							4,760	2,650	1,904								
		11-2	Road Improvement of the Southern Section of Av. 6 - New Bridge - San Jose - Lomas de Toncomán	4,740	5,346							1,604	2,138	1,604								
		12	Road Improvement of Av. 8 in the Center of Conasaguala	1,860	4,245								1,274	1,836	1,274							
		21	Santa Fe		198																	
		22	21 de Octubre		198																	
		23	Miraflores		198																	
		24	Arroyo		198																	
		25	Las Brujas		436																	
		26	Paraiso		1,220																	
Long-term	Improvement & Construction of Roads	18	Introduction of Bus Exclusive Lanes																			
		19	Introduction of Bus Exclusive Ways																			
		20	Introduction of Transit Mall	530	139																	
		6-1	Inner Ring Road (North Section)	2,200	4,226																	
		10	Road Improvement of Blvd. Juan Manuel Galvez	1,790	8,146																	
		13	Road Improvement of Anillo Periférico - Colonia La Puente - Blvd. Fuerza Armada	1,860	2,669																	
		14	Road Construction and Improvement of Colonia San José de la Vega - La Cañada - Anillo Periférico	2,360	3,150																	
		15	Road Construction of Colonia Kennedy - Residencial Plaza - Anillo Periférico	2,300	7,635																	
		16	Improvement of Anillo Periférico - Colonia Loma de Jalapa - Carretera a Oriente	3,115	5,243																	
		27	Construction of Parking Building outside the CRD Area near Puente la Hoya		790																	
		28	Construction of Truck Terminal in Laguna el Pedregal		7,780																	
					Annual cost	3,773	3,904	3,407	2,169	4,760	4,660	5,316	3,902	3,274	1,694	1,694	6,812	4,164	4,964	7,442		

to provide public parking lots with sufficient capacity.

### 7. Cost Estimation and Implementation Program

The project cost is estimated based on the results of preliminary design, the consideration of construction method, operation and maintenance. On the other hand, implementation program of selected project is prepared based on each objective of the term and engineering matters. As a result, estimated cost and implementation program are summarized as shown in Table 1.

### 8. Economic Evaluation

All the projects are evaluated to be feasible judging from the calculation of evaluation indicators as shown in Table 2. Project 6-2 cannot be judged to be feasible against the increase of the cost by sensitivity analysis.

**Table 2 Result of Evaluation**

PROJECT	EIRR(%)	NPV(1000Lps)	B/C	PROJECT	EIRR(%)	NPV(1000Lps)	B/C
Project 6-1	16.24	1,160,000	1.33	Project 11-2	22.71	4,330,000	1.98
Project 6-2	13.64	811,000	1.12	Project 12	27.70	5,670,000	2.61
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Project 10	19.72	4,430,000	1.66	Project 16	16.80	1,710,000	1.37
Project 11-1	26.35	4,420,000	2.43				

### 9. Fund Source

Following new funds should be sought for the execution of the Master Plan.

- City Planning Tax
- Development Tax
- Automobile Fuel Surcharge Tax
- Automobile Tonnage Tax

### 10. Initial Environmental Examination

The environmental impacts are predicted as follows;

- (1) Relief from traffic congestion ( Positive Impact)
- (2) Relocation of inhabitants, public facilities and cultural inheritances (Negative Impact)
- (3) Fauna and Flora (Negative Impact)
- (4) Air pollution and noise (Negative Impact)

### 11. Recommendation

The following points are concluded and recommended;

- (1) Realization of master plan
  - Implementation of urgent projects
  - To construct two new bridges during the short term
  - To continually implement the projects recommended in the master plan
  - To reform the organization
  - To make haste to complete the outer ring road
  - To restructure the bus route network system
  - To secure the financial sources for the projects
- (2) To continue road maintenance work
- (3) To make use of various data obtained during the study
- (4) To conduct further study

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## LIST OF ABBREVIATIONS

GOJ	: The Government of Japan
JICA	: Japan International Cooperation Agency
GRH	: The Government of the Republic of Honduras
METROPLAN	: The Urban Planning Bureau of Tegucigalpa Municipality of the Central District
SECPLAN	: Planning, Coordination, and Budget Ministry
SECOPT	: Communications, Public Works, and Transportation Ministry
HONDUTEL	: Honduran Telephone Company
SEDA	: Environment Ministry
AADT	: Average Annual Daily Traffic
ADT	: Average Daily Traffic
GDP	: Gross Domestic Product
GRDP	: Gross Regional Domestic Product
OD	: Origin and Destination



**CHAPTER 1**  
**INTRODUCTION**



## **CHAPTER 1 INTRODUCTION**

### **1.1 Background**

Tegucigalpa with a population of approximately 670,000 inhabitants is the capital city of the Republic of Honduras, located in mountainous terrain 900m above sea level. The city is the administrative, political, academic and economic center of the country, and is expanding every year. This city is expected to continue along these lines in the future.

The structure of the city is similar in style to cities of southern Europe. The roads in the city are generally very narrow and interlaced. Also, the majority of the arterial roads, go through the center of the city, and the ring and radial road networks in the metropolitan area do not sufficiently meet present traffic demand. In addition, public transport systems such as buses and taxis are also somewhat insufficient.

As a result, traffic congestion occurs everywhere in the city, creating traffic problems. The sound development of regional economy is also hampered.

The Government of the Republic of Honduras (hereinafter referred to as "GRH") studied many improvement plans for transport in the past. Some plans were implemented, but the majority were not accomplished due to lack of budget. Therefore, the GRH needs realistic plans to improve the transportation problems.

In support of this, GRH has requested the government of Japan for technical assistance in formulation of a master plan, investment plan and implementation program for the transportation network.

### **1.2 Objectives**

The objectives of the Study are:

- (1) Collection of the data on the existing transport sector and road conditions by conducting field surveys.
- (2) Review and evaluation of the on-going and/or proposed projects and programs, and, if necessary, preparation of a recommendation of a program to be implemented.
- (3) Formulation of a master plan up to the year 2010 for the transportation network.
- (4) Technology transfer to the Honduran counterparts during the study.

### **1.3 Study Area**

The study area will cover the Tegucigalpa metropolitan region.

### **1.4 Study Procedure**

The study is comprised of three stages: (1) First Stage; the review, analysis and evaluation of the existing transportation conditions is conducted; (2) Second Stage; a transportation master plan is formulated and; (3) Third Stage; an investment plan is prepared. The detailed activities for each stage are as follows:

## 1) First Stage : Review, analysis, and evaluation of the existing transportation conditions

- (1) Collection and analysis of the relevant data and information
- (2) Review and analysis of the existing transportation study data
- (3) Review of the existing master plans and preparation of a future development plan to be considered
- (4) Person/trip survey
- (5) Supplemental surveys
  - Traffic count surveys on selected points of arterial road and intersections
  - Survey on the public transport systems and their passengers
  - Supply and the demand survey on parking spaces
  - Road inventory and condition survey, and survey on running speed
  - Traffic signs and marking
- (6) Evaluation of the existing transportation and traffic conditions, and analysis of the traffic capacity
- (7) Review and evaluation of the short-term road transport projects and plans
- (8) Present environmental examination

## 2) Second Stage : Formulation of a Transport Master Plan

- (1) Formulation of development scenarios and evaluation
- (2) Development of methodologies and transportation demand forecasting
- (3) Review of strategies for transport development
- (4) Formulation of an urban transport master plan and recommendation
- (5) Selection of priority projects and recommendation
- (6) Review of the existing implementing agencies for the urban transport master plan, and recommendation

## 3) Third Stage : Formulation of an investment plan

- (1) Preparation of a project list and its evaluation (including a preliminary plan and cost estimates)
- (2) Economic evaluation and prioritization
- (3) Formulation of an investment plan
- (4) Initial environmental examination
- (5) Management and operation plan for maintenance
- (6) Recommendation

A general flow chart of the Study is shown in Fig.1.4.1. The first stage of the study commenced in June 1995 and was completed in September 1995. The second stage of the study commenced in October 1995 and was completed March 1996. The third stage of the study commenced in May 1996 and was completed October 1996, including the preparation of the final report of the study.

## 1.5 Study Organization

The Study is carried out by the JICA Study Team, which is comprised of members of Oriental Consultants Co., Ltd. (OC) and Central Consultant Inc. (CCI), which is organized by JICA, and the

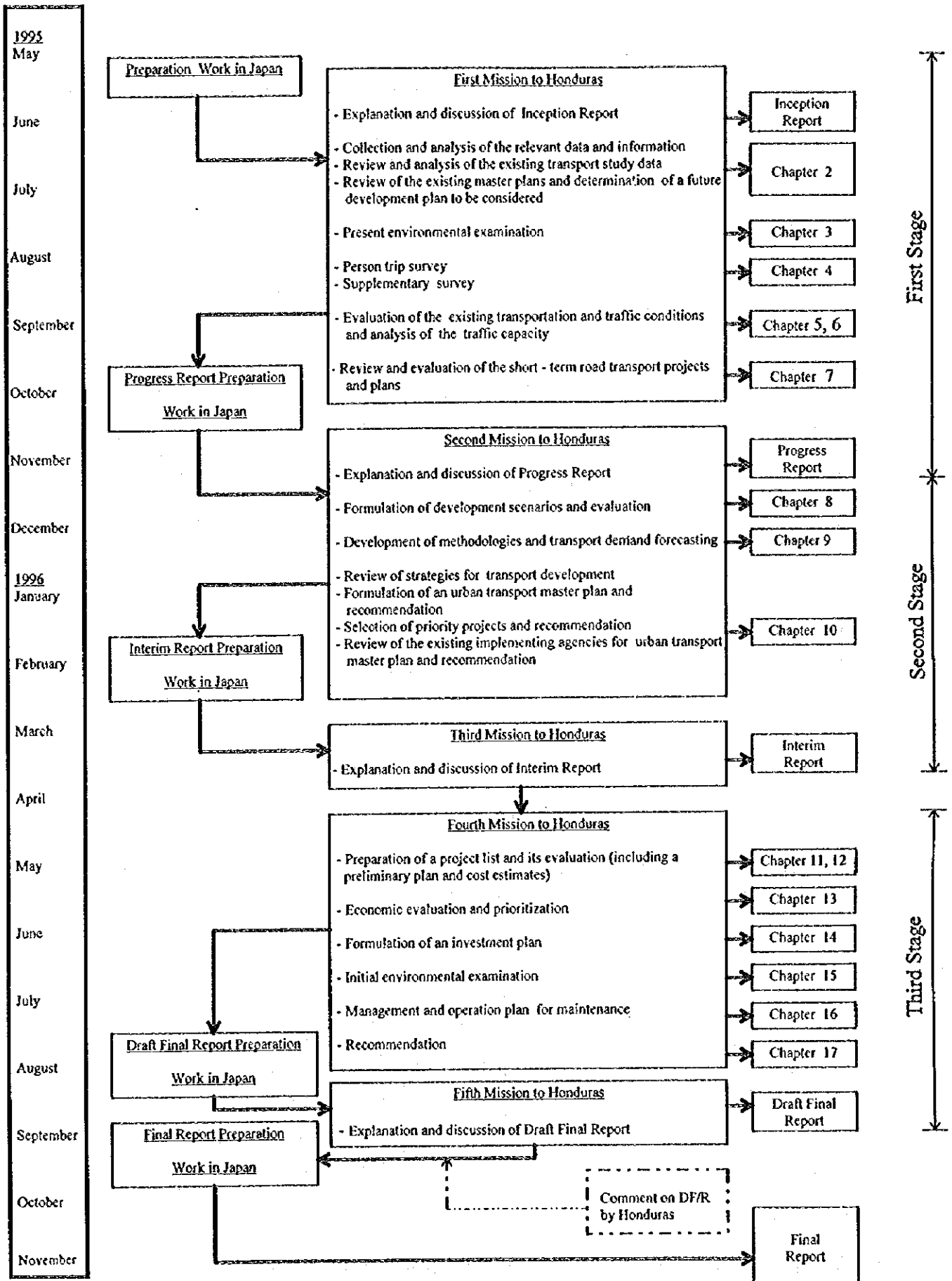


Fig. 1.4.1 Study Flow

Honduran counterpart team organized by their government. The JICA Study Team is Headed by Mr. Kazuro YANAGIDA of OC. For the duration of the Study the following committees are set up.

- JICA Advisory Committee
- Honduras Steering Committee

The Study organization is shown in Fig. 1.5.1.

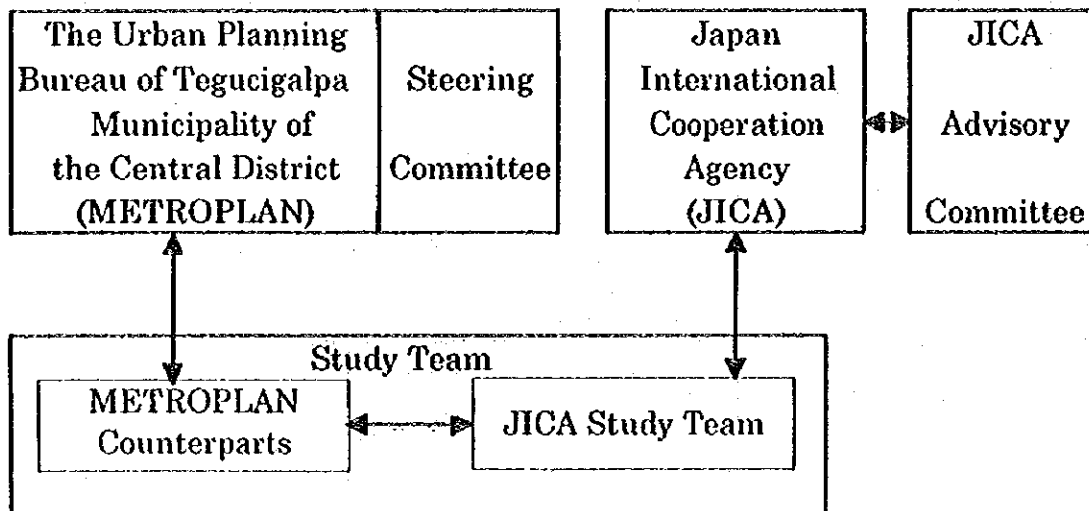


Fig. 1.5.1 Study Organization

The members of the Honduras counterpart team, steering committee, JICA Study Team, JICA steering committee, and JICA staff are as shown below.

(1) Members of Counterpart Team (METROPLAN)

- |                             |                            |
|-----------------------------|----------------------------|
| Mr. Norman Zuniga Rorjas    | Chief of Counterpart Team  |
| Mr. Lisandro Calderon       | Member of Counterpart Team |
| Mr. Henry Banegas           | Member of Counterpart Team |
| Ms. Delfina Maria Solorzano | Member of Counterpart Team |
| Mr. Felipe Mejia Cruz       | Member of Counterpart Team |
| Ms. Katya Maria Aguilera    | Member of Counterpart Team |
| Mr. Ovidio Andrade          | Member of Counterpart Team |
| Mr. Carlo Ballea            | Member of Counterpart Team |

(2) Members of Steering Committee

- |                            |  |
|----------------------------|--|
| Mr. Oscar R. Acosta Zepeda | Alcalde Municipal del Distrito Central |
|----------------------------|--|

Mr. Alejandro Ulloa de Thuin  
Mr. Roberto Abadie Abarca  
Mr. Virgilio Ordenez  
Mr. Obdulo Garrido  
Mr. Hector Suazo  
Mr. Miguel Angel Valladares  
Mr. Jesus Valle  
Mr. Issac Vilorio B.  
Mr. Roy Alonzo  
Ms. Zolia Estela Dominguez  
Mr. Mauro Mejia  
Mr. Norman Zuniga Borjas

Asesor del Alcalde  
Comandante General de Bomberos  
HONDUTEL  
Gerente de Infraestructura / A.M.D.C.  
Direccion Nacional de Transito  
Direccion General de Transporte, SECOPT  
SECOPT  
Departamento de Señalización Vial,SECOPT  
SECPLAN  
SEDA  
Ministerio de Educacion Publica  
Gerente de METROPLAN / A.M.D.C.

**(3) Member of the JICA Study Team**

Mr. Kazuro Yanagida  
Mr. Takao Yamane  
Mr. Takao Inami  
Mr. Malcolm MacNair  
Dr. Shouichi Haryu  
Mr. Akio Tatsuno  
Mr. Keiichi Ichikawa  
Mr. Shigeru Okutsu  
Mr. Nobuhiro Kuboya  
Mr. Hiroyuki Kotani  
Mr. Hitoshi Okita

Project Manager  
Deputy Project Manager/Traffic Planner  
Highway Engineer  
Regional Planner  
Environment Specialist  
Public Transportation Planner  
Traffic Operation Planner  
Traffic Surveyor  
Structure Engineer  
Economic Analyst  
Project Coordinator

**(4) Member of the JICA Advisory Committee**

Dr. Mitsuyuki Asano  
Mr. Jun Nakamura  
Mr. Akihiko Nagano

Head of Committee/Urban Planner  
Road Planner  
Public Transport Planner

**CHAPTER 2**  
**PRESENT CONDITIONS**



## CHAPTER 2 PRESENT CONDITIONS

### 2.1 Socioeconomic Conditions

#### 2.1.1 Natural Conditions

##### 1) Topography and Geology

The Tegucigalpa metropolitan area is located in the Southern region of Honduras in mountainous terrain, about 900 m above sea level. It is surrounded by mountains that are 1000 m above sea level. Landslides occur around the urban area in the rainy season.

The geology of the central and eastern areas in Tegucigalpa metropolitan consist of sedimentary rock. There is also an area of volcanic rock.

##### 2) Climate

This area is divided into two seasons: the rainy and dry seasons. Basically, the rainy season is between May and October and the dry season is between November and April.

The record monthly rainfall was recorded at 354.4 mm in June, 1952. The yearly rainfall in 1988 was 1264.4 mm.

Table 2.1.1 shows the maximums and averages of rainfall and temperature over the past 50 years in Tegucigalpa.

**Table 2.1.1 Rainfall and Temperature in Tegucigalpa**

	JAN	FEB	MAR	APR	MAY	JUN
Average Monthly Rainfall (mm)	6.7	3.8	8.8	38.5	150.2	163.3
Maximum Daily Rainfall (mm/24hours)	35.6	27.3	54.4	93.0	109.0	83.3
Average Temperature (°C)	19.4	20.4	22.1	23.4	23.5	22.7

	JUL	AUG	SEP	OCT	NOV	DEC	Total
Average Monthly Rainfall (mm)	81.4	86.9	180.3	110.6	33.6	9.6	873.5
Maximum Daily Rainfall (mm/24hours)	59.2	61.7	82.0	79.2	85.4	31.8	
Average Temperature (°C)	22.1	22.3	22.2	21.5	20.4	19.5	

Source: Department of Meteorology

## 2.1.2 Population

Population censuses were carried out in Honduras in 1950, 1961, 1974, and 1988. The population in 1988 was 4,443,721, an increase at an annual growth rate of 4.3% from 1974. The population in 1995 was estimated 5,608,275 by the Secretaria de Planificación, Coordinación y Presupuesto. the growth rate per annum from 1988 to 1995 was 3.4%. These figures are shown in Table 2.1.2.

**Table 2.1.2 Population of Honduras**

Year	Population	Growth Rate(%)	Comment
1950	1,386,605		
1961	1,884,765	3.0	1950-1961
1974	2,656,948	2.7	1961-1974
1988	4,443,721	4.3	1974-1988
1995	5,608,275	3.4	1988-1995

Table 2.1.3 shows the population by department in 1988. The department of Francisco Morazán, where the capital city is located, has the largest population, 828,274, which accounts for 18.6% of the entire nation.

**Table 2.1.3 Population by Department**

Department	Population	Share(%)
Atlantida	238,741	5.4
Colon	149,677	3.4
Comayagua	239,859	5.4
Copan	219,455	4.9
Cortes	662,772	14.9
Choluteca	295,484	6.6
El Paraiso	254,295	5.7
Francisco Morazan	828,274	18.6
Gracias a Dios	34,970	0.8
Intibuca	124,681	2.8
Islas de la Bahia	22,062	0.5
La Paz	105,927	2.4
Lempira	177,055	4.0
Ocotepeque	74,276	1.7
Olancho	283,852	6.4
Santa Barbara	278,868	6.3
Valle	119,965	2.7
Yoro	333,508	7.5
Total	4,443,721	100.0

The population of the study area is shown in Table 2.1.4 according to 1950, 1961, 1974, and 1988 census data. However, population in 1995 is estimated by the Study Team. The population in 1988 was 624,542, however, in 1995 the population is estimated to have reached 892,530.

**Table 2.1.4 Population in the Study Area**

Year	Population	Growth Rate(%)	Comment
1950	99,948		
1961	167,254	4.8	1950-1961
1974	305,387	4.1	1961-1974
1988	624,542	5.2	1974-1988
1995	892,530	5.2	1988-1995

### 2.1.3 Economy

#### (1) GDP

The economy in Honduras was in poor condition until the end of 1980s because of a huge budget deficit and the deterioration of foreign balance. Since the economic reforms were introduced under the IMF and World Bank in 1987, the Honduran economy has been gradually improving. In 1994 the GDP is estimated to reach 27,359 million Lempiras as shown in Table 2.1.5. However, reflecting the recent slump of the world economy, the economic growth of Honduras has also been stagnating over the past three years as shown in the last low (GDP is represented at constant price) of the same table, that is, the GDP in 1993 exceeded slightly the GDP in 1992, but in 1994 the GDP fell below the GDP in 1993. Among sectors of GDP, the agricultural products occupies about 30% of the total GDP, which indicates that the Honduran economy still depends highly on agriculture.

**Table 2.1.5 Past Trend of GDP**

(Unit : million lempiras in 1978 price)

Sectors	1992	1993*	1994**
Agriculture, Forestry, Fishery	3,286	3,993	6,693
Mining, Quarrying	308	369	464
Manufacturing	2,875	3,456	4,161
Construction	1,061	1,457	1,498
Electricity, Gas, Water	530	589	673
Transportation, Warehouse, Communication	1,048	1,102	1,271
Commerce, Restaurant, Hotel	1,762	2,056	2,420
Financial business, Insurance, Real estate	1,328	1,654	2,068
Housing	1,042	1,162	1,342
Public administration, Defense	1,187	1,446	1,565
Community services	1,704	2,033	2,395
GDP(Factor price)	16,134	19,317	23,450
Indirect tax	2,669	3,127	3,909
GDP(Market price)	18,803	22,444	27,359
GDP(in 1978 price)	5,634	5,980	5,898

Source: Informe Preliminar de la Economía  
 Hondureña durante 1994  
 (Departamento de Estudios Económicos, 1995)  
 \* : Preliminary  
 \*\* : Estimation

(2) Per Capita GNP

The per capita GNP of Honduras was 580 dollars in 1994. According to the classification of economies by income by the Development Assistance Committee (DAC), this per capita income level is classified in the low income economies ( the per capita income is less than 675 dollars). Among the Central-American countries Honduras is placed on the second from the last as indicated in Table 2.1.6. Considering that Nicaragua was a war-torn country until recently, the level of Honduras is thought to be quite low.

**Table 2.1.6 Per Capita GNP among  
 the Central-American Countries**  
 (Unit: Dollars)

Country	Per Capita GNP
Guatemala	980
Nicaragua	340
Honduras	580
El Salvador	1,170
Costa Rica	1,960

Source : World Development Report  
 (World Bank, 1994)

(3) Export and Import

As shown in Table 2.1.7, the Honduran export of goods and services has increased in the past three years, on the other hand, the import has fluctuated in the same period. The import has always exceeded the export, however, and the amount of deficit has been decreasing during the past three years.

**Table 2.1.7 Export and Import**  
 (Unit: Million Dollars)

Year	1992	1993	1994
Export	1,102.7	1,141.2	1,179.2
Import	1,576.8	1,666.5	1,554.6

Source: Informe Preliminar de la Economía  
 Hondureña durante 1994  
 (Departamento de Estudios Económicos, 1995)

Table 2.1.8 shows the major trade countries with Honduras in 1986 and 1991. The weight of The United States among the trade countries has enlarged during this five years in both export and import. As for Japan, the weight of export decreased from 9.0% to 5.1% , on the other hand, the weight of import has increased up to 9.0% from 8.6% of the total import amount of Honduras.

**Table 2.1.8 Major Trade Countries with Honduras**  
(Unit : %)

Export	1986	1991	Import	1986	1991
United States	45.7	51.9	United States	32.2	40.5
Germany	10.9	8.3	Japan	8.6	9.0
Belgium	4.1	6.7	Mexico	4.7	7.2
Japan	9.0	5.1	Venezuela	9.5	6.6
Italy	6.3	3.4	Germany	3.6	4.3

#### (4) Financial Situation of the Central Government

The financial position of the central government, shown in Table 2.1.9, has constantly been deficit in the past years in spite of the government effort for reducing the financial deficit under the economic structural reform by IMF and World Bank. As a result, in 1994 the expenditure reached about two times of the revenue.

**Table 2.1.9 Financial Position of the Central Government**

(Unit : Million Lempiras)

Year	1992	1993	1994
Revenue	3,244.0	3,823.6	4,599.8
Expenditure	5,893.0	7,702.1	8,047.3

Source: Informe Preliminar de la Economía Hondureña durante 1994  
(Departamento de Estudios Económicos, 1995)

#### 2.1.4 City Budget

The Tegucigalpa municipal budget in 1995 totaled Lps.133,364,000. The public works budget for construction and the improvement was Lps.18,747,000, about 14.1% of the total budget.

The municipality carries out constructions and transportation improvements with their own budget. However, if lacking funds, the municipality requests funds from the central government, support of friendly nation or international organization.

#### 2.1.5 Registered Vehicles

The number of registered vehicles (those vehicles by the Transit Police) between 1992 and 1994 is shown in Table 2.1.10. The annual growth rate is 20% or more. Passenger cars and pickup trucks are about 65% of total registered vehicles.

The number of registered vehicles in the Tegucigalpa metropolitan area is 63,140 vehicles. This represents 34.8% of vehicles of total in the whole of Honduras.

**Table 2.1.10 List of Registered Vehicles**

(vehicles)

Vehicle type	1992	1993	1994
Passenger Cars	34,326	43,306	
Wagon Cars	8,237	10,392	
Jeep	3,781	4,265	
Pick Up	42,000	52,881	
Light Truck	8,610	10,496	
Buses	5,129	6,826	
Motorcycle	8,580	9,969	
Tow Truck	2,853	2,335	
Box Cars	350	431	
Dump Truck	1,693	2,172	
Truck Crane	24	33	
Heavy Truck	2,982	3,645	
Others	656	652	
Tank Lorry	167	192	
Total	119,388	148,596	181,280
			(63,140)
Annual Growth Rate	-	24%	22%

Note: ( ) Number of Registered Vehicles in Tegucigalpa

## 2.2 Road Inventory

### 2.2.1 Road Network

#### 1) Road network

The roads for which the Secopt has responsibility are divided into three classes according to route number as follows;

	<u>Route No.</u>
Principal road	001 - 050
Secondary road	051 - 199
Feeder road	200 - 999

Fig. 2.2.1 shows the road network of the principal and secondary roads in Honduras. The total length is 14,202.60 km in 1992 and the road length of each class and pavement type is in Table 2.2.1. The pavement type of the principal road is mainly the asphalt pavement but that of the secondary road is macadam pavement. At present in Honduras macadam pavement accounts for about 69.2% of all roads.

Table 2.2.1 Road Length

	(km)					
	Concrete Pavement	Asphalt Pavement	Treatment Surface	Macadam Pavement	Soil	Total
Principal Road	0.00	1,825.00	334.50	932.60	0.00	3,092.10 (21.8%)
Secondary Road	25.00	101.60	114.80	2,141.50	96.00	2,478.90 (17.4%)
Feeder Road	0.00	0.00	0.00	6,755.50	1,876.10	8,631.60 (60.8%)
Total	25.00 (0.2%)	1,926.60 (13.6%)	449.30 (3.2%)	9,829.60 (69.2%)	1,972.10 (13.8%)	14,202.60 (100%)

The road network in Tegucigalpa metropolitan area is shown in Fig. 2.2.2. The roads in the urban area of Tegucigalpa metropolitan area are generally very narrow and steep gradient sections are found in several places. The majority of the arterial roads go through the center of the city, and the ring and radial road networks in the metropolitan area are lacking to meet present traffic vehicles and demand.

#### (2) One-way roads

Buses pass on the narrow roads where vehicles are parked on one sides or both sides of the road, Accounting for many one-way roads. These are shown in Fig. 2.2.3.

### 2.2.2 Accidents in Honduras and Tegucigalpa

#### (1) Nationwide

In Honduras, the number of accidents and the number of fatalities due to traffic accidents have

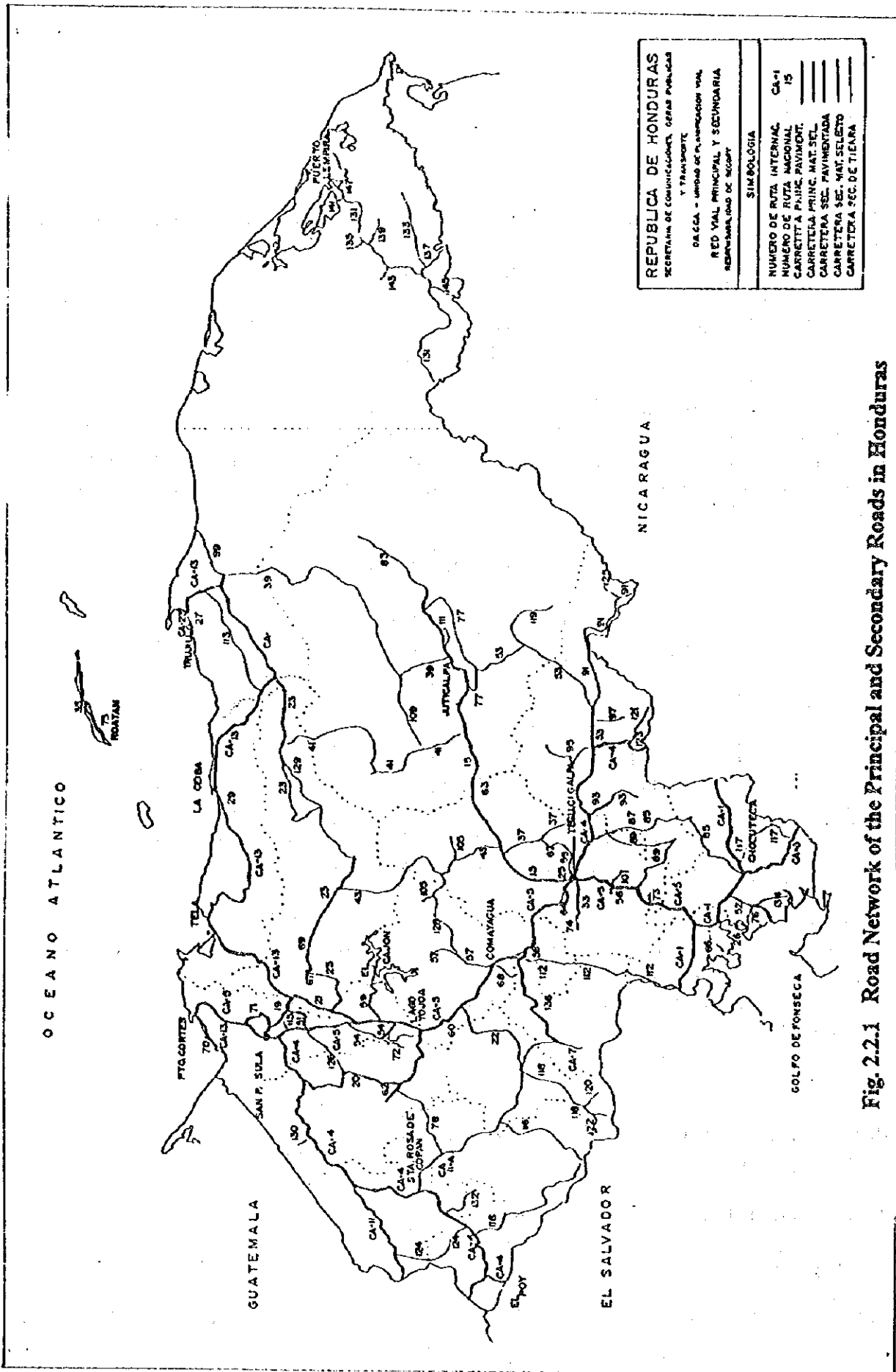


Fig. 2.2.1 Road Network of the Principal and Secondary Roads in Honduras



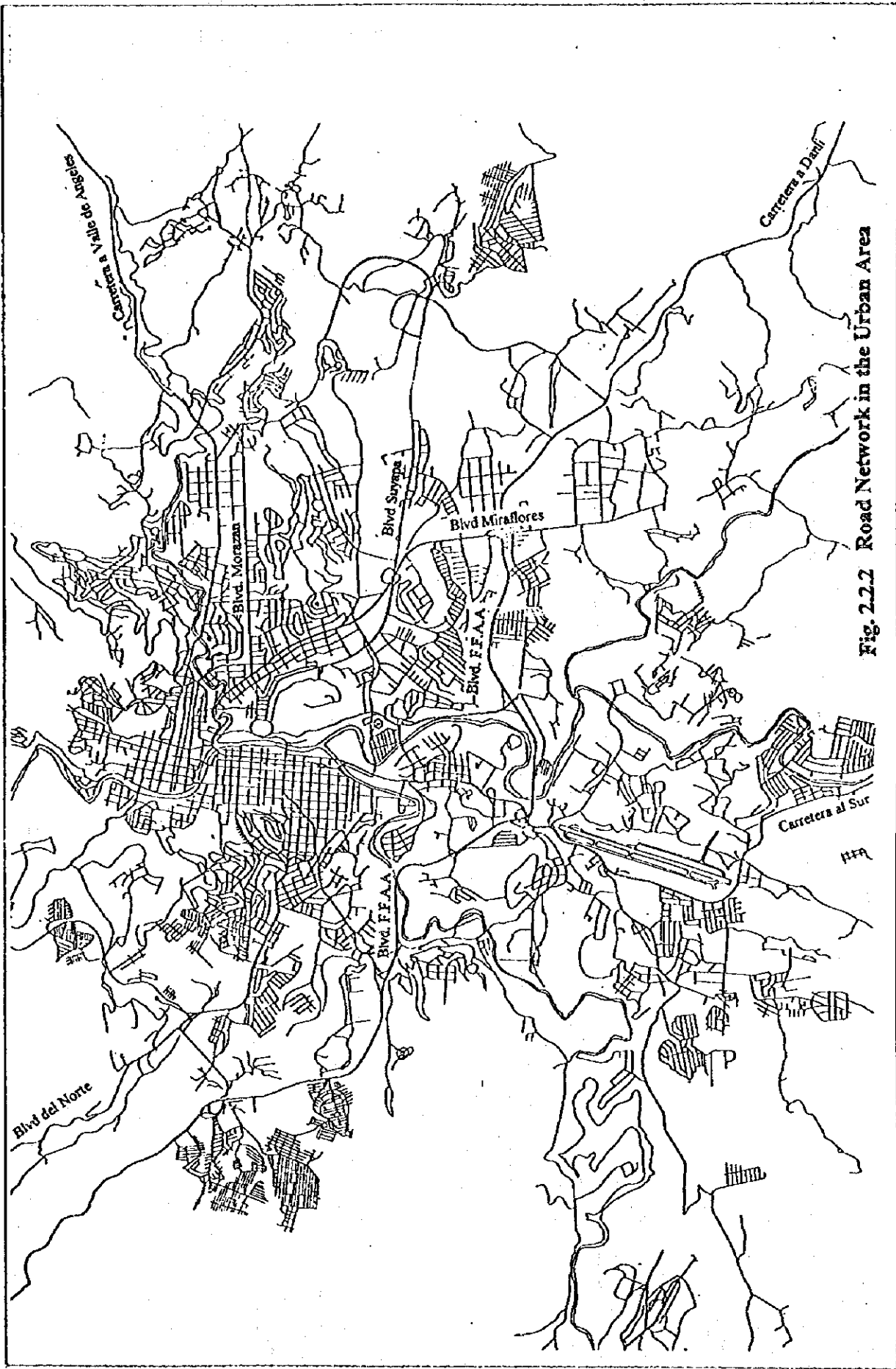


Fig. 2.2.2 Road Network in the Urban Area

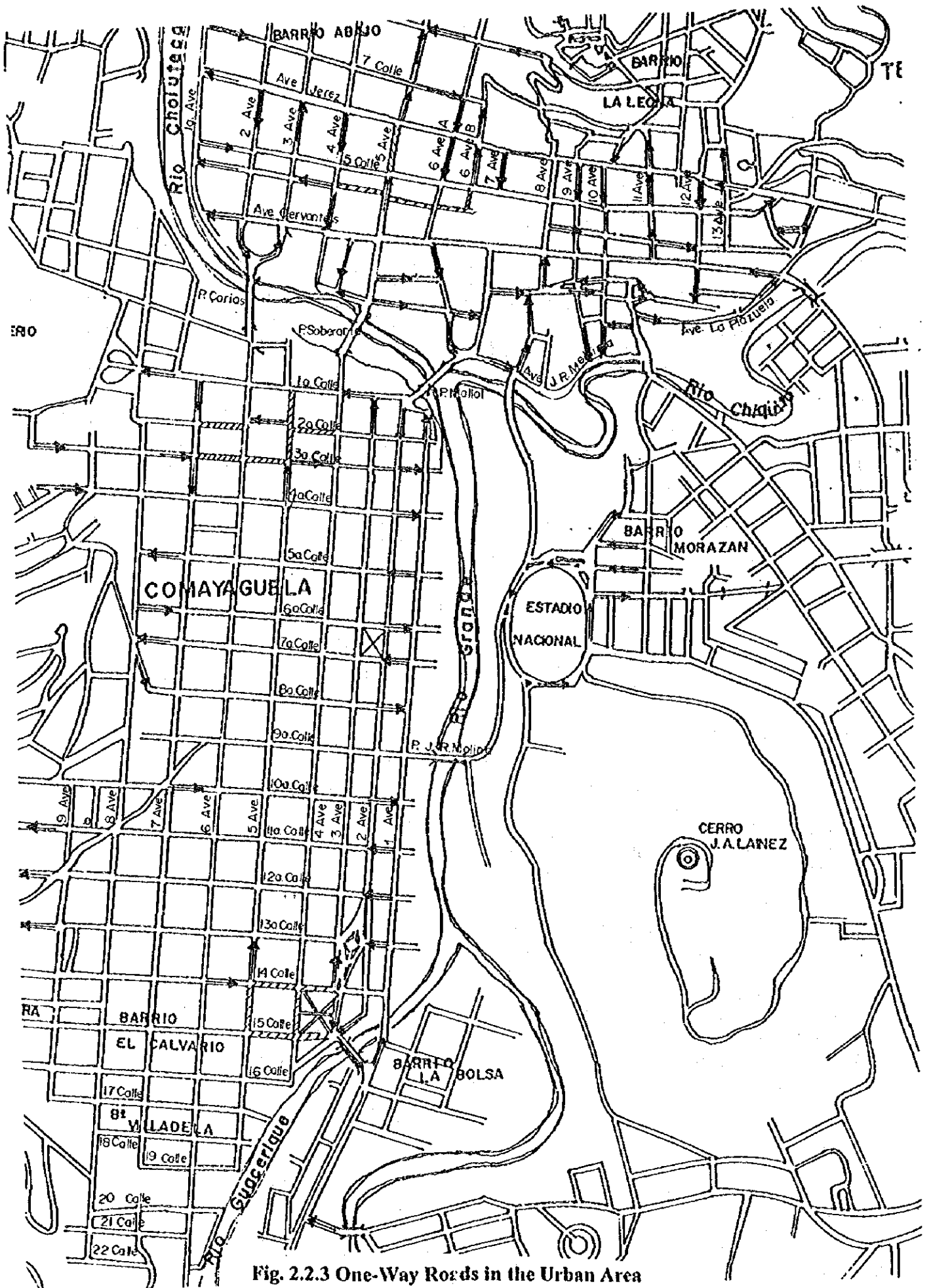


Fig. 2.2.3 One-Way Roads in the Urban Area

seriously increased in the last 5 years. In 1994, 11,871 accidents occurred resulting in 706 deaths. The number traffic accidents and fatalities increase yearly. Details of the traffic accidents from 1988 to 1994 are shown in Table 2.2.2.

**Table 2.2.2 Number of Traffic Accidents in Honduras**

Year	No. of Accidents	No. of Fatality (A)	No. of Injury (B)	(A)+(B)
1988	7,272	443	2,021	2,464
1989	8,088	441	3,089	3,530
1990	7,024	411	2,196	2,607
1991	8,001	527	1,956	2,483
1992	8,014	575	4,262	4,837
1993	11,474	726	4,044	4,770
1994	11,871	706	3,267	3,973

Source: Análisis a La Apreciación De La Dirección National De Transito" Marzo 2, 1995 By NPT (Nacional Police De Trnsit)

**(2) Accidents in Tegucigalpa**

There is no specific accident data available such as shown in above table. Only the data shown in Table 2.2.3 were available. Traffic accidents occur mainly on Boulevard Norte, Boulevard Comunidad Europea, and Boulevard Fuerzas Armadas. The available data on traffic accidents in Tegucigalpa is shown in Table 2.2.3..

**Table 2.2.3 Traffic Accidents in Tegucigalpa  
( June to September in 1995)**

Name of Road	No. of Accidents	No. of Fatality	No. of Injury	Total
Blvd. Norte	238	4	28	32
Blvd. Morazán	174	2	2	4
Blvd. C.A.	109	4	21	25
Blvd. Fuerzaz Armadas	226	9	26	35
Blvd. Comunidad Europea	233	4	7	11
Ave. Cabnas	62	0	27	27
Ave. 7 (Comayagüela)	77	9	64	73
Al Sur	77	16	89	105
Al Norte	45	21	48	69
Others	1,732	329	476	805
<b>Total</b>	<b>2,973</b>	<b>398</b>	<b>788</b>	<b>1,186</b>

Source: Analisis A La Apreciacion De La Direccion National De Transito" Marzo 2, 1995 By NPT(Nacional Police De Trnsit)

### (3) Comparison of Traffic Accident Indicators

To understand the traffic accident situation in Honduras, the situation in Honduras was compared with some other countries. Table 2.2.4 shows the results of the comparison.

**Table 2.2.4 Comparison of Traffic Accidents in 1994**

	Honduras	Guatemala	U.S.A	Japan
No. of Accidents	11,871	6,228	2,335,434	614,481
No. of Fatalities	398	338	46,385	10,344
Population	50	89	2,445	1,229
No. of Vehicles Registered	18	19	17,904	5,253
Rate of Motorization	3.6	2.2	73.2	42.8
Fatality Rate (1)	8.0	3.8	19.0	8.3
Fatality Rate (2)	22.1	17.8	2.6	2.0

Note: Unit Population =100,000 persons  
Vehicle registered =10,000 vehicles  
Rate of Motorization =Vehicles per 100 persons  
Fatality Rate (1) = per 100,000 persons  
Fatality Rate (2) = per 10,000 vehicles

It is clear from this Table that the number of fatalities per 10,000 vehicles in Honduras is much worse than that of other countries. This means that since the rate of motorization in Honduras is still low, the potential danger in the traffic accidents is very high.

#### 2.2.3 Traffic Control Facilities

##### (1) Traffic Signal

The traffic signals are installed at major intersections in the study area. These signals are not managed systematically and sometimes the lack of the electric power causes the suspension in operation. In such occasions the traffic congestion at intersections becomes much worse.

In Tegucigalpa, planning and maintenance of traffic signals is in charge the COMITE VIAL. The COMITE VIAL decides the location where signals are to be installed through special groups from SECOPT, TRASIT POLICE and METROPLAN. The maintenance work is done by the COMITE VIAL:

The budget for the above is approved and assigned by the COMITE, based on the present situations. But in the past 10 years, no new traffic signal has been installed in Tegucigalpa due to financial problems. In addition, maintenance is rare.

##### (2) Number of signalized intersection

There are 51 signalized intersections in Tegucigalpa as shown in Fig. 2.2.4.

### (3) Types of traffic signals

Existing traffic signals are installed according to "Manual Centroamericano de Dispositivos para el Control del Tránsito de Calles y Carreteras" established in 1975. This manual is widely utilized in Central American countries (Honduras, Guatemala, El Salvador, Costa Rica, and Nicaragua). Almost all of existing signals are vertical type and the number of horizontal type of signals is few. The following 3 types of signals are installed;

- Pedestal type

This is a vertical type of traffic signal installed atop a pole. There are very few of these. They are installed at large intersections and placed at the for left-hand side of each approach.

- Suspension type

This is a vertical type of traffic signal suspended by wires at the center of the intersection. This type of traffic signal is found at the center of Tegucigalpa and the northern side of Comayagüela, and is installed at narrow intersections.

- Overhung type

This is a horizontal type used commonly throughout the city. Normally this type has a 1.00 to 1.5m-long arm, but at wide roads or large intersections, it has a longer arm and a big billboard hanging from it.

### (4) Control System

Every traffic signal controller in the study area is operated under a single program pretimed signal and it is impossible to change the phasing pattern or cycle length according to the traffic conditions at the site. There is no central control system, synchronized system, or other control system in the study area.

### (5) Operating of Traffic Signals

As mentioned above, there is no operation system in this study area. During the whole day, the same phasing model and cycle length are kept.

### (6) Signal Equipment

Most of signal equipment used in the study area were made by SEMEX(Mexico). Basically, lenses with 21cm diameter are used for signal displays excepting 30cm diameter lenses for red light at some intersections. However, it was observed that the number of signals is not enough and the visibility for drivers is poor.

### (7) Traffic Condition and Signal Phasing

Every traffic signal function in the study area is the single program pretime signal. Hence, it is impossible to change the signal phasing and cycle length according to the variation of traffic volume. The phasing and the cycle length of most of the signalized intersections in the study area are presented in a technical report "Intersection Survey", together with the results of intersection inventory and traffic volume survey.



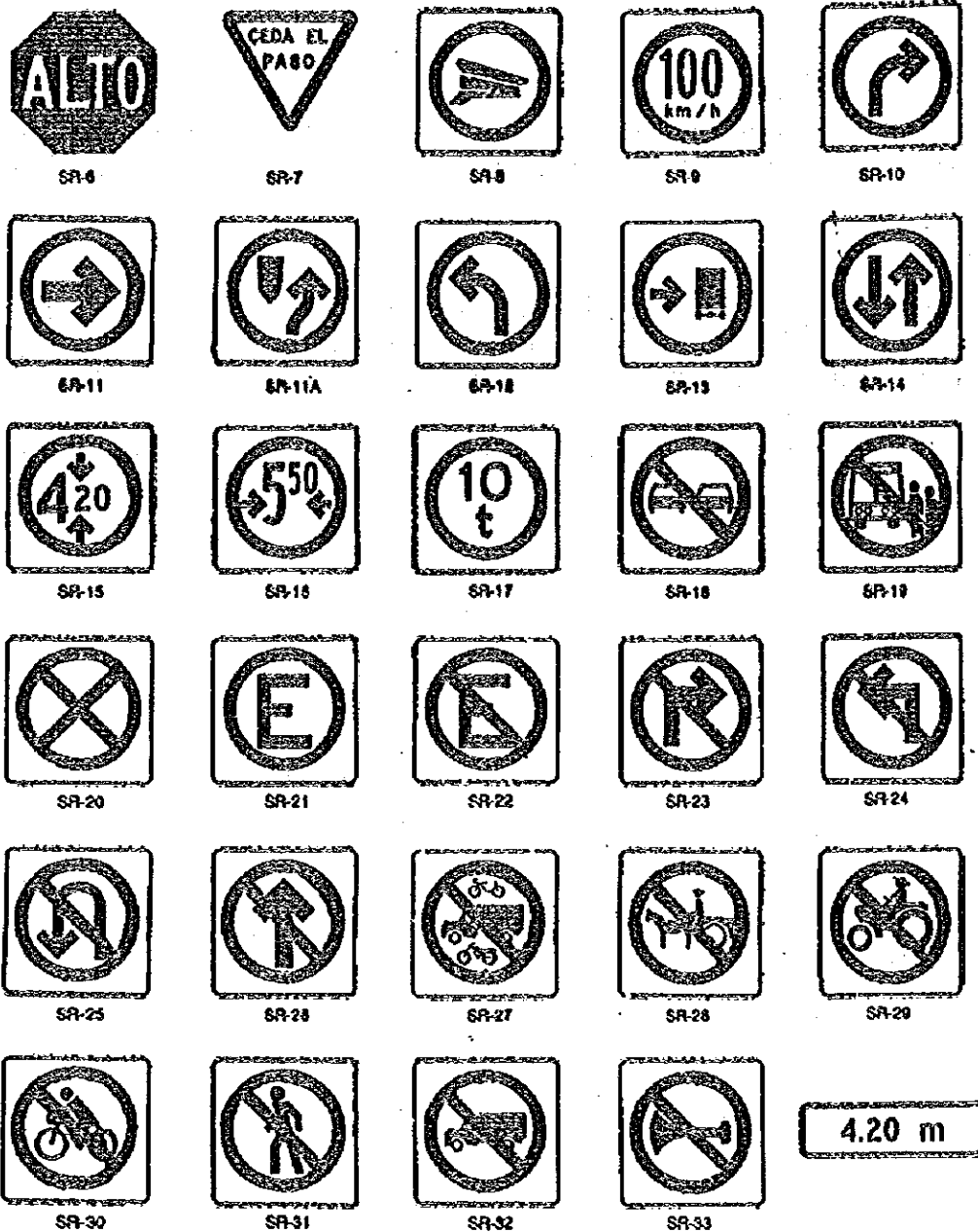
## **(8) Traffic Signs**

The traffic signs in Honduras follow the Traffic Communication of the Central America standard. Fig. 2.2.5 to 2.2.7 show the regulation, warning, and guide signs used in Honduras.

### **2.2.4 Design Standard**

The road design standards in Honduras follow the Central American Standard as shown in Table 2.2.5, or American standards, such as American Association of State Highway and Transportation Officials (AASHTO).

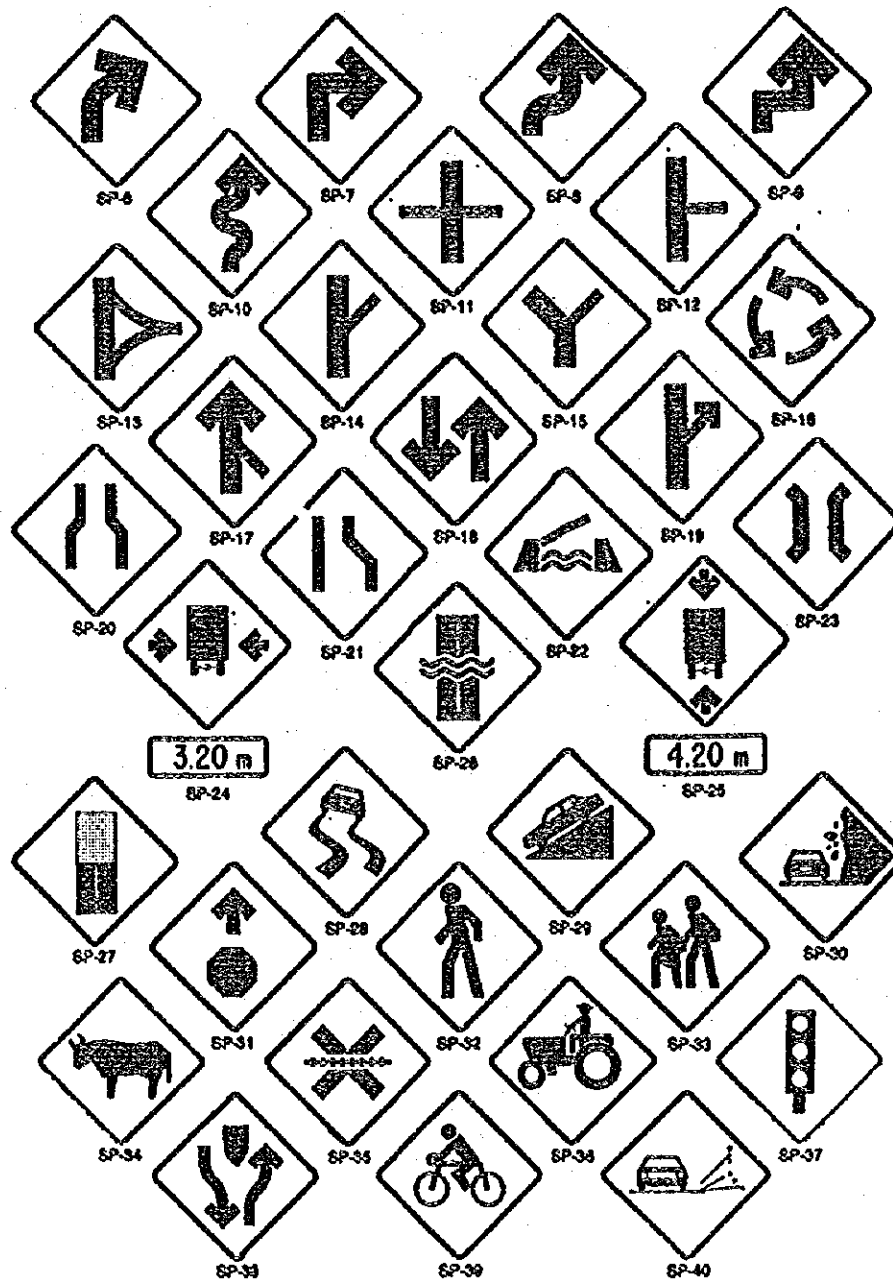
The Central American standard provides for five road classes determined by traffic volume.



- |       |                        |       |   |
|-------|------------------------|-------|---|
| SR-6  | STOP                   | SR-21 | PARKING ALLOWED                           |
| SR-7  | YIELD RIGHT OF WAY     | SR-22 | NO PARKING                                |
| SR-8  | INSPECTION             | SR-23 | NO RIGHT TURN                             |
| SR-9  | SPEED LIMIT            | SR-24 | NO LEFT TURN                              |
| SR-10 | RIGHT TURN ONLY        | SR-25 | NO U-TURN                                 |
| SR-11 | KEEP RIGHT             | SR-26 | DO NOT ENTER                              |
| SR-12 | LEFT TURN ONLY         | SR-27 | NO BICYCLES, HEAVY TRUCKS AND MOTORCYCLES |
| SR-13 | USE RIGHT LANE         | SR-28 | NO ANIMAL TRACTION VEHICLES               |
| SR-14 | TWO WAY TRAFFIC        | SR-29 | NO AGRICULTURE MACHINERY                  |
| SR-15 | RESTRICTED FREE HEIGHT | SR-30 | NO BICYCLES                               |
| SR-16 | RESTRICTED FREE WIDTH  | SR-31 | NO PEDESTRIANS                            |
| SR-17 | RESTRICTED WEIGHT      | SR-32 | NO HEAVY LOAD VEHICLES                    |
| SR-18 | NO PASSING             | SR-33 | SILENCE                                   |
| SR-19 | PROHIBITED STOP        |       |   |
| SR-20 | NO STOPPING            |       |   |

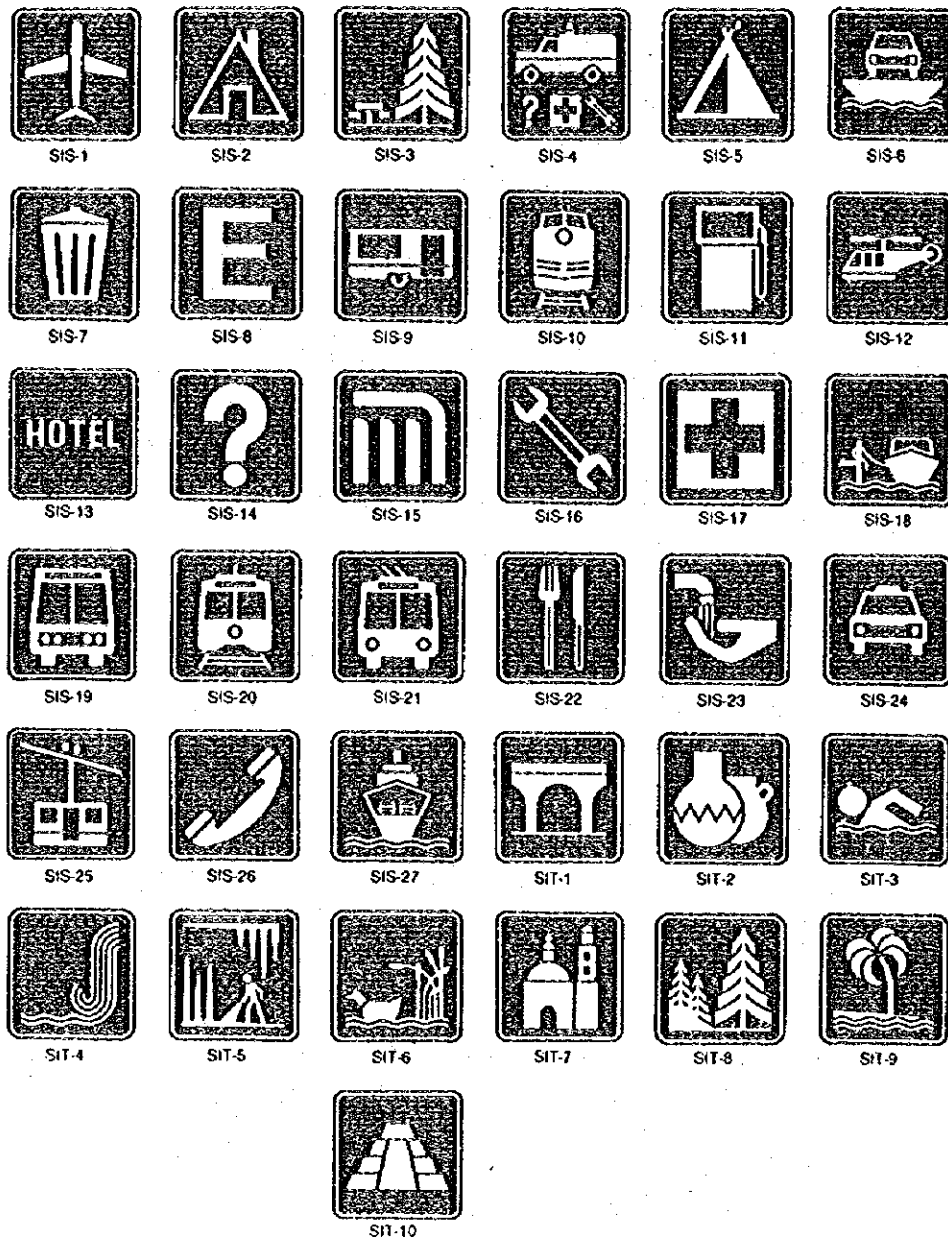
Fig. 2.2.5 Regulation Signs





- |       |                          |       |                    |
|-------|--------------------------|-------|--------------------|
| SP-6  | CURVE                    | SP-24 | FREE WIDTH         |
| SP-7  | TURN                     | SP-25 | VERTICAL CLEARENCE |
| SP-8  | CLOSE CURVE              | SP-26 | DIP                |
| SP-9  | DOUBLE TURN              | SP-27 | END OF PAVEMENT    |
| SP-10 | WINDING ROAD             | SP-28 | SLIPPERY WHEN WET  |
| SP-11 | ROAD CROSSING            | SP-29 | STEEP HILL         |
| SP-12 | T- JUNCTION              | SP-30 | LANDSLIDES AREA    |
| SP-13 | DELTA JUNCTION           | SP-31 | STOP AHEAD         |
| SP-14 | LATERAL OBLIQUE JUNCTION | SP-32 | PEDESTRIANS        |
| SP-15 | Y- JUNCTION              | SP-33 | SCHOOL ZONE        |
| SP-16 | TRAFFIC CIRCLE           | SP-34 | CATTLE             |
| SP-17 | YIELD                    | SP-35 | RAILROAD CROSSING  |
| SP-18 | TWO WAY TRAFFIC          | SP-36 | TRACTOR            |
| SP-19 | EXIT                     | SP-37 | TRAFFIC SIGNAL     |
| SP-20 | SYMMETRIC NARROWING      | SP-38 | DIVIDED ROAD       |
| SP-21 | ASYMMETRIC NARROWING     | SP-39 | CYCLISTS           |
| SP-22 | MOVABLE BRIDGE           | SP-40 | LOOSE GRAVEL       |
| SP-23 | NARROW BRIDGE            |       |                    |

Fig. 2.2.6 Warning Signs



- SIS- 1 AIRPORT
- SIS- 2 LODGE
- SIS- 3 RECREATION AREA
- SIS- 4 TRAVEL ASSISTANCE
- SIS- 5 CAMPING AREA
- SIS- 6 BARGE
- SIS- 7 DUMPING GROUND
- SIS- 8 PARKING
- SIS- 9 PARKING FOR CAMPING CAR
- SIS-10 STATIONS OF RAILWAY
- SIS-11 GAS STATION
- SIS-12 HELIPORT
- SIS-13 HOTEL
- SIS-14 INFORMATION
- SIS-15 SUBWAY
- SIS-16 MECHANIC
- SIS-17 DOCTOR
- SIS-18 PIER
- SIS-19 BUS STOP

- SIS-20 STREETCAR STOP
- SIS-21 TROLLEY BUS STOP
- SIS-22 RESTAURANT
- SIS-23 SANITARY
- SIS-24 TAXI
- SIS-25 ROPEWAY
- SIS-26 TELEPHONE
- SIS-27 FERRY
  
- SIT- 1 WATERWAY
- SIT- 2 HANDICRAFT
- SIT- 3 HOT SPRING
- SIT- 4 WATERFALL
- SIT- 5 CAVE
- SIT- 6 LAGOON
- SIT- 7 COLONIAL MONUMENT
- SIT- 8 NATIONAL PARK
- SIT- 9 BEACH
- SIT-10 RUIN ZONE

Fig. 2.2.7 Guide Signs

Table 2.2.5 Road Design Standard

GENERAL ROAD DEPARTMENT REPUBLIC OF HONDURAS		DEPARTMENT OF PROJECTS AND STUDIES		GEOMETRIC DESIGN OF HIGHWAYS		CENTRAL AMERICAN SPECIFICATIONS	
CONCEPTS	SPECIAL	PRINCIPAL	SECONDARY	FEEDER	FROM PENETRATION		
TYPE OF ROAD							
Design Vehicles	More than 3000 per day	More than 1000 per day	More than 500 per day	More than 100 per day	More than 100 per day		
Type of Traffic	Mixed	Mixed	Mixed	Mixed	Mixed		
Design Speed	According to Terrain	According to Terrain	According to Terrain	According to Terrain	According to Terrain		
Land Classification							
Level Terrain	0% to 10% (0 to 6)	Same as the previous one	Same as the previous one	Same as the previous one	Same as the previous one		
Rolling Terrain	10% to 25% (6 to 14)	Same as the previous one	Same as the previous one	Same as the previous one	Same as the previous one		
Mountainous Terrain	25% to 60% (14 to 31)	Same as the previous one	Same as the previous one	Same as the previous one	Same as the previous one		
Sharp Terrain	60% to more (more of 31)	Same as the previous one	Same as the previous one	Same as the previous one	Same as the previous one		
Design Speed							
Level Terrain	100 Km per Hour	80 Km per Hour	60 Km per Hour	50 Km per Hour	50 Km per Hour		
Rolling Terrain	80 Km per Hour	60 Km per Hour	50 Km per Hour	40 Km per Hour	40 Km per Hour		
Mountainous Terrain	60 Km per Hour	50 Km per Hour	40 Km per Hour	30 Km per Hour	30 Km per Hour		
Sharp Terrain	40 Km per Hour	40 Km per Hour	40 Km per Hour	30 Km per Hour	30 Km per Hour		
Horizontal Alignment							
Unit Arch	10 METERS	10 METERS	10 METERS	10 METERS	10 METERS		
Level Terrain	R 450 m G 1 16'	R 350 m G 1 36'	R 200 m G 2 52'	R 100 m G 5 44'	R 100 m G 5 44'		
Rolling Terrain	R 350 m G 1 36'	R 200 m G 2 52'	R 100 m G 5 44'	R 50 m G 11 26'	R 50 m G 11 26'		
Mountainous Terrain	R 250 m G 2 52'	R 100 m G 5 44'	R 50 m G 11 26'	R 30 m G 19 07'	R 30 m G 19 07'		
Sharp Terrain	R 50 m G 9 33'	R 50 m G 9 33'	R 50 m G 9 33'	R 50 m G 9 33'	R 50 m G 9 33'		
Sight Distance	Speed D1 D2	Speed D1 D2	Speed D1 D2	Speed D1 D2	Speed D1 D2		
Level Terrain	100k/h 200 m 400 m	80k/h 150 m 300 m	60 k/h 100 m 200 m	50k/h 70 m 140m	50k/h 70 m 140m		
Rolling Terrain	80k/h 150 m 300 m	60k/h 100 m 200 m	50 k/h 70 m 140 m	40k/h 50 m 100m	40k/h 50 m 100 m		
Mountainous Terrain	60k/h 100 m 200 m	50k/h 70 m 140 m	40 k/h 50 m 100 m	30k/h 35 m 70m	30k/h 35 m 70 m		
Sharp Terrain	40k/h 60 m 100 m	40k/h 60 m 100 m	40k/h 60 m 100 m	30k/h 35 m 70m	30k/h 35 m 70 m		
Tangent Between curves(Mas)	Same way Dif. way	Same way Dif. way	Same way Dif. way	Same way Dif. way	Same way Dif. way		
Level Terrain	200 m 160 m	170 m 140 m	140 m 110 m	110 m 86 m	110 m 86 m		
Rolling Terrain	160 m 140 m	140 m 120 m	120 m 96 m	95 m 75 m	95 m 75 m		
Mountainous Terrain	140 m 120 m	125 m 105 m	110 m 86 m	85 m 65 m	85 m 65 m		
Sharp Terrain	115 m 96 m	115 m 96 m	115 m 96 m	85 m 65 m	85 m 65 m		
Vertical Alignment	More than 300m less than 300m	More than 300m less than 300m	More than 300m less than 300m	More than 300m less than 300m	More than 300m less than 300m		
Level Terrain	3%	3%	5%	5%	5%		
Rolling Terrain	4%	4%	6%	6%	6%		
Mountainous Terrain	5%	5%	8%	8%	8%		
Sharp Terrain	6%	6%	10%	10%	10%		
Transversal Section							
Lane Width	2 x 7.20 m	7.20 m	6.50 m	5.50 m	4.00 m		
Width of Shoulders	2.40 m on each side	2.40 m on each side	1.75 m on each side	0.75 m on each side	0.70 m on each side		
Width of Right of Way	60 m Total	50 m Total	30 m Total	30 m Total	20 m Total		
Width of Structures							
D1 Stopping Sight Distance							
D2 Passing Sight Distance							

## **CHAPTER 3**

# **PRESENT ENVIRONMENTAL CONDITION**

## CHAPTER 3 PRESENT ENVIRONMENTAL CONDITION

### 3.1 General

This chapter summarizes the results of our study on the present environmental conditions of Tegucigalpa M.D.C. It should be noted here that the meaning of "environment" includes not only natural conditions surrounding development project site but also all the human activities which may be affected by the implementation of the project. The issue of compensation for resettlement, for example, is also an important environmental matter.

The purposes of the study are: 1) to reveal the present environmental issues in Tegucigalpa Metropolitan and 2) to prepare the basic data to be utilized for the Initial Environmental Examination of the project at detailed design stage later.

This chapter was presented on the basis of results of environmental survey consisting of 1) environmental informations collection and 2) interviews to the local people affected by this project. Outline of the survey is given in Section 3.2. After the intpretation of survey results, we summarize policy for the environmental protection and the present environmental issues in Sections 3.3 and 3.4 respectively.

### 3.2 The Environmental Survey

A environmental survey was done by Dr. Mezquita heading consultant team from angust to september 1995 and the factual results were compiled in a separate volume " Preliminary Study of Environmental Impact in the Metropolitan Area, 1995 ". Followings describe their activities.

#### 3.2.1 Collecction of Environmental Information

One of the activity conducted by the consultant team is collection of Environmental Information. The consultant team has collected statistical data from municipality and other goveramental organization and prepared maps including environmental information.

Table 3.2.1 indicates the detail of statistical information colleted while Table 3.2.2 presents the title of map prepared by then.

Table 3.2.2 Environmental Map

Clasification	Title
Water Resource	Reservoir and Pump Station
Economy	Land Use
Contamination	Manufacturing Factory
Fauna & Flora	Park and National Resort
Hazard	Landslide and Flood Areas
Education	Public Facilities
Culture	Historical Monument

**Table 3.2.1 Environmental Statistical Data**

<b>Classification</b>	<b>Detail</b>
Population	Population by Age Town and Population Ranges Growth Rate of Metropolitan Population
Area	Growth Rate of Urban Area of Metropolis
Poverty Level	Percent of Malnutrition, Tap Water Shortage and Sewage Service Shortage
Employment	Employed Person by Occupation Type of Employee Employed Person by Industry Type of Unemployee Employment in Metropolis and in Country Rest
Water Resources	Capacity of Reservoirs Water Quality in Each Reservoirs
Economy	Major Enterprises in Honduras
Forest	Loss of Forest by Fire
Climate	Major Hurricanes
Solid Waste	Frequency of Waste Collection Service Area Without Waste Collection Service Waste Collection Fleet Waste Production
Contamination	Environmentally Hazardous Factories in Metropolis
Transportation	Public Transportation
Fauna and Flora	Major Species of Metropolitan Fauna Major Species of Metropolitan Flora
Hazardous Area	Risky Area and Grade of Risk Population in Risky Area
Health	Annual Rate of Respiratory Disease Major Causes of Death, General Infant Mortality Rate Major Causes of Death, Infant Major Causes of Death, Children Major causes of Death in Metropolis Age of Death in Metropolis Level of Attention Hospital and Bed, Metropolis Address of Hospital and Clinics, Metropolis
Education	Distribution of School Number of Private and Public School

### **3.2.2 Interview to Local People**

Another activity performed is the interview to local people in Metropolis. Characteristics of the people interviewed are indicated in Table 3.2.3. Results of the interview is summarized in Appendix.

## **3.3 Policy of Environmental Protection**

### **3.3.1 General Environmental Laws**

In 1972, United Nation's conference about Human Environment at Stockholm, Sweden started to draw attention to environmental matters at a world level. It was the 1992 Conference of the Environment and Development (CNUMAD) at Rio de Janeiro, Brazil that proposed Action Plan, Agenda 21, emphasizing that health at a worldwide level was maintained only when the environment at the process of development was properly protected.

To meet this policy, the Honduran Government founded the National Commission of the Environment (CONAMA), which, afterward, was promoted to Department of the Environment (SEDA, Secretaria del Estado en el Despacho del Ambiente). At the same time, the General Law of Environment was issued. This law enforces:

- (1) To appoint SEDA to establish a system of environmental impact assesment
- (2) To create a nationwide consultative council as an adviser; and
- (3) To clarify the penalties for violation of this law.

On the basis of this law, SEDA has established the technical manual of National System of Environmental Impact Evaluation (SINEA, Sistema Nacional de Evaluación de Impacto Ambiental), and formulated an action plan for the protection of water, forest, soil, fishery, national culture and prevention of contamination and plagues.

### **3.3.2 Protection of Cultural Properties**

The idea of protecting cultural inheritance of Honduras became clear at the time of the great 1976 Guatemala earthquake, by which many old buildings suffered from great damages; not only ones located near the border with Guatemala, but also century-old churches in M.D.C. as well. The Honduras Anthropology and History Institute (HHAH), then a branch office of the Cultural General Administration appealed to the central government for preservation and protection of such old architecture for their great symbolic values representing the nation. Responding to this request from HHAH, Tegucigalpa Municipality performed the investigation of existing old churches in the Metropolitan area and found that 34 works of old architecture were historically valuable, listing them up with the aid of foreign experts.

In 1977, the Metropolitan Council issued resolution No. 738, declaring the listed architecture as national monuments to be preserved. Furthermore, in 1984 the nation's Cultural Inheritance Protection Law was created. This law entitles I.H.A.H. full responsibility to preserve the National Cultural Inheritance. And the secretariat of culture and tourism announced the resolution No. 527 on 20 December, 1994.

**Table 3.2.3 Characteristics of Interviewed Person**

<b>Stratum</b>	<b>Name of Colonia</b>	<b>Number of Persons</b>
Medium-High Income	Los Almendros	10
	El Prado	8
	15 de Septiembre	10
	Lomas del Toncontin	50
<b>Subtotal</b>	<b>4</b>	<b>78</b>
Medium Income	Buenos Aires	20
	Hato de Enmedio	20
	Morazan	15
	San Jose de la Pena	30
	San Jose de la Vega	30
	Pedregal	39
	La Hoya	10
	Kennedy	50
	Villadela	29
	<b>Subtotal</b>	<b>9</b>
Poor and Marginal	Zapote Norte	20
	Los Profesores	50
	Flor del Campo	20
	Los Pinos	40
	Sipile	25
	Villanueva	50
	Chiverito	9
	Soto	74
	El Chile	22
	Reparto Abajo	50
	Reparto Arriba	50
	Las Crucitas	50
	Las Torres	20
	La Esperanza	30
	San Miguel	42
<b>Subtotal</b>	<b>15</b>	<b>552</b>
Commercial Area	1a. Ave. Comayaguela	59
	La Burrera	14
	6a. Ave. Comayaguela (Bo. Colon)	16
	Salida al Norte (Belén)	40
<b>Subtotal</b>	<b>4</b>	<b>129</b>
<b>Total</b>	<b>32</b>	<b>1002</b>



Nowadays, I.H.A.H. and the municipality cooperate trying to preserve the traditional architecture, limiting signs, coloring of building wall, and construction of new buildings which are not compatible to the scenic environment where these architecture are concentrated.

### **3.3.3 Resettlement.**

Since previous experience of involuntary resettlement is not available at the moment, we propose a basic idea of compensation system for resettlement in this section.

Although the development project would produce great benefit to society in general, it should not be forgotten that certain people suffer from adverse effects resulting from the project.

The people who lose their land, houses and base of life should be properly compensated by means of, for example, providing alternative land, rebuilding houses and communities, providing of jobs, and developing them as productive members of society, at least to the same level at which they had been enjoying before the development project.

The above is especially important when the affected people are religious or ethnic minorities, poor and vulnerable without capacity to absorb such adverse impact, or unable to regain former living standard.

## **3.4 Present Environment Condition**

### **3.4.1 Natural Environment**

#### **(1) Climate**

Table 3.4.1 summarizes climate conditions observed at Toncontin Airport of Tegucigalpa in 1994.

As shown in the table, average temperatures for each month are moderately constant in a short range of 20 - 24 centigrade throughout the year. The maximum temperature is about 6 centigrades higher than average temperature while the minimum is 6 centigrades less than average in each month.

May to October is the wet season with monthly rainfalls of 100 to 170 mm while December to March is the dry season with rainfall of 0 to 10 mm.

April and November are transitional months between the two seasons.

Humidity is quite constant in a range of 60 of 80% throughout regardless of the amount of rainfall.

Hours of sunshine are 190 to 250 hour per month which implies that there is one cloudy day in every 3 days.

Monthly average of wind velocity is 4 to 7 knots each month while its direction is north through the year, except in April and August when wind blows to west.

**Table 3.4.1 Summary of Climate Conditions at Toncontin Airport**

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperature (°)	Max.	26	28	31	30	30	29	29	30	29	29	27	27
	Min.	14	14	15	17	18	18	17	17	18	17	16	15
	Aver.	20	21	23	24	24	23	23	24	23	23	21	20
Humidity (%)	Ave.	74	67	59	61	68	72	67	72	75	73	78	76
Rainfall (mm)	Total	6	5	0	26	150	56	3	26	174	101	30	9
	max/day	3	4	0	10	88	15	12	9	30	18	12	8
Sunshine (hr)	Total	203	225	180	250	187	196	216	178	163	209	208	210
Wind Vel. (kn)	Ave.	6.9	6.1	5.2	5	4.3	4.2	6	4.8	4.6	3.6	6.1	6.8
Wind Dir. (°)	Ave.	360	360	360	90	360	360	360	90	360	360	360	360

## (2) Topography and Geology

Tegucigalpa, M.D.C. which is the capital of Republic of Honduras and, at the same time head of Department of Francisco Morazán, is located at an elevation of 900 m above sea level.

A narrow basin developed along Rio Choluteca surrounded by hills at the foot of mountain ranges is the center portion of Tegucigalpa M.D.C, the busiest commercial area

Many residential areas are located on the slopes of surrounding hills that have been causing land slides for many years repeatedly. Rio Choluteca meanders with a width of 50 meters, through the central portion of M.D.C. from south to north, causing erosion of the river banks at densely populated areas and flooding at lowland residential areas.

The basic formation distributed over the basin and its east area is the Rio Chiquito Formation which consists of sedimentary rocks such as shale, siltstone, sandstone and conglomerate that were formed in the late Cretaceous period of Mesozoic era.

Distributed in the north, west and south of the basin are the products of geologically recent volcanic activities such as andesite, tuff, dacite and pyroclastic rocks which were formed in the tertiary period of Cenozoic era. Over these formations are alluvial sediments such as clay, sand and silt and residual soils which resulted from weathering of parent rocks.

## (3) Fauna and Flora

There are two national parks, one wildlife refuge and three biological reserves in the department of Francisco Morazán, all of which are quite far away from Tegucigalpa M.D.C.

Inside M.D.C., there are 6 ecologically protected areas. Among them, El Picacho Park is located in the hills which flank the north side of Tegucigalpa. Juan A. Lainez park occupies a small hill which

is located on the opposite bank to Comayaguela across Rio Choluteca. Four other parks are about 7 to 17 Km away from the study area. The location is presented in Fig 3.4.1.

Major trees and shrubs in the M.D.C. are pine, oak, laurel, rubber plant, acacia, mimosa family, rose, orange, cypress, eucalyptus, etc. Predominant fauna are doves, crows, buzzards, woodpeckers, sparrow hawks, falcons, rabbits, squirrels and reptiles. Fauna and flora distributed inside M.D.C. are very common without any rare species, although some of them are said to be endangered.

### 3.4.2 Social Environment

#### (1) Life Factor

The following gives the outline of life factor in M.D.C. in 1995

Population	757,106
0 - 4 years	15%
5 - 14 years	25%
15 - 49 years	50%
50 - older	10%

Life expectancy	
men	65.2 years
women	70.1 years

Population in Economic Activity	207,793
Primary industry	1%
Secondary industry	29%
Tertiary industry	70%

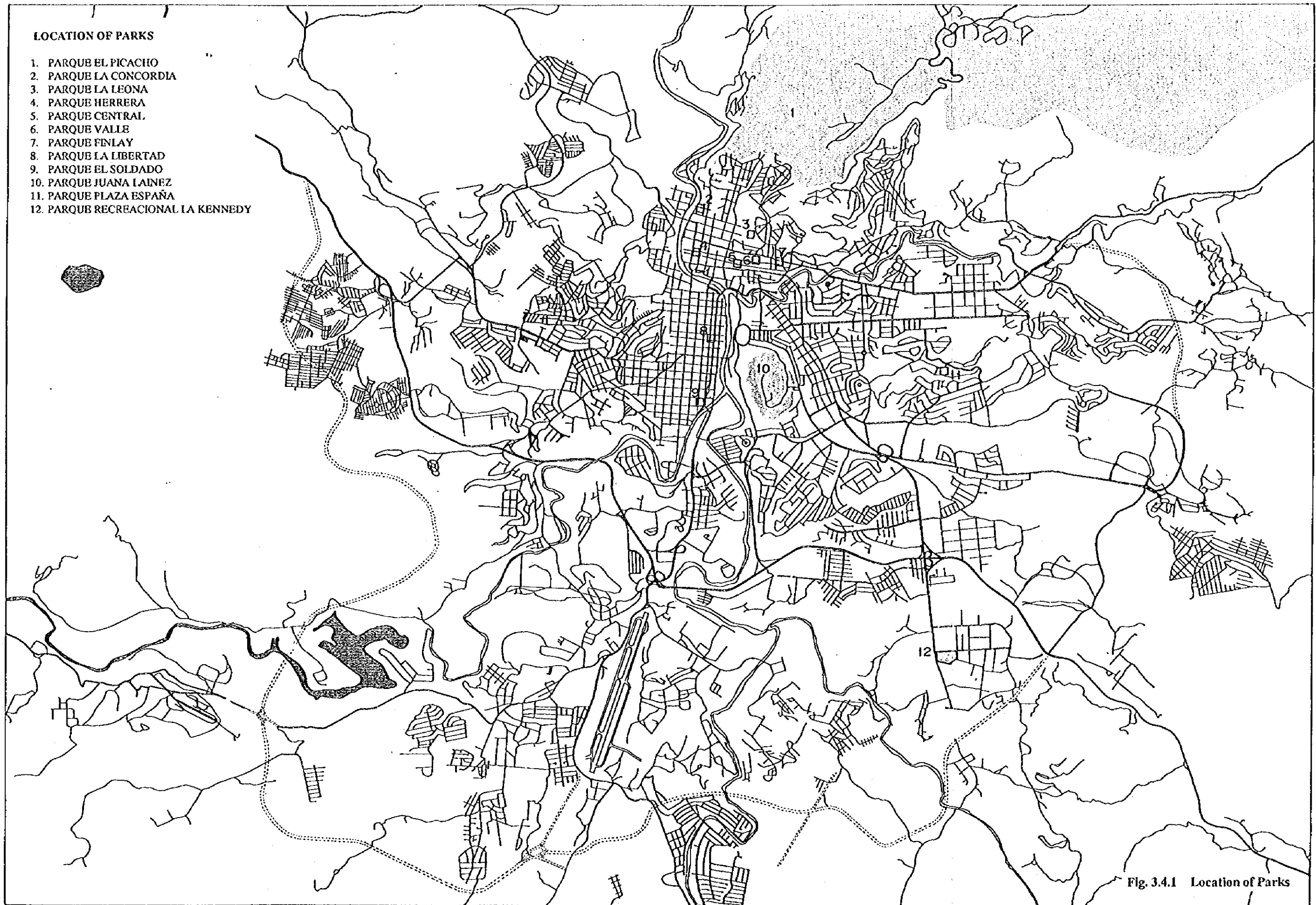
Illiteracy rate	13%
Extreme poverty	70%
No water service	20%
No garbage collection	30%
No electricity provided	10%

#### General Causes of Death

1. Circulation system diseases
2. AIDS
3. Accidents and violence
4. Infectious intestine diseases
5. Malignant tumors

#### Causes of Death in Children

1. Infectious intestine diseases
2. Hereditary diseases
3. Bronchial asthma
4. Pneumonia
5. Accidents and violence



FUENTE: TAHAL ACTUALIZACION DEL PLAN MAESTRO DE ALCANTARILLADO SANITARIO PARA LA CIUDAD DE TEGUCIGALPA S - A - N - A , enero 1992



## (2) Transportation and Public Facilities

The number of cars registered in Tegucigalpa M.D.C. is more than 60,000 and the number of vehicles used for public transportation is:

	<u>Number</u>
Large bus	700
Mini bus	400
Pick-up Truck	100
Taxi	<u>3,000</u>
Total	4,200

However, 40% of the above is out of service and only the remaining 60% is in service, creating serious crowding of passengers inside vehicle.

The numbers of public facilities closely related to daily life are shown below:

	<u>Number</u>
Kindergartens	313
Primary Schools	231
Secondary Schools	120
Churches	91
Public Hospitals	5 with about 2,000 beds

Presently, there is a shortage of school buildings and about half of them conduct two shifts of daytime and evening classes.

The number of churches is obtained from the topographical map of Tegucigalpa, 1 to 10,000 scale. There are many private clinics in M.D.C. of which the number is not known. In all of Honduras, the number of doctors and nurses is only 3 to 4 per 10,000 inhabitants, and an infant can go to doctor only 4 times per year. Locations of public facilities are shown in Fig 3.4.2

## (3) Hazards

Since old Tegucigalpa started its development in a narrow valley surrounded by hills, many of the residential areas, especially of poor people, have no choice but to be located on the steep slopes or low lands along rivers in the process of expansion. Such houses which are not founded on firm rock are always subject to the threat of landslides in times of heavy rain. Also threatened are lowland houses which can be immersed in water or washed away by flood in rainy season.

The following is a summary of type of hazard, total area affected and number of threatened residents.

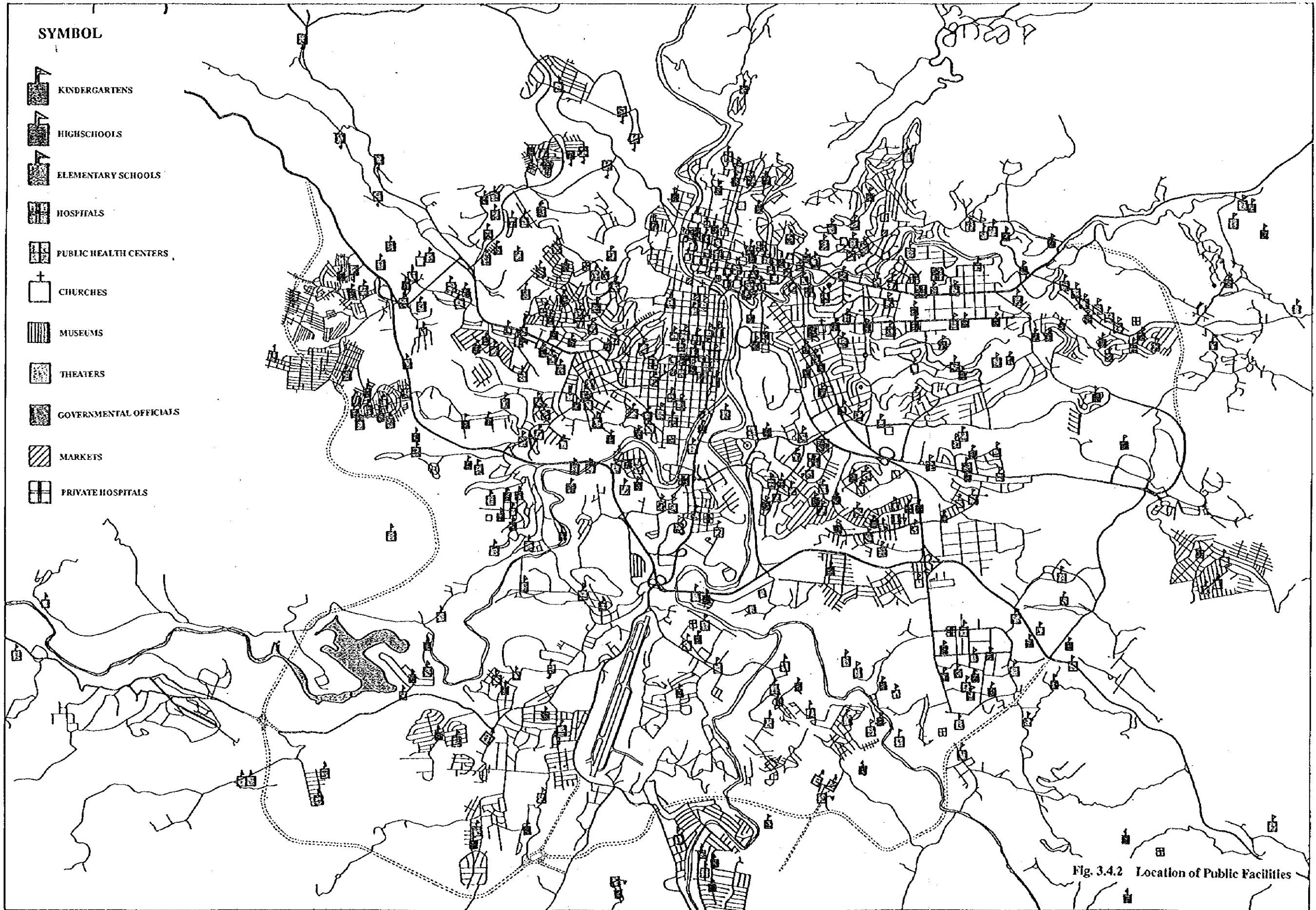


Fig. 3.4.2 Location of Public Facilities





<u>Type of Hazard</u>	<u>Area (Km2)</u>	<u>Number of Affected Residents</u>
Landslide	3.5	74,000
Flood	0.2	12,000
Landslide & Flood	0.3	29,000
<b>TOTAL</b>	<b>4.0</b>	<b>115,000</b>

Locations of these hazard areas are presented in Fig 3.4.3.

### 3.4.3 Pollution

#### (1) Air Pollution

According to the standard of World Health Organization, the air pollution of Tegucigalpa is already at "an alarming level" all over the city.

The old cities of Tegucigalpa and Comayagua are potentially vulnerable to air pollution because of the characteristics of their terrain, surrounded by many hills on four sides that prevent the smooth circulation of air. Narrow streets with closely spaced buildings worsen the situation of ventilation once the air on the street is contaminated.

Pollutant Control and Study Center (CESSCO, Centro de Estudios y Control de Contaminantes) performed air pollution survey at 9 locations in M.D.C. and the maximum values obtained between December 1994 to March 1995 are:

Location	TPS	Pb	NO2	
Guanacaste	320	0.7	38	inner city
Central Park	400	1.0	48	inner city
DIAPA	290	0.8	34	inner city
Bld. CEE	570	1.2	54	trunk line
Bld. Morazan	360	4.5	38	trunk line
I.H.S.S.	200	0.1	24	city outskirts
P.R. School	200	0.4	34	city outskirts
Hatillo	160	0.3	14	suburban
Col. Florencia	60	0.4	12	suburban
International Standard	240 mg/m <sup>3</sup>	0.7mg/m <sup>3</sup>	100mg/m <sup>3</sup>	

As shown, most inner city areas and points at trunk lines are contaminated with higher concentrations of total particles suspended (TPS), and lead (Pb), than standard, while they are within the range of acceptance at outskirts of the cities and suburban area.

Carbon monoxide (CO), was also measured and its concentration was found to be acceptable at both inside and outside cities

**COLONIAS DEL DISTRITO CENTRAL  
SEGUN RIESGO POR DERRUMBE,  
HUNDIMIENTO, DESLIZAMIENTO, INUND.**

1. B. EL CARAZAL
2. COL. EL LUJO DUARTE
3. COL. ABRAHAM LINCOLN
4. COL. SAN JUAN DIOS
5. COL. EL EDEN (de Tegucigalpa D.C.)
6. COL. CARAÑAS
7. COL. CERRO GRANDE ZONA 1
8. COL. LAS PAVAS
9. COL. VILLA UNION
10. COL. FLOR No. 1
11. COL. ZAPORTE NORTE Y CENTRO
12. COL. INDEPENDENCIA
13. COL. 3 de MAYO
14. COL. AYESTAS
15. COL. SAN MARTIN
16. B. EL PASTEL
17. COL. BELLA VISTA
18. COL. SOTO
19. COL. EL PORVENIR
20. B. EL CHIELE
21. COL. ARAMESTI
22. COL. GUANACASTE
23. B. MORAZAN
24. COL. DIVANHA
25. B. LA BOLSA
26. SECOP
27. EL SANAA
28. EL OBLISCO
29. COL. GUADALUPE
30. B. REPARTO ARRIBA
31. COL. 14 de OCTUBRE
32. COL. MODESTO RODAS ALVARDO
33. COL. VENEZUELA
34. COL. EL PROGRESO
35. COL. EL EDEN
36. COL. LAS BRISAS
37. COL. FALDAS DE SAN JOSE
38. COL. SUAZO CORDOZA
39. COL. JARDINES DEL TONCONTEN
40. COL. 14 de MARZO
41. COL. SAN JOSE DE LOS LLANOS
42. COL. MONTERREY
43. COL. NUEVA SUYAPA
44. COL. VILLA BELMI
45. COL. CAMPO CIELO
46. COL. LAS VEGAS
47. COL. EL SITO
48. ALDEA DE SAN JUNCITO
49. COL. BEFANIA
50. COL. PROVIDENCIA
51. COL. CANADA
52. COL. CANAAN
53. COL. AMATES
54. COL. SANTA ISABEL
55. COL. GUILLEN
56. FLOR DEL CAMPO

- COLONIAS DE ALTO RIESGOS**
18. COL. SOTO
  19. COL. EL PORVENIR
  20. COL. EL CHIELE
  21. COL. ARAMESTI
  56. COL. EL EDEN Y CARAÑAS
  15. COL. SAN MARTIN
  16. COL. EL PASTEL
  45. COL. CAMPO CIELO
  14. COL. LAS AYESTAS
  13. COL. 3 de MAYO
  11. COL. ZAPORTE CENTRO Y NORTE
  10. COL. FLOR No. 1
  31. COL. EL REPARTO
  55. COL. GUILLEN
  38. COL. SUAZO CORDOZA
  36. COL. LAS BRISAS
  35. COL. JARDINES DEL TONCONTEN
  34. COL. EL PROGRESO
  33. COL. VENEZUELA
  32. COL. EL EDEN Tegucigalpa
  32. COL. MODESTO RODAS ALVARDO
  56. COL. FLOR DEL CAMPO
  54. COL. SANTA ISABEL
  51. COL. LA CANADA
  42. COL. MONTERREY



Fig. 3.4.3 Location of Hazard Areas

The major sources of air pollution are considered as:

1. Emission gas from vehicle
2. Smoke from farm burning
3. Smoke from sawmills and timber factory
4. Domestic combustion smoke

Among the above, emission gas is the most critical source of air pollution. There is no governmental control of gas emission and especially no restriction for the use of leaded gasoline so far. However, at present the regulation of the emission gas is being considered and the importance of unleaded gas is recognized. Such gas is emitted in larger volumes at locations where traffic is congested and/or the roads are steeply sloped, a situation common in this city.

Concentrations of emission gas in terms of carbon monoxide (CO), and Hydro-carbon (HC), were measured from about 4,000 vehicles in Tegucigalpa in May of 1995. It reveals that vehicles emit gases with average concentrations of 4.0% of CO and 430 ppm of (HC), where international standard allows 4.3% and 800 ppm and the fumes remain for a longer period of time. Such conditions are due to poor ventilation resulting from the city's topography and close configuration of buildings.

## (2) Water Contamination

Drinking water is piped to M.D.C. from 5 resources where treatment plants purify the water in each location. However, due to poor maintenance of water delivery system, the quality of potable water has deteriorated by the time water arrives at each house.

Quality of water of Rio Choluteca inside M.D.C. is very poor due to uncontrolled dumping of both domestic and industrial liquid wastes into the river. The 1992 investigation revealed that the dissolved oxygen was too low for aquatic life to subsist in the river

## (3) Noise

In Tegucigalpa M.D.C. major sources of noise are airplane and vehicles. Airplane are restricted from landing and taking off between 6:00 in the evening to 6:00 in the morning.

The noise from vehicles is steadily increasing nowadays due to the increment of traffic volume along highways.

Indiscriminate use of horn by taxi also becomes a nuisance inside cities, in spite of municipal government regulations which prohibit it.

Power generators that are used at many stores in the cities and at high-income people's residential area make noise, causing degradation of the living environment.

**CHAPTER 4**  
**TRAFFIC SURVEY**



## CHAPTER 4 TRAFFIC SURVEY

### 4.1 Introduction

#### 4.1.1 Importance of the Traffic Survey

Recently, the traffic volume has been increasing rapidly, reflecting the high growth rate of the number of the registered vehicles in the study area, from which occur various traffic problems. In order to solve these problems, their cause can be identified, analyzed, and forecast, then the appropriate countermeasures should be applied. However, since the traffic problems are not simple, the countermeasures should be selected from not only the short-term but also the long-term point of view. For this purpose, the establishment of the comprehensive transportation plan is required. Therefore, in the initial stage of this Study, various traffic surveys are conducted with the purpose of obtaining the necessary information related to the transportation master plan. Among various traffic surveys, the most important survey is the person/trip survey. The reason is that to set up the comprehensive transportation plan, the future traffic demand should be projected with some accuracy. The future traffic demand can be grasped through the movement of persons behind the phenomena of the vehicle movement. That is, the movement of persons decides the movement of vehicles and not vice-versa. Since the future traffic demand is projected on the basis of the existing movement of persons, grasping the personal and trip characteristics is the starting point for solving the existing and/or anticipated traffic problems. Therefore, the person/trip survey holds an important position in this Study. Other than this person/trip survey, the various traffic surveys also were conducted in this Study. All these surveys not only complement the person/trip survey but also contribute to comprehension of the existing traffic situation. As a result, the traffic surveys implemented in this Study are the following:

1. Person/Trips
2. Screen Lines
3. Cordon Lines
4. Vehicle Velocities
5. Traffic Volumes at Intersections
6. Traffic Volumes on Major Roads
7. Parking on Streets
8. Parking in Lots
9. Bus Passengers
10. Bus Terminals
11. Bus Stops
12. Taxi Pools
13. Truck Terminal
14. Road Inventory

In order to evaluate the countermeasures for the transportation problems, especially, the transportation network and facilities from the long-term viewpoint, the four-step method is applied according to the transportation theory hereafter. The steps of the four step method are "Traffic generation and Traffic attraction", "Distribution", "Modal Split" and "Traffic Assignment". To these steps, some mathematical models are adopted. For the model building, the results of the above-mentioned various traffic surveys are used as shown in Fig. 4.1.1 in the four-step method.

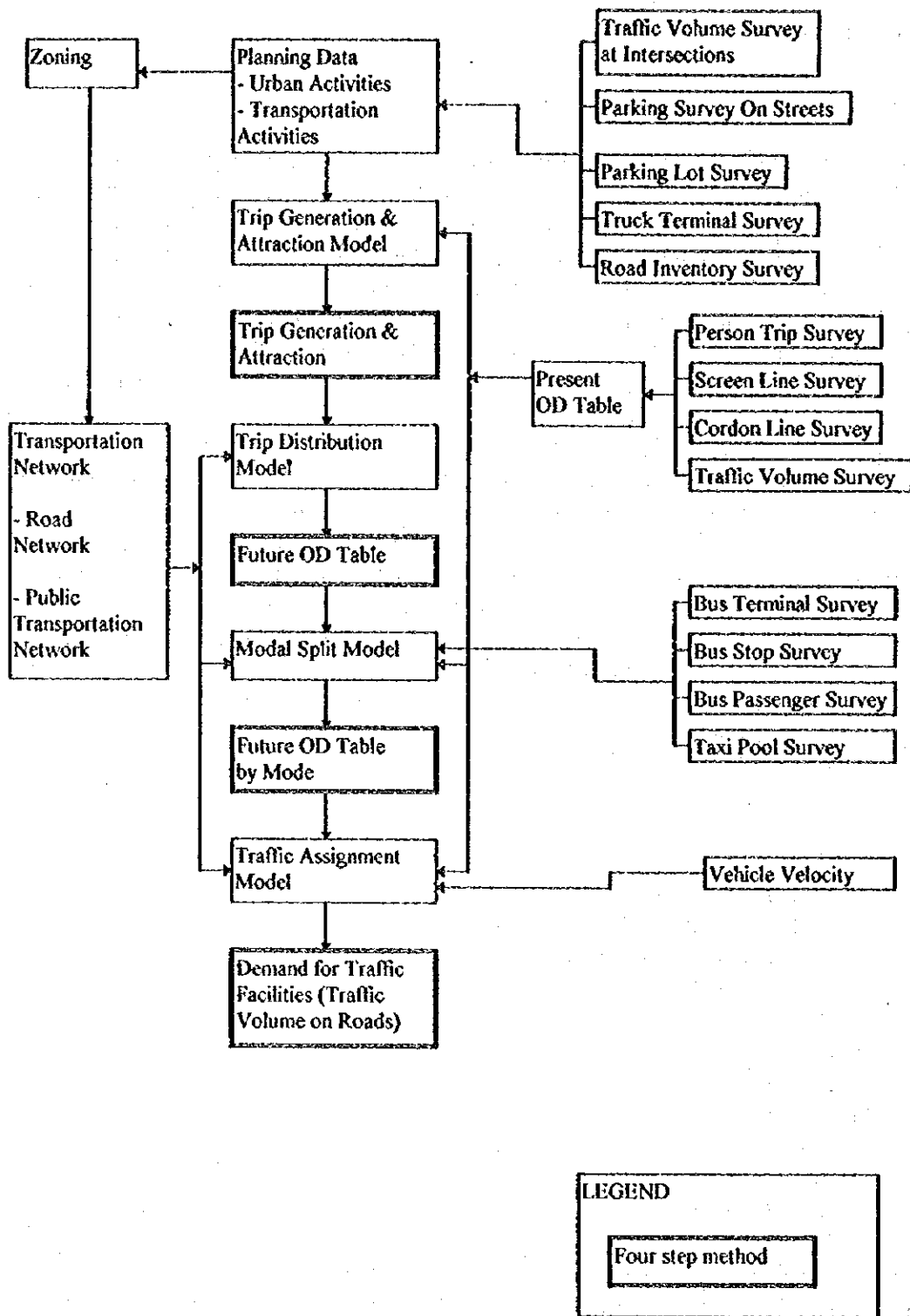


Fig. 4.1.1 Flow of Four Step Method

### 4.1.2 Zoning

Before starting the above traffic surveys, the Study area was divided into traffic zones. A traffic zone is used as a unit of analyzing and forecasting traffic demand. The zoning was performed by dividing sectors ( 29 sectors in the study area) into several smaller areas, considering not only the location of 524 colonias and barrios but also the areas expected to develop. As a result the study area was divided into 74 zones and the area outside was divided into 18 zones. The central area of Tegucigalpa and Comayagilela were divided into 3 zones and 4 zones, respectively. The zone map and the zone code table are shown in Appendix 4.

## 4.2 Person Trip Survey

### (1) Purpose of Survey

This survey was conducted to obtain the most basic information on the personal and trip characteristics necessary for the urban transportation plan, especially the daily movement of people. The traffic demand is a result of each person's desire to travel from place to place with a certain purpose, therefore, information such as the place of origin and destination, the purpose of the trip, means of transport, and facilities to be visited is obtained through this survey.

### (2) Sampling

The sample rate was determined by the following formula under 95% of confidence of coefficient and less than 20% of relative error.

$$RSD = K \times \sqrt{(ZK - 1) \times (1 - r)/r \times (1/N)}$$

where RSD: Relative Error

K : Confidence coefficient (1.96)

ZK : Number of category (40 zones x 40 categories)

r : Sampling Rate (5%, 6% and 7%)

N : Population parameter (700,000 x 3 trips =2,100,000)

Assuming that the target relative error is 20 percent at the maximum, a sample rate around 6.7% is sufficient to obtain reliable data. That is, the effective sample rate is 6% under the effective response rate of 90%. The results of calculations based on the three different rates are shown in Table 4.2.1.

Among these three cases, the relative errors of Case 1 and Case 2 exceed 20 percent if an effective response rate does not achieve 90%. On the other hand, the accuracy of Case 4 does not increase so much in spite of increasing the sample rate. Therefore, Case 3 with a sample rate of 6.7 percent (a survey rate of 6.0 percent) was adopted in this person/trip survey. As a result, the sampling was aimed at about 10,000 households as shown in Table 4.2.2.



**Table 4.2.1 Sampling Rate and Relative Error**

CASE	Sampling Rate (%)	Survey Rate (%)	Relative Error (%)
CASE 1	5.00	4.5	23.57
CASE 2	5.56	5.0	21.41
CASE 3	6.67	6.0	19.71
CASE 4	7.78	7.0	18.32

**Table 4.2.2 Number of Samples and Sampling Rate by Zone**

**Result of Sampling**

Zone	No. of Sample	Sample Rate by Hecotera	Zone	No. of Sample	Sample Rate by Hecotera	Zone	No. of Sample	Sample Rate by Hecotera	Zone	No. of Sample	Sample Rate by Hecotera
1	87	8.55	18	157	8.88	39	112	16.05	58	477	21.69
2	59	17.58	19	404	7.52	40	125	11.25	59	121	10.23
3	31	5.70	20	347	8.09	41	71	13.73	60	179	17.24
st	177	9.33	21	488	8.42	42	169	8.37	st	777	17.58
4	83	9.05	22	197	8.55	43	281	9.34	61	293	14.69
5	255	7.78	st	1593	7.85	st	758	9.49	62	50	9.90
6	88	12.10	23	145	9.32	44	201	16.04	st	343	13.72
st	408	8.53	st	145	9.32	st	201	16.04	63	49	20.33
7	128	11.57	24	118	7.75	45	51	21.79	64	171	11.48
8	148	8.70	25	98	7.23	st	51	21.79	st	220	12.72
st	274	8.34	28	71	22.98	48	82	11.05	65	123	11.88
9	98	12.73	27	82	7.28	47	488	14.07	68	210	9.53
10	41	7.72	st	385	8.57	st	550	13.52	67	122	10.17
11	40	8.24	28	83	17.85	48	59	36.20	st	455	10.25
st	177	9.19	29	91	18.08	49	75	43.60	68	439	21.25
12	20	5.87	30	21	13.48	50	38	21.23	st	439	21.25
13	111	8.31	31	29	9.88	st	172	33.46	69	0	0.00
st	131	8.24	32	20	7.87	51	212	17.48	st	0	0.00
14	139	11.08	st	224	14.60	52	367	10.96	70	0	0.00
15	103	5.98	33	10	12.20	53	28	55.32	st	0	0.00
16	51	8.91	34	45	13.20	st	805	13.13	71	18	14.08
17	82	5.92	35	99	13.79	54	328	14.31	st	18	14.08
st	355	7.45	st	154	13.50	55	38	7.78	72	183	9.95
ssl	1520	8.11	38	50	11.08	st	384	13.21	73	15	10.79
			37	113	8.77	56	458	6.48	74	173	7.45
			38	122	10.43	57	150	24.12	st	351	8.58
			st	285	8.88	st	808	7.91	SST	2803	13.43
			ssl	2788	8.48	ssl	3309	11.37	GT	10198	10.21

### (3) Sample List

Generally the interview in the person/trip survey is performed for all the members of 5 years old and over of selected households. Therefore, at first, the list to select the sample households should be determined. In Honduras the following four lists were examined for this survey. These lists include some problems as described below;

#### a) National Census 1988

All the file, data, floppy disk, etc. were disposed when the Director General was changed lest the personal records should leak out. Therefore, the sampling is impossible from this list.

#### b) Customer List of Empresa Nacional de Energia Electrica (ENEE)

This list includes not only households but also business offices, commercial stores and factories. If the interview is performed to the person in the selected households and offices, the same person has a possibility to be interviewed twice, for example, once in his house, another time in the office. In the sample survey it is desirable to avoid the overlapping as much as possible.

#### c) List of Service Nacional Acueductos y Alcantarillado (SANAA)

The coverage area differs from the above ENEE list, and the covered area is smaller. In addition, this list has the same problem as the list of ENEE.

#### d) Catastro (Departamento de Alcaldia Municipal)

Catastro has the data related to registration of land and house, however, this list does not cover all the houses in the study area since all of them are not always registered. It is sure that this list includes the latest information on the location of houses which were built in recent years.

As a result of the examination of the above four lists, The ENEE customer list was selected as the sampling list according to its wide coverage. The other data were used as supplemental lists.

### (4) Survey Items

In the person/trip survey much information was obtained through interviewing. Main items are as follows;

#### Information of household

- Address
- Number in family
- Gender and age
- Employment status
- Occupation
- The number of vehicles owned
- Annual income

### Trip information

- The number of trips
- Origin and destination
- Transportation means for above trips.
- Trip purpose

The questionnaire sheet used for the person trip survey is shown in Fig. 4.2.1.

### (5) Survey Procedures

Since much information must be obtained through the interview of the randomly selected persons, careful attention must be paid while conducting the survey. In this Study, this survey was implemented under the steps shown in Fig. 4.2.2. Among these steps the Study team not only spared time for the education and training of the surveyors but also conducted the pre-survey (the test survey) in order to have surveyors experienced the actual survey. The detailed survey procedures such as survey schedule, preparation of survey, survey organization, field survey, etc. are described in Appendix 4.

### 4.3 Supplemental Surveys

#### 4.3.1 Screen Line Survey

A screen line survey aims at obtaining data for verifying whether the contents of OD table made on the basis of the person trip survey reflect the reality or not. In this Study the person/trip survey area was divided into two by the Choluteca River, therefore, it is possible to compare the traffic volume passing through this line estimated on the basis of the person/trip survey with those actually counted on this line. A line such as the Choluteca River is generally called a screen line. Therefore, the screen line survey is to count the traffic volume passing over this line.

The section of the Choluteca River in the study area has 10 bridges. All of these bridges were set as survey stations. These survey stations and survey duration are described in Fig. 4.3.1.

#### 4.3.2. Cordon Line Survey

The object of this survey is to obtain information on origins and destinations of the traffic passing through the border of the study area. The amount of the traffic volume and characteristics of trips coming from the outside of the study area is used as supplemental data when the present OD table is formulated, based on the person trip survey. The person trip survey is conducted only for persons living inside the study area, therefore, the information on the movement and characteristics of trips made by these residents can be obtained. However, trips in the study area include ones made by persons living outside the area. These trips can not be obtained by the person/trip survey. In order to obtain the above information, the interview survey is conducted for drivers of vehicles flowing into the Study area. The boundary of the study area is called a cordon line and this survey is to count the traffic volume and interview the drivers about their trip characteristics at the boundary of the study area.



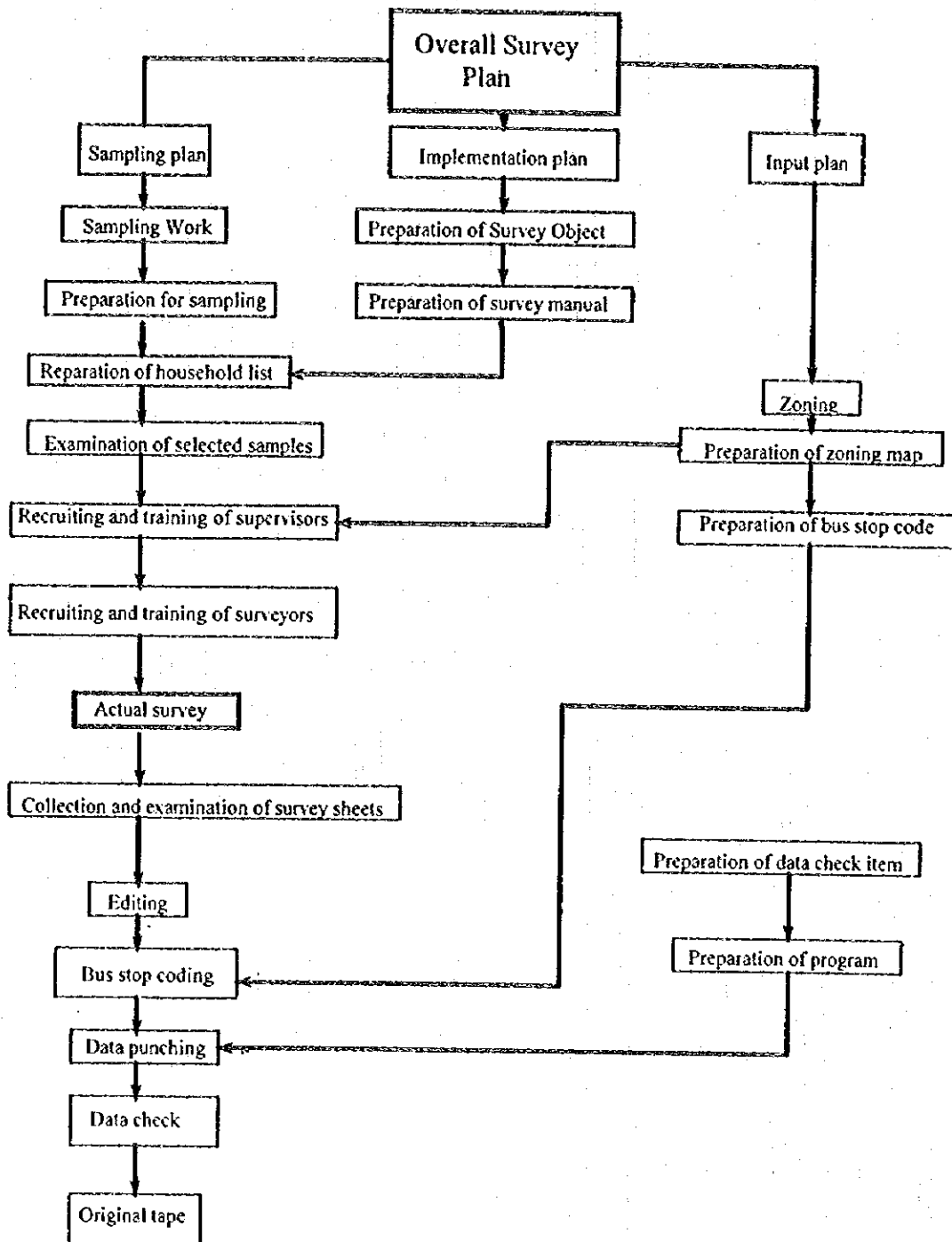


Fig. 4.2.2 Procedures of Person Trip Survey

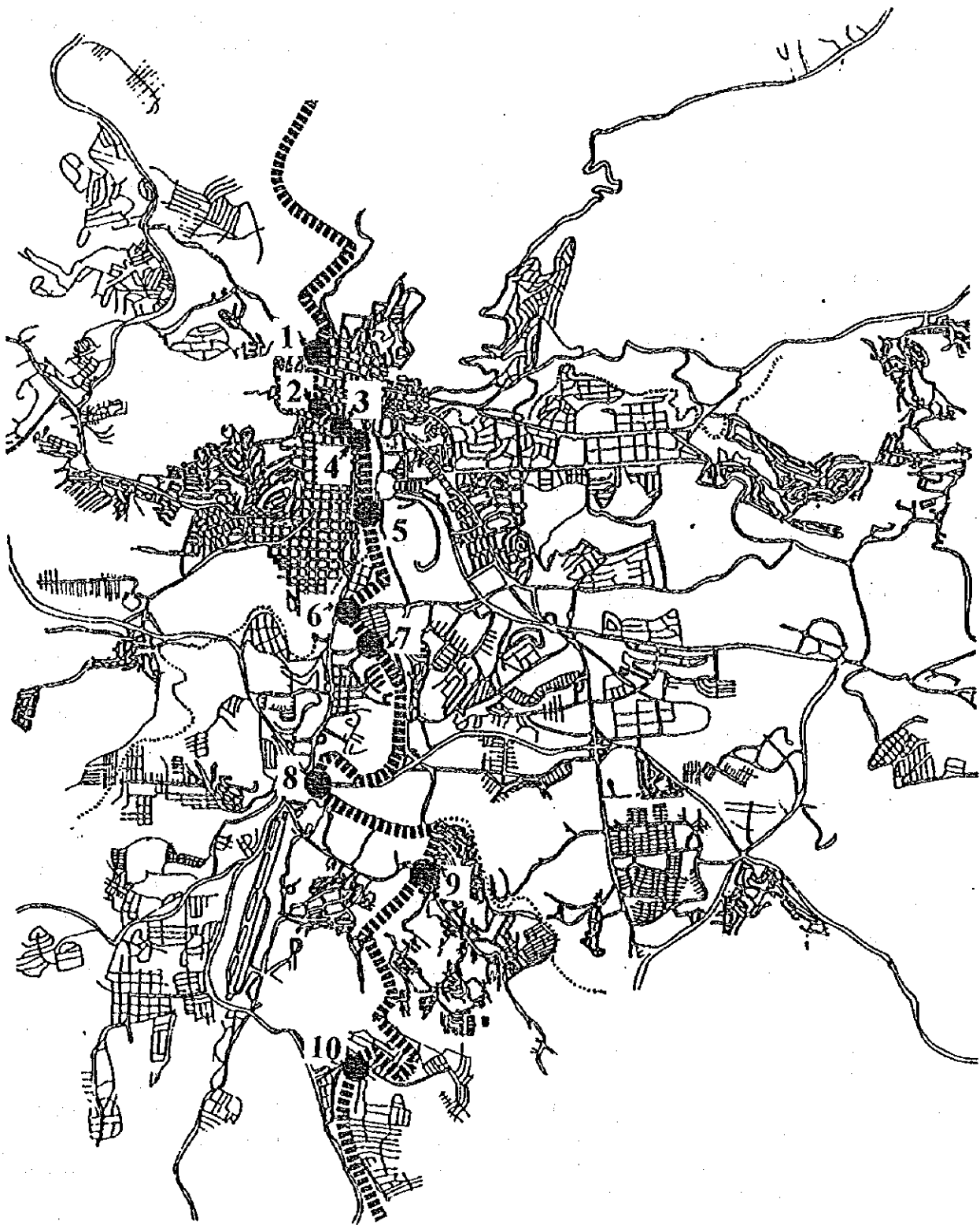


Fig. 4.3.1 Survey Points of Screen Line Survey